ARROW LNG PLANT

MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

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MARCH 2012

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Arrow CSG (Australia) Pty Ltd

Arrow LNG Plant

Matters of National Environmental Significance

Referral No. EPBC 2009/5007 - LNG plant and ancillary infrastructure

March 2012

CR 7033_7_v3

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1. INTRODUCTION

This report identifies potential impacts to matters of national environmental significance (MNES) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The report has been prepared, as required by the final terms of reference for the Arrow LNG Plant, to describe the environmental values of MNES and assess the potential impacts of the project on these matters.

The EPBC Act provides for the protection of the environment, especially MNES. Under the act, actions likely to have a significant impact on MNES trigger assessment under the EPBC Act. MNES include:

- World Heritage properties.
- National Heritage places.
- Wetlands of international importance.
- Listed threatened species and communities.
- Listed migratory species.
- Protection of the environment from nuclear actions.
- Commonwealth marine environment.
- Protection of the environment from actions involving Commonwealth land.
- Protection of the environment from Commonwealth actions.
- Commonwealth Heritage places outside the Australian Jurisdiction.

1.1 EPBC Referrals

In May 2009, the then project proponent, Shell CSG (Australia) Pty Ltd (now as Arrow CSG (Australia) Pty Ltd (Arrow Energy)) submitted an initial advice statement to the Coordinator-General of the State of Queensland (Coordinator-General) to request the Arrow LNG Plant be designated as a 'significant project' for which an EIS is required. On 12 June 2009, the Coordinator-General declared the project a 'significant project' under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act).

The Coordinator-General based their decision on:

- Details of the project provided in the initial advice statement.
- Relevant planning schemes or policies as specified by local, state or Commonwealth governments.
- The project's potential effects on the environment and on relevant infrastructure.
- The employment opportunities that will be provided by the project.
- Investment necessary for Arrow Energy to carry out the project.
- The local, region and state strategic significance of the project.

In July 2009, referrals were submitted to the Commonwealth Minister for the Department of Sustainability, Environment, Water, Population and Communities. The referrals were made to determine whether the project constituted a controlled action under s.75 of the EPBC Act. The referrals were for the LNG plant on Curtis Island (Referral No. EPBC 2009/5007), and the high pressure feed gas pipeline from Gladstone City Gate to Curtis Island (Referral No. EPBC 2009/5008).

On 21 August 2009, Department of Sustainability, Environment, Water, Population and Communities determined the project was a 'controlled action' for which assessment and approval is required under the EPBC Act. The assessment and approval of a 'controlled action' involves

the evaluation of the impacts the project may have on matters of national environmental significance. The matters of national environmental significance that are considered in the EIS include:

- World Heritage Properties (section 12 and 15A).
- National Heritage places (section 15B and 15C).
- Listed threatened species and communities (section 18 and 18A).
- Listed migratory species (section 20 and 20A).

Since these referrals were made, Arrow Energy has sought a variation to the scope of both referrals to clarify infrastructure associated with the establishment and operation of mainland facilities (Referral No. 2009/5007) and the nature of activities associated with installation of the feed gas pipeline (Referral No. 2009/5008).

In accordance with the Commonwealth Minister's decision, as well as the Coordinator-General declaring the project a 'significant project', the Arrow LNG Plant will be assessed under a bilateral agreement between the Queensland and Commonwealth governments. Under this agreement, the Commonwealth Government has accredited the Queensland SPDWO Act EIS process to meet the impact assessment requirements under Commonwealth legislation.

Pursuant to this agreement, the EIS will be coordinated by the Queensland Coordinator-General. Relevant Commonwealth, Queensland and local government authorities have been invited to participate in the EIS process as advisory agencies.

This report assesses potential impacts to MNES relevant to Referral No. EPBC 2009/5007, for the LNG facility on Curtis Island (which includes the LNG plant, marine infrastructure and associated dredging and marine facilities and potential temporary workers accommodation facilities on the mainland). This attachment has been developed as a standalone report, in accordance with the requirements of the Terms of Reference. It is based on the information and assessments contained in the technical specialist's reports that support the EIS and should be read in conjunction with the environmental impact assessment undertaken for the Arrow LNG Plant.

Table 1.1 identifies EIS chapters (and their supporting appendices) that are relevant to the assessment of impacts on MNES. Each EIS chapter is structured similarly, to provide a consistent discussion of the potential impacts for each of the environmental aspects, with information on the existing environment pertinent to the subject area, potential impacts from project activities and mitigation measures to reduce potential impacts to as low as reasonably practicable, based on the hierarchy of avoid, minimise, manage and offset.

This document and the EIS on which it is based provide the information required by the Australian Government to assess potential impacts on MNES and decide whether or not to approve the project.

Table 1.1 Guide to supporting information on the assessment of MNES

Referral No. EPBC 2009/5007	
MNES	**Chapter**
World Heritage Properties (Sections 12 and 15A)	• Chapter 13, Surface Water Hydrology and Water Quality (Appendix 5 Surface Water Impact Assessment, Appendix 6 Stormwater Quality Impact Assessment) • Chapter 16, Marine Water Quality and Sediment (Appendix 8 Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment) • Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment) • Chapter 21, Air Quality (Appendix 14 Air Quality Impact Assessment) • Chapter 22, Noise and Vibration (Appendix 16 Noise and Vibration Impact Assessment) • Chapter 23, Landscape and Visual (Appendix 17 Landscape and Visual Impact Assessment) • Chapter 24, Indigenous Cultural Heritage (Appendix 18 Indigenous Cultural Heritage Impact Assessment) • Chapter 25, Non-Indigenous Cultural Heritage (Appendix 19 Non-Indigenous Cultural Heritage Impact Assessment) • Chapter 32, Cumulative Impacts
National Heritage Place (Sections 15B and 15C)	• Chapter 13, Surface Water Hydrology and Water Quality (Appendix 5 Surface Water Impact Assessment, Appendix 6 Stormwater Quality Impact Assessment) • Chapter 16, Marine Water Quality and Sediment (Appendix 8 Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment) • Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment) • Chapter 21, Air Quality (Appendix 14 Air Quality Impact Assessment) • Chapter 22, Noise and Vibration (Appendix 16 Noise and Vibration Impact Assessment) • Chapter 23, Landscape and Visual (Appendix 17 Landscape and Visual Impact Assessment) • Chapter 24, Indigenous Cultural Heritage (Appendix 18 Indigenous Cultural Heritage Impact Assessment) • Chapter 25, Non-Indigenous Cultural Heritage (Appendix 19 Non-Indigenous Cultural Heritage Impact Assessment) • Chapter 32, Cumulative Impacts
Listed threatened species and communities (Sections 18 and 18A)	• Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment)
Listed migratory species (Sections 20 and 20A)	• Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine And Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment)

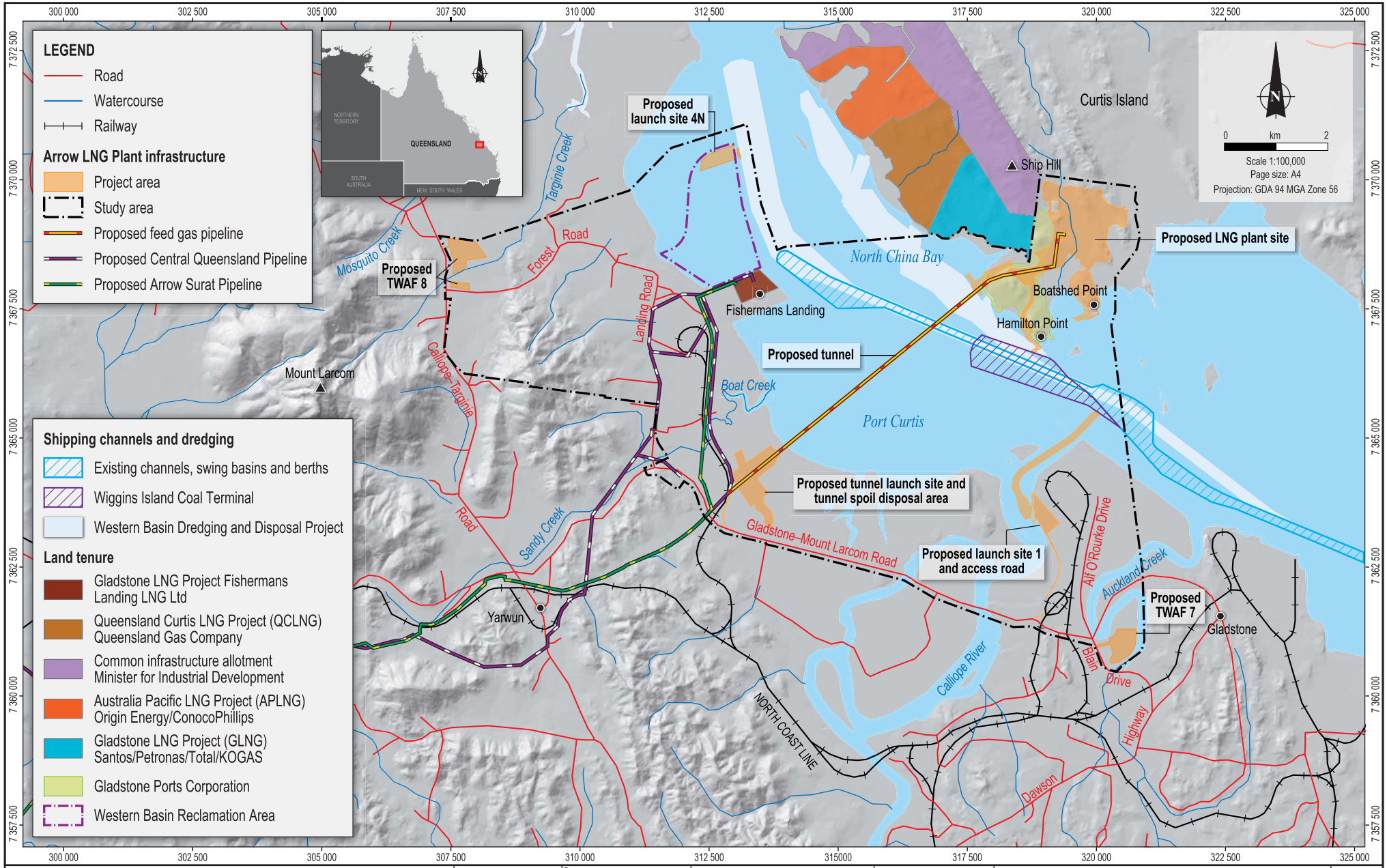
1.2 Project Overview

Arrow Energy proposes to develop a liquefied natural gas (LNG) plant on Curtis Island on the central Queensland coast, near Gladstone (Figure 1). The project, is known as the Arrow LNG Plant, and aims to meet growing export gas market opportunities.

The project comprises three components: the LNG plant and ancillary infrastructure, a feed gas pipeline, and dredging and disposal works. Major infrastructure required to develop the project will include LNG trains, LNG storage tanks, LNG jetty and loading lines (cryogenic pipelines), a seawater inlet for desalination and stormwater outlet pipelines, water and wastewater treatment, a 110 m high flare stack, power generators, administrative buildings and workshops.

The project site forms part of the 1,500 ha Curtis Island Industry Precinct of the Gladstone State Development Area in the southwestern part of Curtis Island gazetted for industrial development by the Queensland Government in July 2008. Arrow Energy has been granted an exclusive right by the Queensland Government to investigate this site for the development of the project. The site is adjacent to the 4,590 ha Curtis Island Environmental Management Precinct which was set aside to protect and enhance ecosystems of southern Curtis Island.

An environmental management plan (EMP) has been developed for the project (Attachment 6), and will be implemented at all stages of the project. Specific commitments in the EMP include measures to address potential impacts to MNES at the construction, operations and decommissioning phases. This will ensure that impacts are adequately managed based on the current environmental issues and risks.



Source:
Place names, roads, watercourses and railways from DME.
Proposed pipelines from Arrow Energy.
Proposed feed gas pipeline, project area, land tenure proponents and digital elevation model from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.

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Site locality

Figure No: 1

2. DESCRIPTION OF THE PROPOSED ACTION

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 in terms of its key infrastructure components: LNG plant and ancillary infrastructure, and dredging activities. The project description reflects the current design status of the project and will be further refined during the front-end engineering design (FEED) and detailed design stages, which may result in further changes to the project description and aspects of this MNES attachment.

Aspects relating to the feed gas pipeline (Referral No. EPBC 2009/5008) are assessed in a separate MNES impact assessment within this attachment.

2.1 Site Selection

The area of interest for the site selection study was defined as the Queensland coast between Brisbane and Townsville, and all land within 5 km of the coast. The northern and southern limits were considered the feasible distance an LNG plant could be located from the Surat and Bowen basins coal seam gas resources. The onshore distance defined the nominal limit for cost-effective operation of the cryogenic pipeline required to transport LNG from the plant to carriers. Proximity of the site to the Surat or Bowen basins was a consideration but not a material constraint.

The investigation was carried out in three phases: a screening exercise, followed by primary and secondary constraints analyses. The screening exercise identified areas that might offer potential LNG plant sites. The primary and secondary constraints analyses used available GIS data to identify sites of least constraint within the identified areas. During each phase, comparison of sites also necessitated semi-qualitative assessment to identify strategic environmental and social issues and constraints.

Four short-listed sites were identified and each had merits. Each site presented significant technical, environmental and/or commercial challenges that required further investigation to determine their feasibility. On the basis of the high level evaluation of potential sites, none of the short-listed sites were distinctly better than the Curtis Island site, which had a number of technical and commercial advantages for the development of a LNG plant, including:

- Stable geology and an elevation that ensured the proposed LNG plant could be constructed to avoid predicted sea level rises and storm surges.
- Access to shipping channels within a sheltered harbour, where the cost of dredging to deepen and widen the channels would be shared with other proponents.
- Although in the Great Barrier Reef World Heritage Area, the site is within the Port of Gladstone and remote from the Great Barrier Reef Marine Park. Dredging would not extend into the marine park.
- The limited dredging required to access the site would avoid or significantly reduce potential impacts on marine ecosystems and threatened species and their habitat, including dugong and turtles.
- The site is located in an industry precinct declared to facilitate the development of LNG plants.

- An exclusive right to investigate the site for development of a LNG plant overcomes potential issues with the acquisition of private freehold and/or perpetual leases of strategic port land.
- The site is remote from existing settlements at Southend and Gladstone although it is closer to residences on the Port Curtis islands.
- Existing and proposed pipelines (licences) overcome the need to identify gas pipeline routes and secure interests in the land.

2.2 LNG Plant and Ancillary Infrastructure

The following section provides a summary of the key elements of the LNG plant and ancillary infrastructure. The LNG plant and ancillary infrastructure comprises the following main components:

- The plant to process the gas into LNG (the LNG plant) with associated utilities and ancillary facilities on Curtis Island.
- A trestle jetty (the LNG jetty) with an LNG berth to facilitate loading and export of LNG on Curtis Island.
- A facilities corridor between the LNG plant and the LNG jetty on Curtis Island.
- A materials offloading facility (MOF) on Curtis Island to receive materials, equipment and construction machinery delivered by barge and an associated personnel jetty.
- A 2,500-person, temporary construction camp on Curtis Island and a potential mainland temporary workers accommodation facility for up to 1,000 people.
- A mainland launch site from which materials and personnel will be transported to Curtis Island.

The proposed layout of these facilities on Curtis Island is illustrated in Figure 2.

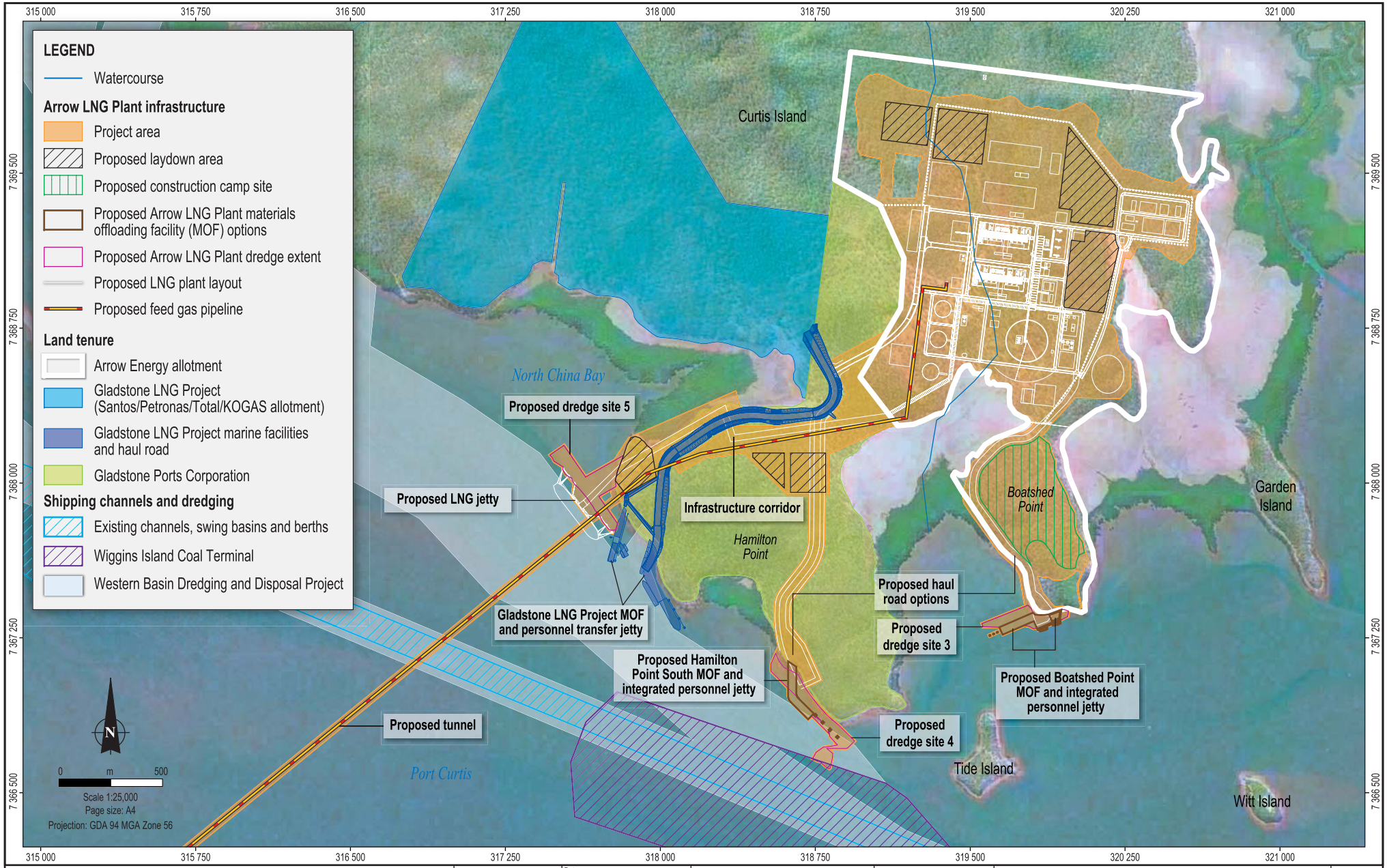
2.2.1 LNG Plant

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 to 4.5 Mtpa. Major infrastructure and components required to develop the project will include LNG trains, LNG storage tanks, LNG jetty and loading lines, a seawater inlet for desalination and stormwater outlet pipelines, water and wastewater treatment, a 110 m high flare stack, power generators, administrative buildings and workshops.

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. Four power supply options have been assessed during the EIS process.

- 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.



Source:
Place names and watercourses from DME.
Proposed LNG plant layout, ancillary facilities and marine infrastructure from Arrow Energy.
Proposed feed gas pipeline, project area and land tenure proponents from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.
Imagery from SPOT (2004-2007).

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LNG plant and ancillary facilities

Figure No: 2

- 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, pre-cooled, 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 -3°C and to compress and condense the mixed refrigerant, which is a mixture of nitrogen, methane, ethylene and propane. The condensed mixed refrigerant and pre-cooled 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 further from -33°C to approximately -57°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 LNG loading lines (cryogenic pipelines) and loading arms for transportation to export markets. The LNG will be re-gasified back into sales specification gas on shore at its destination location.

LNG Plant Utilities and Ancillary Facilities

The LNG plant utilities comprise various systems that store or produce inputs required by the plant as follows:

- Power generation and distribution systems.
- Water systems (fresh water, potable and service water, and demineralised water).
- Cooling water system.
- Heating system.
- Fuel gas system.
- Instrument and tool air system.
- Nitrogen system.

LNG plant ancillary facilities refer to equipment and facilities that support the LNG processing trains and the LNG plant utilities. The LNG plant ancillary facilities are:

- LNG storage, loading and boil-off gas system.
- Flare system.
- Wastewater treatment system.
- Fire-protection system.
- Diesel storage and distribution system.
- Refrigerant storage and makeup system.
- Waste management system.

LNG Shipping

Shipping activities associated with the construction phase of the project will include the following:

- Ferries and barges for the transport of the construction workforce and goods to the LNG plant site on Curtis Island.
- Cargo vessels for the transport of imported construction materials and/or prefabricated LNG plant components direct from overseas ports.
- Dredgers and support vessels to undertake dredging activities associated with shipping access to LNG jetty, materials offloading facility and passenger jetty and the mainland launch site.

Table 2.1 sets out the estimated type, number and frequency of marine vessels required for the construction of the first two LNG trains.

Table 2.1 Estimated type, number and frequency of marine vessels – peak construction

Type	Indicative Description	Indicative Frequency
Fast Cat Ferry	High-speed people movers with a capacity of up to 200-250 people; up to four fast passenger ferries will be required during construction.	38 trips per day[a]
RoPax ferry	Roll-on, roll-off ferry approximately 80 m long with a capacity of 200 people and 80 cars.	18 trips per day[a]
Barges	Typically 80 m long and 20 m wide with a capacity of 5,000-6,000 m^3. Require tugs to manoeuvre. Will be used to transport bulk materials.	60 to 70 trips per year
Heavy purpose cargo vessels[b]	Capable of transporting modules and major components (gas turbines, cryogenic heater exchanger, acid gas removal absorption column and refrigerant storage spheres) to the materials offloading facility on Curtis Island.	30 to 40 deliveries in total
Cutter suction dredging vessel	Size and specifications will not be determined until closer to construction.	To be confirmed[d]
Support vessel	Medium sized support vessel.	To be confirmed[d]

Table 2.1 Estimated type, number and frequency of marine vessels – peak construction (cont'd)

Type	Indicative Description	Indicative Frequency
Backhoe dredging barge	Size and specifications will not be determined until closer to construction.	To be confirmed[d]
Backhoe dredger support tugs	Standard tugs.	To be confirmed[d]

a. Indicative ferry movement assuming worst-case scenario for transferring personnel on a daily basis, based on a staggered shift arrangement.

b. Alternatively, ships might be roll-on roll-off vessels.

c. Barges and heavy purpose vessels may be engaged on an ad-hoc basis or chartered.

d. Frequency of dredge vessels (including tugs and support vessels) will be specified in the dredge management plan.

During operations, a variety of marine support vessels will be required to service LNG plant operations on Curtis Island. Table 2.2 sets out the estimated type, number and frequency of these vessels.

Table 2.2 Estimated type, number and frequency of marine vessels – operations

Type	Indicative Description	Frequency
Fast passenger ferry	High-speed people movers with a capacity of 200-250 people.	Up to 6 return trips per day.
RoPax ferry	Roll-on, roll-off ferry approximately 80 m long with a capacity of 200 people and 80 cars.	Up to 6 return trips per day.
LPG vessel	Unknown	1 return trip in the first year of operation.
Barge/cargo vessels	Unknown	Occasional deliveries of fuel, lubricants, equipment and plant required for maintenance activities direct to MOF.
LNG escort tug	70 to 80 t bollard pull tugs	960 per year (based on 240 LNG carriers per year).

The number of LNG carriers required to export LNG will vary depending on the type and size of the vessel which is still to be determined. Table 2.3 details the number of LNG carriers required for two and four LNG trains.

Table 2.3 LNG carrier movements

LNG Carrier Type and Nominal Capacity	Two LNG Trains		Four LNG Trains	
	LNG carriers per week	LNG carriers per year	LNG carriers per week	LNG carriers per year
Membrane design 145,000 m^3	2 to 3	120	4 to 5	240
Membrane design 215,000 m^3	1 to 2	88	3 to 4	176

The indicative route for LNG carriers travelling from Gladstone to Asia uses the recommended outer shipping channel within the Great Barrier Reef Marine Park. The coastal passage to the deep-water channel from Port Curtis can be executed in all weather and visibility.

The operation of LNG carriers within the Port of Gladstone are required to comply with industry recommendations as agreed by Maritime Safety Queensland and the requirements of the Port Procedure Manual. Detailed LNG protocols have been developed for LNG carrier movements in Port Curtis including requirements for pilots, tug support, vessel passing and separation

distances, minimum under keel clearances, and weather conditions. The protocols will be reviewed periodically. Operational performance and experience may lead to the refinement of rules or the introduction of further rules as required.

A safety exclusion zone of 250 m out from the centre of the LNG jetty will be in place around docked LNG carriers. Gas detectors on the LNG jetty compliment the safety exclusion zone.

2.2.2 Marine Facilities

Marine facilities will include the LNG jetty, materials offloading facility (MOF), personnel jetty and mainland launch site as follows:

- A MOF and personnel jetty at one of three locations. Boatshed Point and Hamilton Point South are two new sites (considered in the EIS) with an option at Santos's Gladstone LNG project Hamilton Point MOF for which Arrow Energy is investigating a sharing arrangement with Santos. This site has been assessed in the GLNG EIS. Arrow Energy's current preference is for a stand-alone facility at Boatshed Point.
- A mainland launch site at one of two locations; on the Western Basin Reclamation Area (launch site 4N) and a site at the mouth of the Calliope River (launch site 1).

LNG will be transferred from the storage tanks on the LNG plant site to the LNG jetty via above ground LNG loading lines. 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.

Delivery of materials to the site on Curtis Island during the construction and operations phases will be facilitated by the 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 routed along the western coastline, entering 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.

A personnel jetty will be constructed at the southern tip of Boatshed Point to transfer workers from the mainland launch site to Curtis Island by high-speed vehicle catamarans (Fastcats) and vehicle or passenger ferries. 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.

On the mainland, the launch site will contain a passenger terminal and a roll-on, roll-off facility. The passenger terminal will include a jetty and transit infrastructure, waiting areas and car parking. The barge or roll-on, roll-off facility will have a jetty, associated laydown areas, workshops and storage sheds.

2.2.3 Workers Accommodation

Temporary workers accommodation facilities (TWAFs) for up to 3,000 people will be constructed. The main accommodation facility will accommodate up to 2,500 workers and will be located on Curtis Island at Boatshed Point. Two options for TWAF locations are being considered on the mainland to provide accommodation for fly-in fly-out workers as an overflow camp once the construction camp has reached full capacity and/or for accommodation of workers associated with mainland based activities e.g., pipeline and tunnel construction. The two options for the mainland TWAFs include a pastoral property near Targinnie (TWAF 8) and the former Gladstone Power Station ash pond (TWAF 7).These sites are shown in Figure 1.

2.2.4 Construction Schedule

The plant will be constructed in two stages. Stage 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), the Curtis Island construction camp and, if additional capacity is required, a mainland TWAF. Marine infrastructure will also be required as part of Stage 1.

The site preparation at the LNG plant site in Stage 1 will be such that only limited site preparation will be required during future expansion for LNG trains 3 and 4. Stage 2 will involve the construction of LNG trains 3 and 4 and potentially a third LNG storage tank.

Construction of Stage 1 is scheduled to commence in 2014. First gas from train 1 is planned for the end of 2017, with LNG train 2 entering operation approximately 12 months later. Market conditions will determine the timing of Stage 2, with a similar offset expected between trains 3 and 4 going into operation.

2.2.5 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 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 or barges. A concrete batching plant will be established on the site. Bulk cement requirements will be delivered to the site by roll-on, roll-off ferries or barges from the mainland launch site.

2.3 Feed Gas Pipeline

An approximately 9 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. Aspects relating to the feed gas pipeline (Referral No. EPBC 2009/5008) are assessed in a separate MNES impact assessment within this attachment.

2.4 Dredging

Construction and operation of the Arrow LNG Plant will require dredging to provide (and maintain) shipping access to marine infrastructure sites on Curtis Island and the mainland. These sites are additional to the much larger dredging program required to improve shipping access within Port Curtis, particularly to facilitate access to the proposed LNG projects. This program is being coordinated by the Gladstone Ports Corporation and the environmental impacts of this dredging have been assessed through the Western Basin Dredging and Disposal Project EIS (GHD, 2009) and EIS Addendum (GHD, 2010).

The EIS assesses the additional dredging required for the construction and operation of the project that is not considered under the WBDD Project. Both capital and maintenance dredging will be required. Capital dredging involves the creation of new shipping channels or berths. Maintenance dredging is required to keep open navigable areas that become silted up over time.

Capital dredging to facilitate construction and operations will be required for the following marine facilities:

- Jetties at launch site 1 and launch site 4N on the mainland (two site options) including dredging in the Calliope River to provide access to launch site 1.
- The MOF and passenger jetty on Curtis Island (two options at Hamilton and Boatshed points).
- The LNG jetty on Curtis Island.

Maintenance dredging may be required for the following areas:

- The Calliope River, including the access channel and LNG jetty areas.
- The MOF and passenger jetty on Curtis Island (minimal dredging expected due to seabed levels and geometry).

Dredging locations are shown on Figure 1.

The dredging site locations (and options) are described below and are summarised in Table 2.4.

Table 2.4 Summary of dredging requirements for the Arrow LNG Plant

Site No.	Marine Infrastructure	Likely Dredging Method	Design Dredged Level (m LAT)	Estimated Maximum Dredge Volume (m^3)	Indicative Timing
1	Launch site 1 Calliope River	Cutter suction or backhoe	-4.5	900,000	Late 2014
2	Launch site 4N Fisherman's Landing (option)	Cutter suction or backhoe	-5	2,500	Late 2014
3	Boatshed Point MOF and passenger jetty	Backhoe	-2.5 to -8	50,000	Late 2014
4	Hamilton Point South MOF and passenger jetty (option)	Cutter suction or backhoe	-8	50,000	Late 2014
5	LNG jetty	Cutter suction or backhoe	-2.5	120,000	Late 2014

2.4.1 Mainland Launch Site

The mainland launch site will contain a passenger terminal and a jetty. Two options are being considered for the mainland launch site. Both sites require dredging and are described below:

- **Dredge site 1 - launch site 1.** Dredging will be required for the construction and operation of launch site 1 located north of Gladstone city near the mouth of the Calliope River, adjacent to the existing RG Tanna coal export terminal. The dredge site will extend from the intertidal area abutting launch site 1, past Mud Island to the main shipping channel, providing adequate under-keel depth for vessel docking and navigation. The access channel will be approximately 2.8 km long by 120 m wide and dredged to -4.5 m LAT.

  The maximum dredge volume estimated at this site is approximately 900,000 m^3.

  A cutter suction dredger is most likely to be used at this site. Excavated material will be pumped either via submerged temporary delivery lines (or booster stations) or via temporary overland delivery pipeline and transported to the Western Basin Reclamation Area. Dredging at launch site 1 is estimated to take between three and four weeks of effective dredging.

- **Dredge site 2 - launch site 4N (option).** Dredging will be required for the construction and operation of launch site 4N located at the northern extent of the Western Basin Reclamation Area. This dredge site would abut launch site 4N and extend east from the launch site to the shipping channel to provide adequate depth for vessel docking and navigation. The area will be dredged to a depth of -5 m LAT.

  The maximum dredge volume identified at this site is approximately 2,500 m^3. Dredge slopes at this site are assumed to be 1:3 m LAT.

  A backhoe dredger will most likely be used at this site. Excavated material will be transferred to shuttle barges and transported to the Western Basin Reclamation Area. Dredging at launch site 4N is estimated to be short in duration (e.g., less than one week of effective dredging).

2.4.2 MOF and Passenger Jetty

The two options being considered for the MOF and passenger jetty will require dredging and are described below:

- **Dredge site 3 - Boatshed Point MOF.** Dredging will be required for the construction and operation of the personnel jetty and MOF on the southern tip of Boatshed Point. Roll-on, roll-off and lift-on, lift-off facilities will be constructed adjacent to a personnel jetty to allow berthing by high-speed catamarans and vehicle or passenger ferries.

  The dredge area around these facilities will provide adequate depth for vessel docking and navigation. The area will be dredged to a depth of -8 m LAT to accommodate roll-on, roll-off and lift-on, lift-off vessels using the MOF, -5 m LAT for barges and passenger ferry berths, and -2.5 m LAT for high-speed catamarans and vehicle or passenger ferries using the personnel jetty berth.

  The estimated maximum dredge volume identified at this site is approximately 50,000 m^3.

  A backhoe dredger is most likely to be used at this site. Excavated material will be loaded onto barges and transported to the Western Basin Reclamation Area. Dredging at Boatshed Point is estimated to take between one and two weeks of effective dredging.

- **Dredge site 4 - Hamilton Point South MOF (option).** Dredging is required for the construction and operation of the MOF on the southern tip of Hamilton Point, Curtis Island. Roll-on, roll-off and lift-on, lift-off facilities will be constructed at the site.

  Dredging will provide adequate depth for docking and navigation at this location. The area between the MOF facilities and the shipping channel will be dredged to a depth of -2.5 m LAT to accommodate floating construction equipment, and to -8 m LAT in a smaller area to accommodate roll-on, roll-off and lift-on, lift-off vessels. The maximum dredge volume identified is approximately 50,000 m^3. Dredging required to maintain navigable depths associated with this location is addressed in the WBDD EIS.

A cutter suction dredger is likely to be used at this site. Excavated material will be loaded onto barges and transported to the Western Basin Reclamation Area. Dredging at Hamilton Point South is estimated to take between one and two weeks of effective dredging.

2.4.3 LNG Jetty

Additional dredging, beyond the scope under the WBDD Project, may be required for the construction of the LNG jetty on Curtis Island in North China Bay, adjacent to the northwest corner of Hamilton Point. Dredging will provide access to floating construction equipment required

to assemble the LNG jetty. Capital dredging of the berth pocket and swing basin is addressed in the WBDD EIS and is not discussed further.

The LNG jetty will be constructed from a barge. Dredging may be required to allow the barge to work in this area. This dredge site extends towards the coast, parallel to the landward edge of the berth pocket, and over an area toward the shoreline. The area will be dredged to a depth of -2.5 m LAT.

The maximum dredge volume identified at this site is approximately 120,000 m^3.

A backhoe dredger is most likely to be used at this site (although a small cutter suction dredger may be used if feasible). Excavated material from the backhoe dredger will be loaded onto barges and transported to the Western Basin Reclamation Area. Dredging of the LNG jetty area is estimated to take between two and three weeks of effective dredging.

2.4.4 Spoil Disposal

Arrow Energy's dredging and disposal requirements will, where possible, be integrated with dredging being undertaken as part of the WBDD project. The preferred option is to place dredged material in the Western Basin Reclamation Area. The dredged material will be treated as required under the conditions of this approval (including for acid sulfate soils if required). The impacts of the placement of dredged material into the reclamation area and the ongoing management of the site are covered in the WBDD EIS.

Dredge spoil disposal options will be discussed with the Gladstone Ports Corporation and relevant government agencies. Arrow Energy's preference is for disposal of spoil in existing and proposed disposal sites that have been approved.

3. ASSESSMENT METHOD

This section describes the method used in this assessment of impacts from the project on MNES.

3.1 EPBC Guidance

The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009) provides the framework for the assessment of potential impacts upon MNES from the Arrow LNG Plant.

What is a significant impact?

> "A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance."

When is a significant impact likely?

> "To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment."

The policy statement provides guidance on determining whether an action is likely to have a significant impact on a MNES. The following measures should be considered:

- Whether there are any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?
- Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), whether there is potential for impacts, including indirect impacts, on matters of national environmental significance?
- Whether there are any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?
- Whether any impacts of the proposed action on matters of national environmental significance are likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

This attachment assesses only whether an impact on a MNES is likely to be significant or not. Impacts upon relevant MNES are assessed within the EIS and the relevant technical studies, where a detailed assessment of the likely impacts of the project on the existing environment has

been undertaken. This assessment formed the basis of whether an impact on MNES was considered to be significant or not.

Significance assessment was adopted for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment. For example, an understanding of the sensitivity of ecosystems in their current state provides a sound basis for determining the severity of potential impacts. Potential impacts that arise through the management of materials and substances (e.g., waste) are more appropriately assessed using the principles of risk management. Compliance assessment was adopted for environmental aspects regulated by statutory guidelines, e.g., air quality, noise and vibration. Chapter 9 Impact Assessment Method provides a more detailed description of the methods used to undertake the impact assessment, including of MNES.

The magnitude and significance of the impacts has been quantified in the EIS. Priority in the development of mitigation measures was given to impacts with a high significance of impact.

3.2 Identifying and Assessing MNES

An EPBC Protected Matters search was undertaken in July 2009 to support the referrals for the project. The search identified 31 threatened species, 34 migratory species and 3 ecological communities to be potentially present in or within 5 km of the project area.

MNES identified in the EPBC Act referral submitted to the Australian Government in July 2009 were investigated and assessed in the EIS. Technical studies were commissioned to describe the existing environment, identify environmental values, assess potential and residual impacts and propose mitigation and management measures, and inspection and monitoring.

Technical studies relevant to the assessment of MNES include:

- Terrestrial Ecology Impact Assessment (Appendix 9 of EIS).
- Freshwater Ecology and Water Quality Impact Assessment (Appendix 11 of EIS).
- Marine and Estuarine Ecology Impact Assessment (Appendix 12 of EIS).
- Indigenous Cultural Heritage Impact Assessment Report (Appendix 18 of EIS).
- Non-Indigenous Heritage Report (Appendix 19 of EIS).

Further desktop searches and field surveys were undertaken by technical specialists to determine the presence of MNES in or adjacent to the project area. Details of the desktop searches and field survey methodology and survey effort are described in Chapter 17 Terrestrial Ecology (Section 17.2), Chapter 18 Freshwater Ecology (Section 18.2) and Chapter 19 Marine and Estuarine Ecology (Section 19.2), with further information provided in the relevant technical reports listed above.

Desktop searches included additional EPBC Protected Matters Searches as part of the terrestrial ecology impact assessment study and freshwater ecology impact assessment study to identify any new species listed since the original search in 2009, and to include the most up to date project area. Desktop research undertaken included searches of:

- DERM Wildlife Online database (Wildnet).
- DERM Biodiversity Planning Assessment GIS database.
- DERM WetlandInfo database.
- Queensland Herbarium HerbRECS database.
- Queensland Museum Collection database.
- Birds Australia Atlas GIS database.

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 and supplementary surveys in September 2010 and February 2011.

All flora 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). A floral inventory was compiled for the study area and relative abundance assessed within each stratum of the community. DERM mapped regional ecosystems were validated in the field and where required, the boundaries of vegetation types were mapped in the field using a hand-held GPS and/or aerial photograph interpretation.

Ancillary information such as areas of weed infestation, habitat areas for rare and threatened species and regional connectivity were also recorded and described.

The review of existing desktop information pertaining to fauna within the study area, allowed the prioritisation of habitat areas and locations for the field survey program, to enable broad habitat types within the study area to be sampled. The fauna survey methods were developed to undertake targeted surveys for species listed under the EPBC Act and *Nature Conservation Act 1992* (Qld) identified from the review of existing information as potentially occurring within the study area.

A faunal inventory was produced representing the vertebrate fauna assemblages present at selected survey sites and the study area as a whole. The habitat values of selected survey sites and the study area as a whole were assessed in relation to fauna presence and distribution.

Faunal survey effort included diurnal and nocturnal searches, call playback, ultrasonic microchiropteran call detection, trapping and gathering of inferential evidence such as fauna tracks, scats and scratches.

The likelihood of a species listed under the Protected Matters search being present within the study area was assessed within the technical studies, through field study and further literature review. The following criteria was used:

- Very Low - the study area is outside the species normal range, habitat does not exist.
- 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.
- 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.
- High - the species is known to occur in the local area and critical habitat exists in the study area.

- Recorded - the species was recorded in the study area as part of field surveys.

The Species Profile and Threats database (DSEWPaC, 2011b) includes a profile on listed species and communities. The profile includes information on the location of 'important populations' of species and communities. Reference to important populations in this attachment is as defined and described in the Species Profile and Threats Database (DSEWPaC, 2011b). Where not identified in the Species Profile and Threats Database (DSEWPaC, 2011b), the following definition of an important population was adopted.

Important populations are defined by evidence of colonies, breeding pairs/camps and multiple roosts i.e., congregations of the species, as this is the basis for information provided in the Species Profile and Threats database. Where possible, this information has been correlated with that observed by Ecosure in their surveys, and the observations from other ecological surveys and desktop analyses undertaken for the study area.

The profiles within the Species Profile and Threats database often include information on core habitat for species. The terms core and critical habitat are used interchangeably in the profiles. This report adopts the term used by DSEWPaC in the profile for the relevant species. Where not defined in DSEWPaC (2011b), the following definition for critical habitat has been adopted.

Critical habitat is defined as habitat containing colonies, breeding pairs/camps and multiple roosts, as well as an area around the species site. The actual area will be dependent on information provided by Ecosure and in literature on EPBC Act listed species, as it relates to the viability of the species. No critical habitat was identified by Ecosure or the other proponents in the study area.

4. LEGISLATIVE CONTEXT

The following sections describe the project specific Commonwealth policies and legislation to be enforced to protect the listed threatened and migratory species. Internationally protected areas are identified which occur within and in close proximity to project infrastructure and which may be affected by construction, operation and decommissioning of the project.

4.1 International Conventions

Matters of international significance including internationally protected areas must be considered during the construction, operation and decommissioning of the project. One convention is relevant to the project for MNES.

The Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention) (UNESCO, 1971) provides for the protection of cultural and natural heritage and aims to protect outstanding heritage around the world for current and future generations. Australia was one of the first signatories to the convention, in 1974.

The Great Barrier Reef supports a large diversity of fauna, flora and coral reef habitats and was proclaimed as a World Heritage Area in 1981. Port Curtis and the study area are both located within the Great Barrier Reef World Heritage Area (GBRWHA), which commences at the low water mark on the mainland side of The Narrows and includes Curtis Island. The offshore areas east of Curtis Island are included within the Mackay/Capricorn section of the Great Barrier Reef Coast Marine Park (GBR Coast MP) (GBRMPA, 1998). Protected species and communities as well as the ecological functioning of the world heritage area must be preserved during project construction, operation and decommissioning phases.

4.2 Commonwealth Legislation

The Commonwealth legislation that is relevant to the construction and operation phases of the project, in relation to the protection of threatened species and ecological values, includes:

- *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act establishes an Australian Government administered environmental assessment and approval system. This operates in addition to but separate from state and territory systems. The EPBC Act determines impacts upon matters of national environmental significance as the primary trigger for Australian Government involvement in environmental protection.

  In accordance with the requirements of the EPBC Act, the project was referred to the Department of Environment, Water, Heritage and the Arts (DEWHA) now known as the Department of Sustainability, Environment, Water, Population and Communities. Two EPBC referrals (EPBC 2009/5007 and EPBC 2009/5008) have been submitted to DEWHA by Arrow Energy. Both referrals proposed the project as a ‘controlled action’ as it is likely to impact MNES.

  Referral No. EPBC 2009/5007 (Liquefied Natural Gas Facility) concerns the clearance of vegetation including seagrass and mangrove areas which will potentially impact ecosystems and EPBC listed fauna and flora species within the investigation area, it will also involve potential dredging which will impact on water quality such as turbidity from increased sedimentation. This is likely to impact humpback whales, dugongs and turtle species (such as the flatback and loggerhead turtle breeding areas).

- *Great Barrier Reef Marine Park Act 1975*. The act is the predominant legislative measure to protect and conserve environmental values, biodiversity and heritage values within the Great Barrier Reef region. While the project is not located within the boundaries of the Great Barrier Reef Marine Park (GBRMP), it is close (within 2 km at the closest point).

  The indicative route for LNG carriers travelling from Gladstone to Asia uses the recommended outer shipping channel within the GBRMP. The coastal passage to the deep-water channel from Port Curtis can be executed in all weather and visibility.

- *Great Barrier Reef Marine Park Regulations 1983*. The regulations made under the Great Barrier Reef Marine Park Act declare Port Curtis and its adjacent waters as part of the Port of Gladstone-Rodds Bay Zone B dugong protection area. The dugong protection areas under the regulations and the Great Barrier Reef Marine Park Zoning Plan 2003 extend from the Narrows to the coastline of Curtis Island and through to Rodds Peninsula.

- Draft Policy Statement 2007: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999. This draft policy outlines the Commonwealth Government's position on provisions in the EPBC Act for environmental offsets. This policy will be used when offset strategies are formulated.

- Recovery Plan for Marine Turtles in Australia 2003. The objective of this plan is to "to reduce detrimental impacts on Australian populations of marine turtles and hence promote their recovery in the wild". This plan will be considered when mitigation methods are developed to reduce project impacts on marine turtles.

5. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

This section describes the potentially impacted MNES for the Arrow LNG Plant:

- World Heritage properties.
- National Heritage places.
- Listed threatened species and communities.
- Listed migratory species.

The EPBC Protected Matters search undertaken in July 2009 to support the referrals for the project identified 31 threatened species, 34 migratory species and 3 ecological communities as being potentially present in or within 5 km of the project area (identified in this chapter as 'the investigation area'), as well as one World Heritage Property and one National Heritage Place. No Wetlands of International Importance (declared Ramsar wetlands) were identified within the investigation area.

Additional EPBC Protected Matters searches, desktop studies and field surveys undertaken for the project identified additional threatened flora and fauna species, migratory species and an ecological community not documented within the original EPBC Protected Matters search tool.

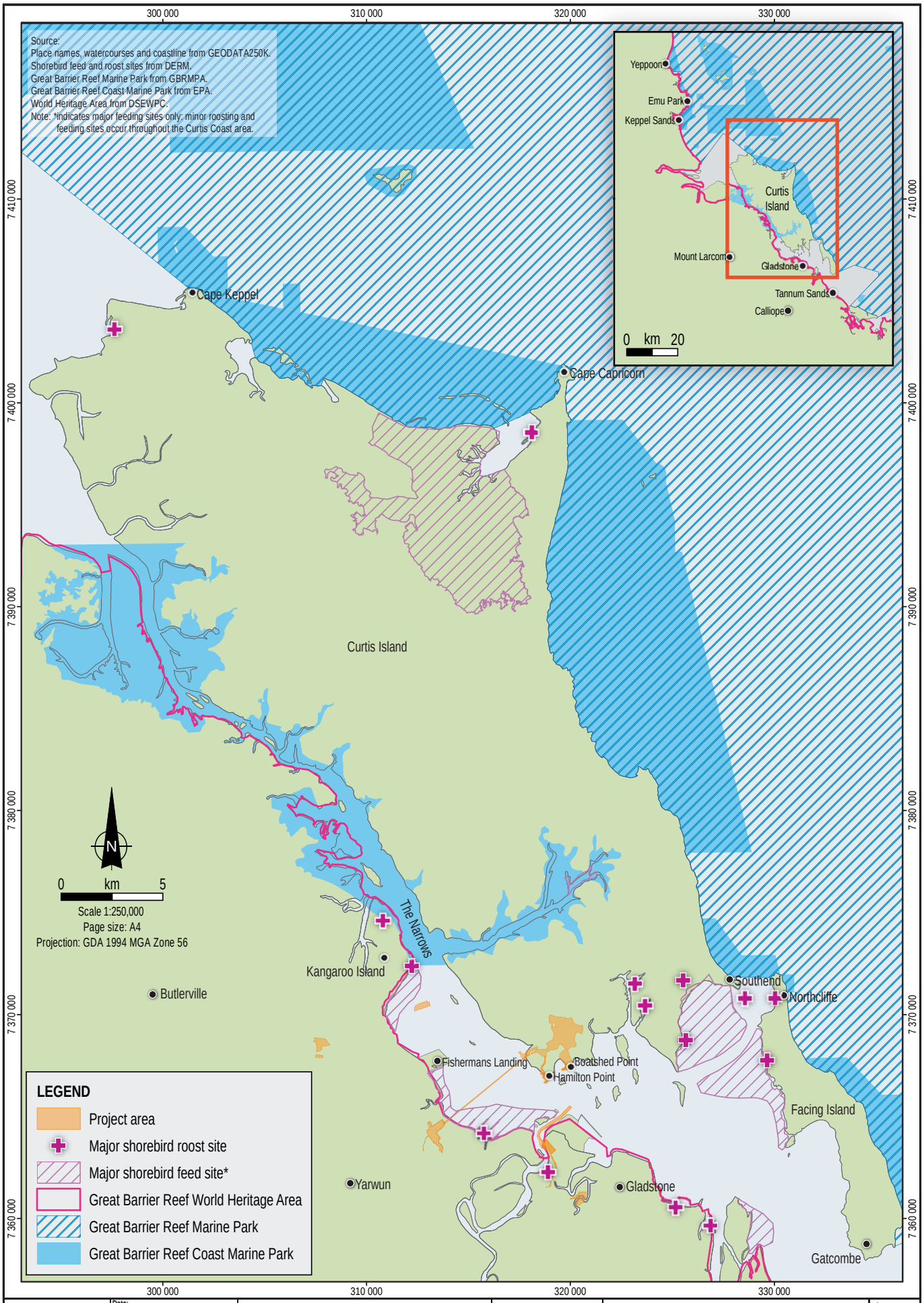
The additional species and community are included within the description of potentially impacted MNES detailed below, and within the assessment of project impacts upon MNES.

Other matters protected by the EPBC Act summarised within the Protected Matters searches, include Commonwealth Lands, Places on the Register of National Estate and additional listed marine species. These other matters are not defined as MNES, and as such are not included within this attachment. Impacts relating to these other matters are assessed within the EIS.

The project area is defined as the potential area of disturbance which encompasses the actual footprint of the project and a buffer required to accommodate construction and operations activities. The study area encompasses the project area and adjacent areas. The project area and nominal study area are shown in Figure 1. While technical studies focussed on the study area, the study area for each environmental aspect was informed by the environmental values and the spatial context required to identify and assess potential impacts. In some instances, desktop studies were carried out over an even wider area to provide an understanding of the relationship of local occurrences to the wider distribution of species and communities. Full details of the field survey and desktop study areas for each technical discipline are given in the technical studies listed in Table 1.1 of this report.

5.1 World Heritage Properties

The sole World Heritage property within the study area is the Great Barrier Reef World Heritage Area (GBRWHA), shown in Figure 3. The GBRWHA is both a World Heritage property and a National Heritage place. Natural Heritage places are discussed in Section 5.2.



coffey environments	Date: 09.01.2012 MXT: 7033CA_07_ATT4_GIS001_v1_1 File Name: 7033_07_ATT4_F003_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Great Barrier Reef World Heritage Area, marine parks and shorebird sites	Figure No: 3

5.1.1 Great Barrier Reef World Heritage Area

The GBRWHA was proclaimed as a World Heritage Area in 1981 and is renowned for its extensive coral reef framework and rich biodiversity. As a whole, the reef supports broad scale distribution of seagrass, mangrove, benthic and coral reef habitats.

The Great Barrier Reef is the world's largest World Heritage Area extending for 2,000 km and covering an area of 35 million hectares on the northeast continental shelf of Australia. The Great Barrier Reef's great biodiversity reflects the maturity of the ecosystem, which has evolved over hundreds of thousands of years. The reef is the world's most extensive coral reef system and is one of the world's richest areas in terms of faunal diversity. The GBRWHA also includes extensive areas of seagrass, mangrove, sandy and muddy seabed communities and island communities.

The GBRWHA commences at the low water mark of the mainland side of The Narrows, and encompasses Curtis Island. The GBRWHA is an MNES on the basis of providing habitat for listed threatened species and communities, and migratory birds. Figure 3 depicts the boundaries for the GBRWHA, the GBRMP and the GBRMCP in relation to the Arrow LNG Plant project area.

The Australian Government and Queensland Government have a cooperative and integrated approach to management of the GBRWHA. The Great Barrier Reef Marine Park Authority (GBRMPA) is the Australian Government agency responsible for overall management, and the Queensland Government, particularly the Queensland Parks and Wildlife Service, provides day-to-day management of the area for the Authority.

The World Heritage criteria against which the Great Barrier Reef was listed are as follows:

- To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance (Criterion vii).
- To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features (Criterion viii).
- To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals (Criterion ix).
- To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation (Criterion x).

The World Heritage values of the Great Barrier Reef, as set out by the Australian Government (DSEWPaC, 2011a) are restated below. Some values have been summarised.

Criterion vii – an outstanding example of superlative natural phenomena

The Great Barrier Reef provides some of the most spectacular scenery on earth and is of exceptional natural beauty. The World Heritage values include:

- The vast extent of the reef and island systems which produce an unparalleled aerial vista.
- Islands ranging from towering forested continental islands complete with freshwater streams, to small coral cays with rainforest and un-vegetated sand cays.
- Coastal and adjacent islands with mangrove systems of exceptional beauty.

- The rich variety of landscapes and seascapes including rugged mountains with dense and diverse vegetation and adjacent fringing reefs.
- The abundance and diversity of shape, size and colour of marine fauna and flora in the coral reefs.
- Spectacular breeding colonies of seabirds and great aggregations of over-wintering butterflies.
- Migrating whales, dolphins, dugong, whale sharks, sea turtles, seabirds and concentrations of large fish.

Criterion viii – an outstanding example of major stages of earth's evolutionary history

The Great Barrier Reef is by far the largest single collection of coral reefs in the world. The World Heritage values of the property include:

- 2,904 coral reefs covering approximately 20,055 km^2.
- 300 coral cays and 600 continental islands.
- Reef morphologies reflecting historical and on-going geomorphic and oceanographic processes.
- Processes of geological evolution linking islands, cays, reefs and changing sea levels, together with sand barriers, deltaic and associated sand dunes.
- Record of sea level changes and the complete history of the reef's evolution are recorded in the reef structure.
- Record of climate history, environmental conditions and processes extending back over several hundred years within old massive corals.
- Formations such as serpentine rocks of South Percy island, intact and active dune systems, undisturbed tidal sediments and "blue holes".
- Record of sea level changes reflected in distribution of continental island flora and fauna.

Criterion ix – an outstanding example of ongoing ecological and biological processes

Biologically the Great Barrier Reef supports the most diverse ecosystem known to man and its enormous diversity is thought to reflect the maturity of an ecosystem which has evolved over millions of years on the northeast continental shelf of Australia. The World Heritage values include:

- The heterogeneity and interconnectivity of the reef assemblage.
- Size and morphological diversity (elevation ranging from the sea bed to 1,142 m at Mt. Bowen and a large cross-shelf extent encompass the fullest possible representation of marine environmental processes).
- Ongoing processes of accretion and erosion of coral reefs, sand banks and coral cays, erosion and deposition processes along the coastline, river deltas and estuaries and continental islands.
- Extensive *Halimeda* beds representing active calcification and sediment accretion for over 10,000 years.

- Evidence of the dispersion and evolution of hard corals and associated flora and fauna from the "Indo-West Pacific centre of diversity" along the north-south extent of the reef.
- Inter-connections with the Wet Tropics via the coastal interface and Lord Howe Island via the East Australia current.
- Indigenous temperate species derived from tropical species.
- Living coral colonies (including some of the world's oldest).
- Inshore coral communities of southern reefs.
- Five floristic regions identified for continental islands and two for coral cays.
- The diversity of flora and fauna, including:
  - Macroalgae (estimated 400 to 500 species).
  - Porifera (estimated 1,500 species, some endemic, mostly undescribed).
  - Cnidaria: Corals - part of the global centre of coral diversity and including hexacorals (70 genera and 350 species, including 10 endemic species) and octocorals (80 genera, number of species not yet estimated).
  - Tunicata: Ascidians (at least 330 species).
  - Bryozoa (an estimated 300 to 500 species, many undescribed).
  - Crustacea (at least 1,330 species from three subclasses).
  - Worms including Polychaetes (estimated 500 species) and Platyhelminthes (include free-living Tubelleria (number of species not yet estimated), polyclad Tubelleria (up to 300 species) and parasitic helminthes (thousands of estimated of species, most undescribed)).
  - Phytoplankton (a diverse group existing in two broad communities).
  - Mollusca (between 5,000 and 8,000 species).
  - Echinodermata (estimated 800 extant species, including many rare taxa and type specimens).
  - Fishes (between 1,200 and 2,000 species from 130 families, with high species diversity and heterogeneity; includes the whale shark (*Rhynchodon typus*)).
  - Seabirds (between 1.4 and 1.7 million seabirds breeding on islands).
  - Marine reptiles (including six sea turtle species, 17 sea snake species, and one species of crocodile).
  - Marine mammals (including one species of dugong (*Dugong dugon*), and 26 species of whales and dolphins).
  - Terrestrial fauna, including invertebrates (pseudoscorpions, mites, ticks, spiders, centipedes, isopods, phalangids, millipedes, collembolans and 109 families of insects from 20 orders, and large over-wintering aggregations of butterflies) and vertebrates (including seabirds, reptiles: crocodiles and turtles, nine snakes and 31 lizards, mammals).

- The integrity of the inter-connections between reef and island networks in terms of dispersion, recruitment, and the subsequent gene flow of many taxa.
- Processes of dispersal, colonisation and establishment of plant communities within the context of island biogeography (e.g., dispersal of seeds by air, sea and vectors such as birds are examples of dispersion, colonisation and succession).
- The isolation of certain island populations (e.g., recent speciation evident in two subspecies of the butterfly (*Tirumala hamata*) and the evolution of distinct races of the bird *Zosterops* spp).
- Remnant vegetation types (hoop pines) and relic species (sponges) on islands.
- Evidence of morphological and genetic changes in mangrove and seagrass flora across regional scales.
- Feeding and or breeding grounds for international migratory seabirds, cetaceans and sea turtles.

Criterion x - important habitats for conservation of biological diversity

The Great Barrier Reef contains many outstanding examples of important and significant natural habitats for in situ conservation of species of conservation significance, particularly resulting from the latitudinal and cross-shelf completeness of the region. The World Heritage values include:

- Habitats for species of conservation significance within the 77 broadscale bioregional associations that have been identified for the property and which include:
  - Over 2,900 coral reefs (covering 20,055 km^2) which are structurally and ecologically complex.
  - Large numbers of islands, including 600 continental islands supporting 2,195 plant species in 5 distinct floristic regions; 300 coral cays and sand cays; seabird and sea turtle rookeries, including breeding populations of green sea turtles and hawksbill turtles; coral cays with 300 to 350 plant species in two distinct floristic regions.
  - Seagrass beds (over 5,000 km^2) comprising 15 species, two endemic.
  - Mangroves (over 2,070 km^2) including 37 species.
  - *Halimeda* banks in the northern region and the unique deep water bed in the central region.
  - Large areas of ecologically complex inter-reefal and lagoonal benthos.
- Species of plants and animals of conservation significance.

Potential impacts to the GBRWHA will be discussed in Section 6.1 along with the management, mitigation and monitoring measures proposed to address these impacts.

5.1.2 World Heritage Values of Port Curtis and Curtis Island

Port Curtis and Curtis Island are both located within the GBRWHA, which extends from the low water mark of the mainland.

Important features of world heritage value for Port Curtis and Curtis Island are described below. Potential impacts to the GBRWHA within Port Curtis will be discussed in Section 6.1 along with management, mitigation and monitoring measures.

Landscape of Port Curtis

Port Curtis is a shallow coastal basin, situated directly offshore from the city of Gladstone. Port Curtis is separated from the Coral Sea by Facing and Curtis islands, which protect the port from ocean swells.

Connections to the Coral Sea exist via South Channel to the south of Facing Island, North Channel between Facing and Curtis islands, and The Narrows, which extends some 40 km to the northwest and separates Curtis Island from the mainland.

The Calliope River flows into Port Curtis and is one of the few remaining waterways in Queensland where major water-retaining infrastructure does not interrupt environmental flows to the coast. Boyne River, Auckland and South Trees inlets also discharge into Port Curtis and to the south, the connected waterways of Colosseum Inlet, Seven Mile Creek and Rodds Harbour. Northward, Grahams Creek and a number of smaller tributaries discharge to The Narrows.

The Curtis Coast Regional Coastal Management Plan (CCRCMP) is the key document designating coastal landscapes and features of scenic value within the study area. It sets out desired environmental outcomes and measures to protect the designated Scenic Coastal Landscapes of state significance which are:

> "areas of outstanding and distinctive scenic quality and are high priority areas for scenic landscape management within Queensland".

The CCRCMP identifies the following elements of the Curtis Coast landscape as contributing to the scenic coastal landscape values of the region (areas of state significance):

> "…islands and offshore features (including large and small coastal islands); coastal wetlands; coastal headlands; estuaries and inlets; riverine corridors and creeks; shorelines; sand dunes; coastal mountain ranges; and coral cays and reefs".

The State Coastal Management Plan includes a policy on Coastal Landscapes. Policy 2.7.1 of the CCRCMP provides the regional direction for implementing the Coastal Landscapes policy in the Curtis Coast Region. It sets out two relevant coastal management principles:

> "7A The values of coastal landscapes are conserved and recognised for their importance to the quality of life of both residents and visitors, as well as to the economic development and growth of Queensland."
>
> "7B The dominance of the natural character of the coast (excluding developed urban areas) is retained, including elements of landscape and vegetation."

The regional context discussion within policy 2.7.1 recognises the importance of landscape values in the Curtis Coast Region. It states:

> "Incompatible development within these areas can adversely impact on their scenic landscape values, particularly in relation to the coastal islands, Mt Larcom and the coastal ranges and remote natural areas such as The Narrows."

It goes on to further state that:

> "The Gladstone Region is identified to be of 'High Scenic Management Priority' with Curtis Island and the Capricorn Group being of Level 1 Scenic Quality."

The Areas of State Significance (Scenic Coastal Landscapes) described in Policy 2.7.1 relevant to the Arrow LNG Plant are detailed in Table 5.1.

Infrastructure associated with the project falls within designated scenic coastal landscapes, and the EIS study area straddles a number of Key Coastal Sites (KCS) specified in the policy. The LNG plant is located in KCS 1 (Curtis Island). Launch Site 1 is located in KCS 7 (Calliope River/Flying Fox Creek). TWAF 8 lies within and adjacent to KCS 5: Targinie Remnant Vegetation. TWAF 7 lies within 'Gladstone City' and is not considered to be a KCS.

Habitat within Port Curtis

Extensive intertidal flats appear at low tide and large intertidal mangrove and saltpan areas are inundated during high tides. Water depths have been modified by the development of shipping channels, land reclamation and coastal armouring.

Port Curtis, as part of the GBRWHA, provides suitable areas of habitat for populations of rare and endangered EPBC Act listed species. Additionally, this area is an interface between a growing industrial zone and an area of unique and natural beauty, thereby providing significant emphasis on environmental management and mitigation measures related to developments in this area.

Table 5.1 Areas of State Significance (Scenic Coastal Landscapes) relevant to Arrow LNG Plant

Landscape	Sites	Description	Desired Coastal Outcomes	Measures
Islands and offshore features	Curtis Island	Large identifiable coastal islands close to shore and visually prominent from the mainland and harbour. These islands provide a strong structural element to the landscape and define the seaward edge of the coastal viewshed. They provide a high degree of contrast and visual diversity between intertidal and upland areas.	The landscape values of the islands and their contribution to the landscape values of the Curtis Coast region are protected and maintained. Views from the mainland and viewpoints to the island are maintained and enhanced.	Ensure the development remains unobtrusive and compatible with landscape values. For example, buildings should not be higher than mature tree height and not on the shorelines or ridgelines or visible from viewpoints. Screen access points and other development from viewpoints.
Coastal wetlands	Port Curtis, The Narrows	Coastal wetlands in the Curtis Coast region comprise a range of mainly tidal wetlands such as mangroves, salt marsh and claypan, with some freshwater wetlands. Coastal wetlands contribute significantly to scenic quality in terms of vegetation, wildlife and naturalness. The landscape qualities of the tidal wetlands are generally appreciated from boats, access points such as boat ramps and elevated lookouts.	The landscape values and ecological integrity of coastal wetlands are maintained. The edges of mangrove vegetation in areas of high scenic quality are managed to maintain or restore their visual continuity. Degraded wetland areas are rehabilitated.	Minimise visual breaks in areas of continuous mangrove vegetation. Maintain existing vegetation along waterways to a maximum extent to form natural landscape edge and screen. Wetlands should be managed to maintain their natural ecological processes, retain their natural drainage and tidal patterns, control exotic plants and animals, prevent weed invasion and maintain buffer zones.
Estuaries and inlets	Port Curtis, The Narrows	The landscape qualities of estuaries and waterways are generally appreciated from boats and access points such as jetties and boat ramps, the shoreline and elevated lookouts. Estuarine and freshwater systems are dominant in the lower reaches by mangroves, claypans and salt marsh. Many areas have a high degree of naturalness and offer a “remote” experience.	The landscape values and ecological integrity of mangroves, inlets and waterways are maintained. The edges of mangrove vegetation in areas of high scenic quality are managed to maintain or restore their visual continuity.	Minimise visual breaks in areas of continuous vegetation. Maintain existing vegetation along waterways to a maximum extent to form a natural landscape edge and screen. Ensure infrastructure in areas of high visual quality does not obscure views to water or intrude on waterways.

Table 5.1 Areas of State Significance (Scenic Coastal Landscapes) relevant to Arrow LNG Plant (cont'd)

Landscape	Sites	Description	Desired Coastal Outcomes	Measures
Riverine corridors and creeks	Calliope River	The landscape qualities of riverine creeks and corridors are generally appreciated from boats, access points such as jetties, boat ramps and elevated lookouts. River and creek systems and riparian vegetation cross the coastal plain and provide a visual contrast in an otherwise largely modified rural landscape. These areas often form the visual edge and link to local views.	The landscape values of remnant riverine vegetation and other natural features are protected. Views of riverine corridors from significant viewpoints are maintained. Fragmented corridors in significant landscapes are linked and rehabilitated.	Maintain creek corridors and riverine vegetation within developments and rural lands, forming a linear open space corridor. Rehabilitate degraded or fragmented corridor vegetation forming part of visual edges to form a continuous band of vegetation.
Shorelines	The coastline	The water's edge of beaches, bays, rivers, creeks and estuaries. Shorelines are highly valued areas that interface between land and water and are the focus of most coastal recreational activity. Scenic quality is most influenced by the character of water and shoreline forms.	The landscape values of shorelines are maintained. Views of shorelines from significant viewpoints are protected. The dominance of natural character and elements of landform and vegetation that frame or are visible from the shoreline or offshore are maintained.	Maintain a foreshore reserve or buffer along shorelines and other dunal areas with significant landscape values. Along shorelines with significant landscape value: • Ensure new development and extractive industries do not degrade the values of beaches and dunes. • Screen existing development and infrastructure. • Ensure building heights adjacent to shorelines are below the mature tree line.

Source: Curtis Coast Regional Coastal Management Plan (Queensland Government, 2003)

Although Port Curtis is not listed as a Ramsar wetland, it is a nationally important wetland under the Directory of Important Wetlands of Australia (Environment Australia, 2001) as it supports a versatile set of habitat types. An array of intertidal and coastal zones exists within Port Curtis and includes salt marshes, mudflats, mangroves and water bodies.

Areas in and around Port Curtis provide important habitats used by a range of species, including the EPBC listed dugong, the potentially endemic Australian snubfin dolphin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphin (*Sousa chinensis*), six of the world's seven species of protected marine turtles, sea snakes, the saltwater crocodile, fish species (including seahorses and pipefish), pelagic and benthic invertebrates and plankton. The project is not situated in any declared fish habitat areas (FHA). The closest FHAs to the study area are Colosseum Inlet situated 20 km south of Gladstone and the Fitzroy River located near the northern end of Curtis Island.

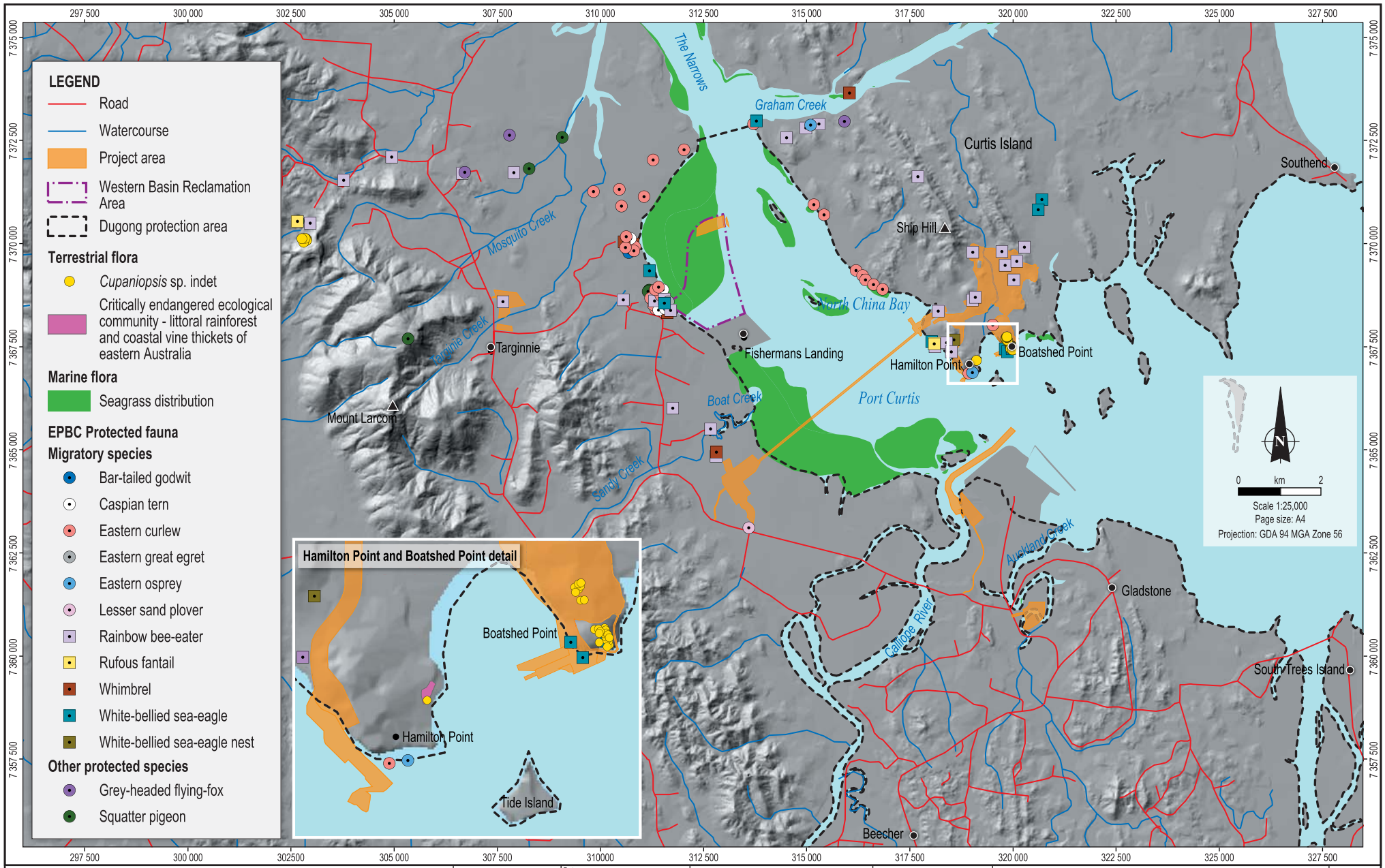
These habitat areas contribute to an ecosystem that sustains fisheries and supports the health of the environment and residing organisms. Physical habitat areas include:

- Intertidal mudflats – Intertidal mudflats support a high biodiversity of benthic species, they support fisheries productivity and provide a feeding ground for migratory birds. Soft mudflats composed of fine sediment are exposed during low tide for approximately 300 m at North China Bay, Kangaroo Island and Friend Point.
- Benthic zone - The benthic zone supports an array of small and microscopic organisms which form an important part of the food chain within the GBRWHA and Port Curtis, and assist in sediment and nutrient recycling.
- Reef and rock substrate - Reef and rock substrate habitat are not a major feature of Port Curtis, but contribute to the community assemblage and overall population and diversity within the GBRWHA and Port Curtis. Rubble reef areas and coral bommies cover approximately 15% of the study area substrate within Port Curtis, and support a broad range of organisms including bivalves, ascidians, bryozoans and hard corals. Rock substrate is widespread throughout Port Curtis and is typically composed of oyster-encrusted boulders and rubble in the coastal margins. The rock provides a solid substrate for attachment of organisms such as algal flora, barnacles, oysters and tubeworms. The precise distribution of rock substrate within the study area has not been mapped.

Flora within Port Curtis

Nationally important marine flora habitat communities listed under the Directory of Important Wetlands include:

- Seagrass beds - Seagrass areas occur within the GBRWHA and Port Curtis. Seagrass beds provide several important ecological functions. They help stabilise sediments, trap and recycle nutrients, and provide habitat for juvenile fish and crustaceans. They also provide feeding areas for EPBC Act listed species such as the dugong and several species of turtles. The importance of seagrasses as feeding areas for dugongs has been recognised, with the establishment of a number of dugong protection areas (DPAs). The Rodds Bay DPA extends into Port Curtis from Rodds Bay in the southeast to the beginning of the Narrows south of Graham Creek (Figure 4). Large areas (as much as 4,000,000 ha) of seagrass are protected or monitored within the GBRWHA and the GBRMP. Seagrass beds are scattered throughout Port Curtis. The main areas are in the west, close to Gladstone and Fishermans Landing. The combined area of all intertidal seagrass beds in Port Curtis is approximately 4,500 ha.



Source:
Place names and roads from DME.
Flora, fauna and critically endangered ecological community from Ecosure (field validated and literature review locations).
Seagrass from DEEDI (November 2002).
Dugong protection area from Fisheries Queensland (DEEDI).
Project area and digital elevation model from Coffey Environments.

coffey environments

Date: 22.02.2011
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File Name: 7033_07_ATT4_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Terrestrial and marine MNES species and communities

Figure No: 4

- Mangroves - Mangroves provide ecological benefits through their functions of high productivity, protection against erosion, nutrient filtering and recycling. They also play an important role in providing nursery areas for young fish and crustacean species (including commercially and recreationally important species), as well as terrestrial habitat for the EPBC Act protected water mouse and migratory bird species. Extensive areas of mangroves occur around Port Curtis and Curtis Island; the largest areas occur within Targinie Creek and Graham Creek, and in the southwest, between Fishermans Landing and the Calliope River.
- Saltmarsh - Saltmarsh areas play an important role as feeding habitat for fish during high tides and provide a good source of organic material to coastal waters. As such they play an important role in maintaining the health and ecological functioning of the GBRWHA and Port Curtis surrounding waters. Saltmarsh environments typically occur landward of mangroves in the extreme high tide areas and are inundated only at the highest spring tides. Saltmarsh areas also provide nesting and feeding areas for EPBC Act protected migratory birds. The most extensive areas of saltmarsh in Port Curtis are around Targinie Creek and in the inner embayments of North China Bay and Boatshed Point. Saltmarsh areas also occur to the west of Kangaroo Island, in the southwest of Port Curtis and at the southeast of Curtis Island. The combined area of saltmarsh and salt-tolerant species in the Port Curtis region is approximately 4,573 ha.

Fauna within Port Curtis

Port Curtis and its surrounding waters are rich in biodiversity and support a large marine fauna population, including several species listed under either the EPBC Act or on the IUCN Red List. Dugongs, marine turtles, cetaceans, fish, sea snakes, seahorses and pipefish all occur within Port Curtis and this area represents the southern limit of habitat for saltwater crocodiles.

Dugong is listed as a protected migratory species under the EPBC Act and the Nature Conservation Act. Large populations (estimated at 14,000 individuals) have been observed within the GBRMP, and their presence has attributed to the area being listed as World Heritage Area and the designation of the Zone B dugong protection area. The entire marine study area falls within the dugong protection area.

Dugong populations are known to feed on the seagrass beds within Port Curtis during their migration along the Queensland coast. They can feed in large herds of approximately 140 individuals, grazing in a single location for four weeks or longer. The long lifespan and low reproduction rate of the dugong means the species population recovery is potentially slow, and the animals are vulnerable to both natural and anthropological factors, including boat strike, underwater noise, Indigenous hunting, commercial fishing or trawling and destruction or fragmentation of habitat.

Six of the seven species of marine turtles worldwide occur within Queensland waters. All six species are listed as vulnerable or endangered by the EPBC Act and Nature Conservation Act.

The flatback, green and loggerhead turtles all nest and forage within the GBRMP and GBRWHA. Some individuals nest within Port Curtis (with the closest nesting area at Southend, 8 km from the proposed LNG plant site and marine facilities). The remaining three species either have wider worldwide distributions or are less likely to nest near Port Curtis.

The marine turtle species found within Port Curtis display a long lifespan, low reproductive rate and high site fidelity. These features restrict the rate of population recovery and, as such, could render the populations more vulnerable to anthropogenic impacts such as loss of foraging habitat,

boat strike, and project lighting (light glare can lead to disorientation in both nesting adults and emerging hatchlings).

Thirteen species of cetaceans (i.e., whales, dolphins and porpoises) have known ranges that include the waters of Port Curtis.

Cetaceans most likely to be found regularly within Port Curtis are the Australian snubfin dolphin and the Indo-Pacific humpback dolphin. Both species are listed under the EPBC Act as migratory species. The blue whale (*Balaenoptera musculus*) is listed as endangered under the EPBC Act, although it is only likely to occur offshore around the continental shelf and not in Port Curtis. While other cetacean species have the potential to migrate through Port Curtis, the three species described above have a higher conservation status and have previously been sighted in the Port Curtis region.

The main habitat of the Australian snubfin dolphin and the Indo-Pacific humpback dolphin is shallow coastal waters in or adjacent to modified environments such as dredged channels, breakwaters and river mouths (Parra, 2006). These habitats exist along the majority of the Queensland coastline (including Port Curtis) and support foraging and mating activities. Generally, adult female cetaceans have a low reproductive rate and calve only every few years.

Anthropogenic activities and coastal developments along the Queensland coast that can have an impact on cetacean species survival include gill netting activities, pollution, vessel traffic (and associated noise), boat strike and overfishing.

Many fish and shellfish species occur within the marine and estuarine waters around Port Curtis. The habitats within the study area provide spawning, nursery and feeding areas for recreationally and commercially important fishing species. No species of conservation importance were recorded within the targeted field studies, although species present are of recreational fishing importance.

Port Curtis and surrounding waters also provide key commercial fishing grounds. All common species identified extend in range beyond the Port Curtis region to areas around northern Australia and, for some species, to southern Australia as well.

Australia has 33 of the world's 54 described species of sea snake. The Species Profile and Threats database (SPRAT), a subordinate of the EPBC Act, identifies 12 sea snakes listed as protected species with an indicative range extending into the study area and the surrounding regions. However, no individuals were recorded in the study area.

The saltwater crocodile is protected under the EPBC Act and is recognised as vulnerable under the Nature Conservation (Wildlife) Regulation 2006 (Qld). Crocodiles are known to inhabit reef, coastal and inland watercourses typically north of the tropics, and their habitat extends to the Gladstone region. The southeast Queensland region is thought to support a moderate density of saltwater crocodiles despite the low quality in nesting and living habitat (Taplin, 1987). Surveys conducted within the region during 1994 and 2000 recorded 434 non-hatchling crocodiles, approximately 10% of the Queensland crocodile population. No saltwater crocodiles were observed during the field surveys.

Selected species of syngnathid fish (seahorses and pipefish) have been recognised to hold significant environmental value and are listed under the EPBC Act. The Species Profile and Threats database lists syngnathid fishes as protected species.

Limited published information exists on the habitat preferences of syngnathid fishes although they have an indicative range extending into Port Curtis and the surrounding regions. As no video recording or diving was performed during the field studies, no individuals were recorded in the area.

Cultural Heritage within Port Curtis

The World Heritage and National Heritage listings pertaining to the Great Barrier Reef acknowledge the presence, generally, of Indigenous cultural heritage values within these areas.

Queensland cultural heritage registers and databases indicate the study area contains a number of stone artefact sites, some scarred trees and a shell midden. Further sites may be uncovered when a comprehensive examination is undertaken with the Aboriginal parties of the areas to be disturbed by the project.

Beyond the known and potential further sites within the study area, the following places in the Gladstone region are generally considered to contain Indigenous cultural heritage values:

- The marine 'spiritscape' within and around Port Curtis.
- The Great Barrier Reef marine area including The Narrows.

Two geotechnical investigations were carried out within the project area and determined that sites currently identified within the study area, when measured against registered sites and those recorded in other literature, are neither unrepresented elsewhere, nor of such order to be described as outstanding examples of site-types of which the loss would be scientifically unacceptable. No non-Indigenous sites of 'national significance' have been identified within the study area.

5.2 National Heritage Places

The National Heritage List records natural, historic and Indigenous places of outstanding national heritage value to the Australian nation. The EPBC Act includes provisions to identify and enhance the protection, conservation and presentation of Natural Heritage places. The Australian Heritage Council deemed the Great Barrier Reef met five National Heritage List criteria and entered the Great Barrier Reef on the list on 21 May 2007. Both World Heritage and National Heritage listings extend over the same geographic area.

The criteria, and the basis on which the Australian Heritage Council deemed that the place meets the criteria, is as follows:

- Criterion A: Events, Processes. The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history. The determination by the World Heritage Committee that the place meets World Heritage criteria (vii), (viii), (ix) and (x) satisfied this criterion.
- Criterion B: Rarity. The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history. The determination by the World Heritage Committee that the place meets World Heritage criterion (x) satisfied this criterion.
- Criterion C: Research. The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history. The determination by the World Heritage Committee that the place meets World Heritage criteria (viii), (ix) and (x) satisfied this criterion.

- Criterion D: Principal Characteristics of a Class of Places. The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:

  – A class of Australia's natural or cultural places; or
  – A class of Australia's natural or cultural environments.

  The determination by the World Heritage Committee that the place meets World Heritage criteria (viii), (ix) and (x) satisfied this criterion.

- Criterion E: Aesthetic Characteristics. The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group. The determination by the World Heritage Committee that the place meets World Heritage criterion (vii) satisfied this criterion.

The values of the Great Barrier Reef recognised on the Natural Heritage List have been derived from the World Heritage listing. Potential significant impacts on world heritage values are discussed in Section 5.1 and apply to National Heritage values.

5.3 Threatened Ecological Communities

Threatened Ecological Communities are listed under the EPBC Act in conservation categories detailed below:

- Critically endangered.
- Endangered.

The EPBC Protected Matters Searches, literature review and field surveys identified four threatened ecological communities as being present or potentially present in and adjacent to the project area, based on their likelihood of occurrence according to distribution.

Field surveys confirmed the presence of one threatened ecological community listed under the EPBC Act. This was the 'critically endangered' littoral rainforest and coastal vine thickets of eastern Australia. Plant species in this community are regionally predictable and typically rainforest species, which include wild prune (*Pouteria serica*), native cherry (*Exocarpus latifolius*) and glossy acronychia (*Acronychia laevis*). This community supports fauna species such as the grey-headed flying-fox and black-breasted button-quail (*Turnix melanogaster*). Within the study area this community was represented by small pockets of low microphyll-notophyll vine forest, including a small pocket on the eastern side of Hamilton Point.

The ecological community of semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions ('endangered') was deemed likely to occur adjacent to the study area by the literature review. Field surveys failed to locate it within the study area, but communities of semi-evergreen vine thicket of the Brigalow Belt were observed on the foothills and lower slopes of Mount Larcom (approximately 25 km away).

The remaining two communities are unlikely to occur within the project area as identified during the literature review.

Table 5.2 summarises the listed ecological communities along with their likelihood of occurrence within the project area.

Table 5.2 Threatened ecological communities, their likelihood of occurrence, structure and location within the project area

Threatened Ecological Community	EPBC Status	Likelihood of Occurrence	Location and Structure of Community
Littoral rainforest and coastal vine thickets of eastern Australia	Critically endangered	Present	This community was representative of the DERM mapped regional ecosystem (RE) 12.2.2. The community 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.
Semi evergreen vine thickets of the Brigalow Belt (north and South) and Nandewar Bioregions	Endangered	Unlikely	Field surveys failed to locate it within the study area, but communities of semi-evergreen vine thicket of the Brigalow Belt were observed on the foothills and lower slopes of Mount Larcom (approximately 25 km away).
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Unlikely	N/A – unlikely to occur in study area.
Weeping myall woodlands	Endangered	Unlikely	N/A – unlikely to occur in study area.

5.4 Protected Species

Protected species are listed under the EPBC Act in conservation categories detailed below:

- Extinct in the wild.
- Critically endangered.
- Endangered.
- Vulnerable.

Conservation listed species identified during database searches as potentially occurring within the study area are included in this assessment along with those species identified within the Protected Matters search to support the referrals for the project.

These species occur within the study area with varying regularity. Some are highly restricted in extent and habitat (e.g., Mount Larcom silkpod (*Parsonia larcomensis*), while others are widely distributed (e.g., squatter pigeon (*Geophaps scripta scripta*)) and others are nomadic and probably vagrant (e.g., Australian painted snipe (*Rostratula australis*)). Others were assessed within the literature review as being unlikely to occur within the study area, despite being identified within database searches.

Terrestrial Fauna Species

Twenty two terrestrial fauna species listed under the EPBC Act were identified as potentially occurring in the study area, through a combination of the EPBC Protected Matters search and database searches for technical studies undertaken for the Arrow LNG Plant. These species are outlined in Table 5.3, and include ten bird, six mammal and six reptile species.

None of the EPBC Act listed species identified in the database searches were recorded in field surveys undertaken for the project. Three species were identified as having a high likelihood of occurrence within the study area in the course of the literature review for the technical studies.

Squatter pigeon (*Geophaps scripta scripta*) was recorded at a number of locations on the mainland, during the project surveys, within 5 km of the study area. Areas of similar habitat present within the study area, especially around TWAF8 makes the presence of the species likely.

Other surveys (URS, 2009; QGC Pty Ltd, 2009; GAWB, 2008) have confirmed this to be the case, locating the species within or adjacent to the study area.

Grey-headed flying-fox is highly likely to be present within the study area, in areas of woodland such as the Arrow LNG plant site. Water mouse (*Xeromys myoides*) is highly likely to be present in fringing mangroves on Curtis Island and at launch site 1, and its presence on the Australia Pacific LNG Plant site has been confirmed (URS, 2009).

Marine Fauna Species

Ten marine fauna species listed under the EPBC Act were identified as potentially occurring in the study area, through a combination of the EPBC Protected Matters search and database searches for technical studies undertaken for the Arrow LNG Plant. These species are outlined in Table 5.3, and include six turtle, two whale and two shark species.

Loggerhead turtle (*Caretta caretta*), flatback turtle (*Natator depressus*) and green turtle (*Chelonia mydas*) all nest and forage within Port Curtis and there is a high likelihood of their presence within the study area, although nesting habitat in the project area is unsuitable for the species. The remaining three turtle species have a moderate likelihood of being present in the study area although Port Curtis is not in the main range of the species. The remaining species of marine fauna are unlikely to occur within Port Curtis and the study area.

Terrestrial Flora Species

Nine terrestrial flora species listed under the EPBC Act were identified as potentially occurring in the study area and are outlined in Table 5.3. All species identified were assessed as having a likelihood of occurrence within the study area of low to moderate and below.

Specimens of an unidentified species of *Cupaniopsis*, thought to be closely related to the threatened flora species, wedge-leaf tuckeroo (*Cupaniopsis shirleyana*), were identified within the study area during early field surveys. The recorded specimens were identified by the Queensland Herbarium as *C. shirleyana*, which is currently listed as ‘Vulnerable’ under both the EPBC Act and Nature Conservation (Wildlife) Regulation 2006 (Qld). These specimens were recorded within an area of semi-evergreen vine thicket, located on the southern extent of Boatshed Point.

This area was revisited and assessed in detail during later surveys. 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. Initial assessment in August 2010 indicated that the sampled species, herein referred to as *Cupaniopsis* sp. indet. is potentially a new taxon.

Table 5.3 summarises the threatened flora and fauna species along with their likelihood of occurrence within the study area and the preferred habitat.

Figure 4 shows previously recorded locations and recently recorded locations of the threatened flora and fauna species which are potentially present within the study area.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds				
Australian painted snipe	*Rostratula australis*	Vulnerable	Low to moderate	Scattered distribution throughout Australia, usually found on shallow inland wetlands. Patches of suitable low-lying grassland habitat (conducive to water ponding) occur in the mainland section of the study area, in particular areas north of Fishermans Landing and in the northern section of TWAF 8.
Herald petrel[1]	*Pterodroma heraldia*	Critically endangered	Low	Marine pelagic species occurring in tropical and subtropical waters of Pacific Ocean. Unsuitable habitat and outside of species range.
Kermadec petrel (western subsp.)	*Pterodroma neglecta neglecta*	Vulnerable	Low	Marine pelagic species occurring in southern Pacific Ocean. Unsuitable habitat and outside of species range.
Squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	High	Inhabits grassy understorey of open woodland. This species was observed frequently in disturbed pasture grassland and woodland within several kilometres of the mainland section of the study area. These habitat types occur throughout the study area.
Black-breasted button-quail	*Turnix melanogaster*	Vulnerable	Low to moderate	This species is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland. Preferred habitat includes drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. Patches of suitable vine thicket habitat occurring in the western half of the mainland section of the study area, may support this species.
Red goshawk	*Erythrotriorchis radiatus*	Vulnerable	Low to moderate	This species is very sparsely dispersed across coastal and sub-coastal Australia, from western Kimberley Division to northeastern NSW, and occasionally on continental islands. Habitat includes coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia. Small patches of suitable open forest/woodland habitat occurring throughout the study area.
Star finch (eastern), Star finch (southern)	*Neochmia ruficauda ruficauda*	Endangered	Very low	A recent expert review of the status has led to the subspecies being assumed extinct
Southern giant-petrel	*Macronectes giganteus*	Endangered	Low	Breeds on subantarctic islands in Australian territory. Unsuitable habitat and outside of species range.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Black-throated finch (southern subspecies) [1]	*Poephila cincta cincta*	Endangered	Low	Occupies grassy woodland dominated by eucalypts, paperbarks or acacias. The species appears to be out of range despite its inclusion in the Wildlife Online database. Patches of suitable woodland habitat exist adjacent to water sources throughout the study area.
Yellow chat (Capricorn subspecies) [1]	*Epthianura crocea macgregor*i	Critically endangered	Moderate	Inhabits wetlands and associated grasslands on seasonally inundated plains under marine influence. Degraded intertidal habitat along the eastern section of the mainland and southern parts of Curtis Island are unlikely to support this species. A known population exists to the north on Curtis Island.
Mammals				
Northern quoll	*Dasyurus hallucatus*	Endangered	Moderate	Inhabits a range of open woodland and open forest types. Patches of suitable vine thicket and open-forest/woodland habitat on rocky slopes occur along the range in the western portion of the mainland section, and suitable open-forest/woodland habitat within the Curtis Island section, may support this species.
Water mouse	*Xeromys myoides*	Vulnerable	High	Occurs in fringing mangroves in the high intertidal zone. Suitable intertidal habitat occurring along the mainland coastline and the southern section of Curtis Island was found. Water mouse has been observed in surveys at the Australia Pacific LNG project site (Worley Parsons, 2011).
Large-eared pied bat, large pied bat	*Chalinolobus dwyeri*	Vulnerable	Low	The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, through to the vicinity of Ulladulla, NSW in the south. Habitat includes sandstone cliffs, fertile woodland valleys, rainforest and moist eucalypt forest at high elevation. Unsuitable roosting habitat and outside of known range.
Grey-headed flying fox	*Pteropus poliocephalus*	Vulnerable	High	Favours variety of woodland types in eastern Australia. Observed in numerous areas within several kilometres of the mainland section of the study area and in an area just south of Graham Creek on Curtis Island. Suitable foraging habitat occurs throughout the study area.
Semon's leaf-nosed bat[1]	*Hipposideros semoni*	Endangered	Low	Occurs from Cape York to Cooktown, but unconfirmed records as far south to Maryborough. Inhabits rocky escarpments and caves. Unsuitable habitat and outside of normal range.
Eastern long-eared bat[1]	*Nyctophilus timoriensis*	Vulnerable	Low	Confined to western slopes of Great Dividing Range in southeast Australia in variety of habitat types. Outside of normal range.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Reptiles				
Brigalow scaly-foot	*Paradelma orientalis*	Vulnerable	Moderate	Largely restricted to the Brigalow Belt bioregion, it extends from approximately 200 km south-west of Charters Towers, south to Bendidee National Park and Eena State Forest. More prevalent in habitats that have few weeds and that consist of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Patches of suitable vine thicket and open-forest/woodland habitat occurring throughout the study area may support this species. It has been recorded on Boyne Island in similar woodland habitat, approximately 12 km to the southeast (DSEWPC, 2011b).
Dunmall's snake[1]	*Furina dunmalli*	Vulnerable	Low	Most records occur in remnant vegetation including Brigalow, open woodland and even tall forests. Confined almost entirely to southern Brigalow Belt region. They may occur in any woodland or forest vegetation types, but are probably absent from disturbed vegetation. Outside of normal range.
Collared delma[1]	*Delma torquata*	Vulnerable	Moderate	This species ranges from Rockhampton in the north, south to Kenmore and inland to the Bunya Mountains. Preferred habitat includes rocky areas associated with dry open eucalypt forests, although the species has also been recorded from semi-evergreen vine thickets. Patches of suitable open-forest and woodland habitat occurring on slopes throughout the study area.
Ornamental snake[1]	*Denisonia maculata*	Vulnerable	Low	Favours brigalow woodland on clay and sandy soils. Unsuitable woodland and open-forest habitat growing on alluvial soils. Recorded approximately 15 km north on the mainland (GAWB, 2008).
Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle[1]	*Rheodytes leukops*	Vulnerable	Low	Favours fast flowing and clear water in Fitzroy River and Brigalow Belt. Unsuitable habitat and outside known distribution.
Yakka skink	*Egernia rugosa*	Vulnerable	Moderate	The yakka skink has a disjunct distribution, with isolated populations occurring from St George, north to Coen on Cape York Peninsula. Habitat includes dry forests and woodlands including poplar box alluvial soils, low ridges, cypress on sands, belah, mulga and *Eucalyptus intertexta*. Suitable dry open forest and woodland habitat occurring throughout the study area.
Marine fauna				
Loggerhead turtle	*Caretta caretta*	Endangered	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna (cont'd)				
Leatherback turtle	*Dermochelys coriacea*	Endangered	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Flatback turtle	*Natator depressus*	Vulnerable	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Green turtle	*Chelonia mydas*	Vulnerable	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable	Moderate	Unsuitable nesting habitat and south of range. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Green sawfish	*Pristis zijsron*	Vulnerable	Low	Species occurs within Queensland waters, but predominantly north of Cairns and has not been recorded in eastern Australia south of Cairns for many years. Frequently observed in inshore muddy or sandy bottom habitats including estuaries.
Whale shark	*Rhincodon typus*	Vulnerable	Low	Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis. Inhabits both deepwater and shallow coastal waters.
Blue whale	*Balaenoptera musculus*	Endangered	Low	The species migrates past Australian coasts to feeding and breeding grounds in the northern hemisphere. Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Humpback whale	*Megaptera novaeangliae*	Vulnerable	Low	The Great Barrier Reef is a breeding ground for the species but it is unlikely the species will be found within Port Curtis.
Plants				
Yarwun whitewood	*Atalaya collina*	Endangered	Low	Small spreading tree in dry rainforest. Small population known only from Yarwun near Gladstone and Ubobo near Miriam Vale. Suitable habitat present but species restricted to small range outside study area.
Heart-leaved bosistoa/Three-leaved bosistoa	*Bosistoa selwyni/ B.transversa*	Vulnerable	Low	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. Marginally suitable habitat present in study area but no records from immediate region.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Plants (cont'd)				
Miniature moss orchid	*Bulbophyllum globuliforme*	Vulnerable	Very low	Epiphytic orchid favouring (almost exclusively) the underside of upper branches of older *Araucaria cunninghamii* in primarily notophyll vine forests and Araucarian microphyll vine forests between 500-800 m altitude. Suitable habitat not present in study area.
Wedge-leaf tuckeroo	*Cupaniopsis shirleyana*	Vulnerable	Low to moderate	Shrub or small tree to 10 m in height from Maryborough district north to Mt. Larcom. Occurs in dry rainforest and scrubby open forest on steep slopes, screeslope gullies and rocky stream channels at elevations between 60-550 m. Suitable habitat present, and has been recorded within the region. An unidentified taxon sharing similar characteristics with this species recorded although status to be confirmed by Queensland Herbarium.
(a) Cycad	*Cycas megacarpa*	Endangered	Low to moderate	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. Suitable habitat present in study area and records within region.
Small-leaved denhamia	*Denhamia parvifolia*	Vulnerable	Low	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. Marginally suitable habitat present but not recorded in vicinity of study area.
Mount Larcom silkpod	*Parsonia larcomensis*	Vulnerable	Low to moderate	Creeping to ascendant climber to 5 m long in subtropical and dry rainforest and adjacent shrublands on cliffs or rocky outcrops. Suitable habitat present, and although the study area does not have the underlying geological requirements, the species is propagated readily by windblown fruit, so isolated specimens may become established.
Quassia	*Quassia bidwillii*	Vulnerable	Low to moderate	Shrub, often suckering from roots, in dry rainforest, vine thickets and lowland rainforests in disjunct populations north from Gympie district. Occasionally open forests adjacent to vine thicket communities, woodlands and fringing mangrove communities on a variety of geological substrates. Suitable habitat present, it has been recorded in similar habitat close to the study area.
Ribbon root orchid	*Taeniophyllum muelleri*	Vulnerable	Low	Common in shrubs and trees in rainforest, sheltered areas in open forest, humid gullies and streamside vegetation. Suitable habitat present, but no records in wider region.

Note 1 – EPBC Status: Vulnerable (V), Endangered (E), Critically Endangered (CE).

Note 2 – All species sourced from EPBC protected matters search tool unless stated (1 = other database searches in technical studies for project).

5.5 Protected Migratory Species

Sixty terrestrial species classed as migratory under the EPBC Act were identified in the database searches as possibly occurring within the study area (refer to Table 5.4). Forty five were bird species, seven reptile species and eight migratory marine species. Ten of these species were identified within or adjacent to the study area by other studies, and surveys for the Arrow LNG Plant located an additional ten EPBC Act listed migratory species during targeted surveys.

The majority of these species related to wetland bird species (terns, egrets and waders) which were found in various intertidal areas around Port Curtis. Small areas of intertidal mudflat are present on Curtis Island adjacent to the project area. Other species included white-bellied sea-eagle (*Haliaeetus leucogaster*) which was recorded in several locations, including a likely nest on the western side of Hamilton Point, and rainbow bee-eater (*Merops ornatus*) which was recorded in a variety of habitat settings.

The likelihood of the presence of turtle species is discussed in Section 5.4. There are patches of suitable estuarine habitat for saltwater crocodile along the mainland coastline and southern section of Curtis Island. Most migratory marine species are unlikely to occur within the study area, with the exception of dugong. Large populations (estimated at 14,000 individuals) have been observed within the GBRMP, and their presence has attributed to the area being listed as World Heritage Area and the designation of the Zone B dugong protection area. The entire study area falls within the dugong protection area.

Other marine species listed are predominantly pelagic in nature, and found well offshore, hence are unlikely to occur within Port Curtis.

Table 5.4 summarises the migratory species along with their likelihood of occurrence within the study area and the preferred habitat.

Figure 4 shows locations of migratory species within the study area.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds				
Australian painted snipe	*Rostratula australis*	Migratory	Low to moderate	Scattered distribution throughout Australia, usually found on shallow inland wetlands. Patches of suitable low-lying grassland habitat (conducive to water ponding) occur in the mainland section of the study area, in particular areas north of Fishermans Landing and in the northern section of TWAF 8.
Barn swallow	*Hirundo rustica*	Migratory	Moderate	Scarce visitor to northern Queensland. Favours open country and agricultural land, particularly those areas associated with water. Patches of suitable disturbed grassland habitat occur within the mainland section of the study area.
Bar-tailed godwit	*Limosa lapponica*	Migratory	Recorded (QGC, 2009)	A common migratory wader occurring across most of the Australian coastline. Found on coastal mudflats, sandbars, shores of estuaries and salt marsh. The species was observed on tidal mudflat less than 1 km from the northern boundary of the mainland section. Suitable intertidal habitat occurs along the mainland coastline and coast of Curtis Island.
Black-faced monarch	*Monarcha melanopsis*	Migratory	Moderate	Summer breeding migrant to southeast Australia preferring eucalypt woodlands, rainforests and coastal scrubs. Patches of suitable eucalypt woodland and vine thicket habitat occur throughout the study area.
Black-tailed godwit	*Limosa limosa*	Migratory	Moderate	Regular summer migrant to Australia. Found on tidal mudflats, estuaries, sand spits as well as shallow river margins. Patches of suitable intertidal habitat occur along the mainland coastline and coast of Curtis Island.
Broad-billed sandpiper	*Limicola falcinellus*	Migratory	Moderate	Uncommon summer migrant mostly to coastal Australia. Inhabits tidal mudflats, freshwater wetlands and saltmarsh. Patches of suitable intertidal habitat occur along the mainland coastline and coast of Curtis Island.
Caspian tern	*Hydroprogne caspia*	Migratory	Recorded (Arrow Energy)	Part-migratory, found over most of Australia. Occurs in coastal and offshore waters, mudflats, beaches and estuaries. The species was observed on tidal mudflat in the northern part of the mainland section. Suitable habitat occurs along the mainland coastline and the southern section of Curtis Island.
Cattle egret	*Ardea ibis*	Migratory	High	Usually associated with grazing cattle where it is found in stock paddocks, pastures, wetlands and tidal mudflats. Patches of suitable disturbed grassland habitat occur throughout the mainland section and suitable intertidal habitat occurs along the mainland coastline and coast of Curtis Island.
Common greenshank	*Tringa nebularia*	Migratory	Recorded (QGC, 2009)	Widespread migrant. Occurs across a range of inland and coastal habitats from billabongs, swamps and floodplains to mudflats and mangrove communities. This species was recorded on Curtis Island in another study, and is likely to occur around Port Curtis.
Common sandpiper	*Actitis hypoleucos*	Migratory	Moderate	Scarce summer migrant to eastern Australia inhabiting a variety of substrates on the edges of rivers and streams from coastal areas to far inland. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Cotton pygmy-goose	*Nettapus coromandelianus*	Migratory	Moderate	Considered a vagrant outside Queensland. Found on freshwater lakes, swamps and large water bodies. 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).
Curlew sandpiper	*Calidris ferruginea*	Migratory	Moderate	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. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Double-banded plover	*Charadrius bicinctus*	Migratory	Moderate	Annual winter migrant, mainly to southern Australia. Favours wide beaches, tidal mudflats, shallow saline and freshwater wetlands as well as paddocks with sparse vegetation. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Eastern curlew	*Numenius madagascariensis*	Migratory	Recorded (Arrow Energy)	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. The species was observed on tidal mudflats along the mainland coastline and on an exposed sandbar at Hamilton Point. Suitable intertidal habitat occurs throughout the study area along the mainland coastline, and southern section of Curtis Island.
Eastern osprey	*Pandion haliaetus*	Migratory	Recorded (Arrow Energy)	Large, fishing raptor distributed along most of the Australian coastline. Preferred habitat includes islands, coasts, bays and estuaries. The species was observed in the bay adjacent to the Southend barge landing and the southern tip of Hamilton Point. Suitable coastal habitat occurs along mainland coastline and the southern section of Curtis Island.
Eastern reef egret	*Egretta sacra*	Migratory	High	Distributed across much of the Australian coastline. Usually frequents rocky shores, islands, beaches, tidal rivers and mangroves. This species was observed on tidal mudflats approximately 7.5 km east of study area, south of the Southend township, Curtis Island. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Fork-tailed swift	*Apus pacificus*	Migratory	Recorded (QGC, 2009)	Aerial summer migrant. Occurs in airspace over a diverse range of habitats including rainforest and semi-arid desert. This species was recorded on Curtis Island in another study and is likely to occur anywhere within the study area.
Great egret	*Ardea alba*	Migratory	Recorded (Arrow Energy)	Widespread throughout Queensland. Occurs in wetlands, flooded pastures, dams and tidal mudflats. This species was observed on tidal mudflats in the northern part of the mainland within the study area. Patches of suitable low-lying disturbed grassland occurs throughout the mainland. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Great knot	*Calidris tenuirostris*	Migratory	Recorded (QGC, 2009)	Abundant across northern Australia. Prefers sheltered coastal mudflats of estuaries and inlets. Occasionally present on salt lakes, lagoons and saltworks ponds. This species was recorded on Curtis Island in another study and is likely to occur around Port Curtis.
Greater sand plover	*Charadrius leschenaultii*	Migratory	Moderate	Regular summer migrant. Favours a variety of habitats including tidal mudflats, mangroves, and saltmarsh. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Grey plover	*Pluvialis squatarola*	Migratory	Moderate	Regular summer migrant to coastal Australia and islands where it inhabits tidal mudflats, saltmarsh and estuaries. Patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Grey-tailed tattler	*Heteroscelus brevipes*	Migratory	Recorded (QGC, 2009)	Common summer migrant. Prefers coastal areas, in particular mudflats and sand beaches. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Latham's snipe	*Gallinago hardwickii*	Migratory	Moderate	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. Patches of suitable disturbed grassland habitat occur throughout the mainland section of the study area.
Lesser sand plover	*Charadrius mongolus*	Migratory	Recorded (Arrow Energy)	Non-breeding migrant. Widespread along Queensland coastal areas. Inhabits tidal sandflats and mudflats. This species was observed on tidal mudflats along the southern boundary of the mainland section. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Little curlew	*Numenius minutus*	Migratory	Moderate	Summer migrant favouring floodplains, tidal mudflats and dry grasslands. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Little tern	*Sterna albifrons*	Migratory	Moderate to high	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. Suitable estuarine habitat occurs south of Fishermans Landing along the mainland coastline, and the southern section of Curtis Island.
Marsh sandpiper	*Tringa stagnatilis*	Migratory	Moderate	Common summer migrant to mainly coastal areas of Australia preferring wetlands, tidal mudflats and mangroves. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Oriental plover	*Charadrius veredus*	Migratory	Moderate	Regular summer migrant. Found in tidal mudflats and bare claypans, as well as margins of coastal marshes. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Oriental pratincole	*Glareola maldivarum*	Migratory	Moderate	Rare, nomadic wader. Found on plains, shallow edges of open wetlands, tidal mudflats and beaches. Patches of suitable habitat occur along the mainland coastline and southern section of Curtis Island.
Pacific golden plover	*Pluvialis fulva*	Migratory	Recorded (QGC, 2009)	Common migrant, disperses mainly to coastal areas such as tidal mudflats, beaches. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Rainbow bee-eater	*Merops ornatus*	Migratory	Recorded (Arrow Energy)	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. This species was observed in numerous habitats both within, and in close proximity to the study area. Suitable habitat occurs throughout the study area.
Red knot	*Calidris canutus*	Migratory	Moderate	Regular, widespread summer migrant. Occurs in tidal mudflats, sandflats, beaches, saltmarshes, as well as flooded pastures and ploughed lands. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Red-necked stint	*Calidris ruficollis*	Migratory	Recorded (QGC, 2009)	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. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Ruddy turnstone	*Arenaria interpres*	Migratory	Moderate	Regular summer migrant to coastal Australia preferring tidal reefs and pools, as well as mudflats. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Rufous fantail	*Rhipidura rufifrons*	Migratory	Recorded (Arrow Energy)	Breeding migrant to southeast Australia. Favours undergrowth of rainforests and wetter eucalypt forests, monsoon forests, paperbarks, coastal scrubs and mangroves. This species was observed in vine thicket habitat on Boatshed Point, Curtis Island. It was also observed several kilometres to the northeast of the mainland section of the study area in similar vine thicket habitat. Suitable habitats were found to occur throughout the study area.
Sanderling	*Calidris alba*	Migratory	Moderate	Regular summer migrant found on broad ocean beaches of firm sand, also inhabits tidal mudflats and coastal lagoons. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Satin flycatcher	*Myiagra cyanoleuca*	Migratory	Recorded (URS, 2009)	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. This species was recorded on Curtis Island and similar habitat exists throughout the study area.
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	Recorded (QGC, 2009)	Abundant wader in southeast Australia. Inhabits mainly fresh or salt water wetlands. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Southern giant-petrel	*Macronectes giganteus*	Migratory	Low	Breeds on subantarctic islands in Australian territory. Unsuitable habitat and outside of species range.
Spectacled monarch	*Monarcha trivirgatus*	Migratory	High	Occurs along coastal northeast and eastern Australia. Prefers understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation. This species was observed in vine thicket habitat, several kilometres to the northeast 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*	Migratory	Recorded (QGC, 2009)	Common summer migrant found on coastal mudflats as well as sandbars, reefs and coastal swamps. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Whimbrel	*Numenius phaeopus*	Migratory	Recorded (Arrow)	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. This species was observed on tidal mudflat in several locations along the mainland coastline. Suitable intertidal habitat was also found along the southern section of Curtis Island.
White-bellied sea-eagle	*Haliaeetus leucogaster*	Migratory	Recorded (Arrow Energy)	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. This species was observed in numerous habitats both within, and in close proximity to the study area. Suitable habitat was found to occur throughout the study area.
White-throated needletail	*Hirundapus caudacutus*	Migratory	Recorded (QGC, 2009)	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. This species was recorded on Curtis Island in another study and may occur anywhere in the study area.
Wood sandpiper	*Tringa glareola*	Migratory	Moderate	Common summer migrant. Occurs in a variety of habitats including mangroves and the margins of mudflats subject to tidal inundation. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna				
Loggerhead turtle	*Caretta caretta*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Leatherback turtle	*Dermochelys coriacea*	Migratory	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Olive Ridley turtle	*Lepidochelys olivacea*	Migratory	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Flatback turtle	*Natator depressus*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Green turtle	*Chelonia mydas*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Hawksbill turtle	*Eretmochelys imbricata*	Migratory	Moderate	Unsuitable nesting habitat and south of range. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Saltwater crocodile	*Crocodylus porosus*	Migratory	Moderate	Inhabits coastal swamps, rivers, estuaries and open sea along Queensland coast south to approximate Rockhampton although records in Port Curtis. Patches of suitable estuarine habitat occur along the mainland coastline and southern section of Curtis Island.
Whale shark	*Rhincodon typus*	Migratory	Low	Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis. Inhabits both deepwater and shallow coastal waters.
Blue whale	*Balaenoptera musculus*	Migratory	Low	The species migrates past Australian coasts to feeding and breeding grounds in the northern hemisphere. Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Humpback whale	*Megaptera novaeangliae*	Migratory	Low	The Great Barrier Reef is a breeding ground for the species but it is unlikely the species will be found within Port Curtis.
Bryde's whale	*Balaenoptera edeni*	Migratory	Low	Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Killer whale	*Orcinus orca*	Migratory	Low	Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Australian snubfin dolphin	*Orcaella heinsohni*	Migratory	High	The species favours shallow coastal waters, and may be observed in Port Curtis.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna (cont'd)				
Indo-pacific humpback dolphin	*Sousa chinensis*	Migratory	High	The species favours shallow coastal waters, and may be observed in Port Curtis.
Dugong	*Dugong dugon*	Migratory	High	Known to be present within Port Curtis in dugong protection area.

Note1 – EPBC Status: Vulnerable (V), Endangered (E), Critically Endangered (CE).

Note2 – All species sourced from EPBC protected matters search tool.

6. POTENTIAL IMPACTS AND MITIGATION MEASURES TO AVOID OR REDUCE IMPACTS ON MNES

This chapter describes potential impacts and mitigation measures to avoid or reduce impacts on MNES. Impacts specific to the GBRWHA and Port Curtis National Heritage Place, threatened ecological communities, protected species and protected migratory species are discussed, in relation to specific guidance within the policy statement on those subject areas. Further detailed assessment of the impacts is provided in the chapters and technical reports described in the EIS.

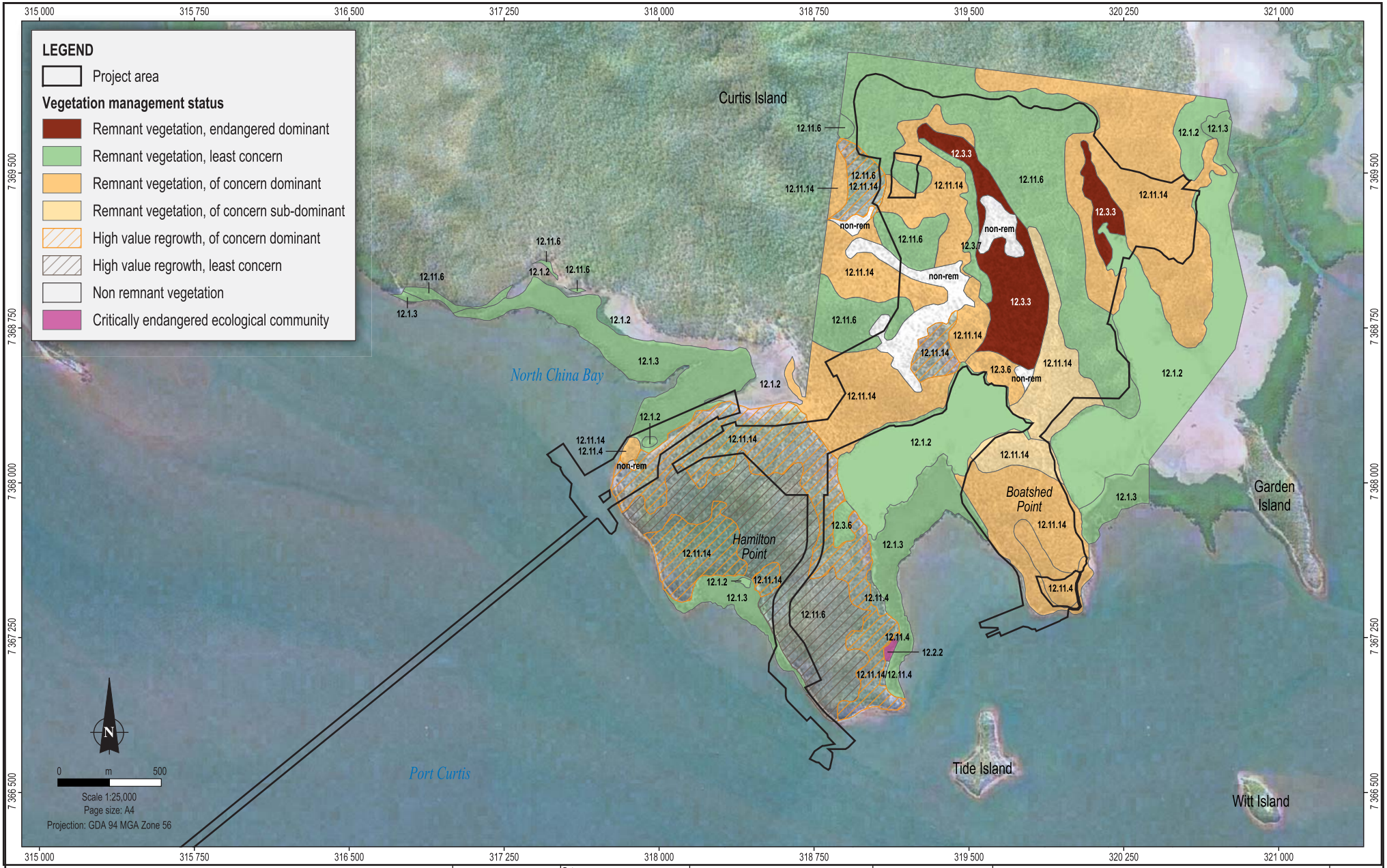
The extent of habitat clearance is presented at the local, bioregion and state level. Habitat for listed species and communities has been identified by reference to regional ecosystems (RE), the system of classifying vegetation communities (and habitat) implemented under the *Vegetation Management Act 1999* (Qld). The distribution of REs in the study area is shown in Figures 5 and 6.

The areas of REs (vegetation communities/habitat) cleared as a result of project activities are expressed in hectares to show the amount of habitat proposed to be cleared by the project which is associated with a particular EPBC Act listed species. The clearance is also discussed cumulatively including in relation to other projects taking place in the Gladstone region, following the framework established in Chapter 32, Cumulative Impacts of the EIS.

In Section 6.3, clearance of REs is expressed as a proportion of the area of each community within the Gladstone Regional Council area. This enables the scale of impacts on local vegetation communities to be clearly ascertained, and Arrow's contribution to these impacts to be determined.

The proportion of clearance is also compared to the area of the vegetation communities mapped in Queensland. These figures are very similar to the figures given in Table 6.4 (Section 6.5) which place the clearance in the context of the amount of each RE within the Southeast Queensland bioregion. The figures are similar as the REs present in the project area are predominantly associated with the Southeast Queensland bioregion of Queensland.

The mitigation measures presented in the EIS and this report are proven techniques for managing the identified impacts. The mitigation measures were proposed by technical specialists and have been reviewed by Arrow Energy and its FEED contractor to ensure they are technically feasible and can be effectively implemented. Mitigation measures that will be applied to the management of impacts on MNES are presented in Appendix 1 to Attachment 4. Specific mitigation measures developed to manage impacts on a particular species are repeated in the relevant section below. The mitigation measures form part of a suite of measures developed for the project. Attachments 6, 7 and 8 to the EIS contain a comprehensive list of all mitigation measures – expressed as commitments – developed for the management of project impacts.



Source:
Place names from DME.
Project area from Coffey Environments.
Vegetation management status (field validated) from Ecosure.
Imagery from SPOT (2004-2007).

coffey environments

Date: 25.11.2011
MXD: 7033CA_07_GIS145_v1_7
File Name: 7033_07_ATT4_F005_GIS_GL

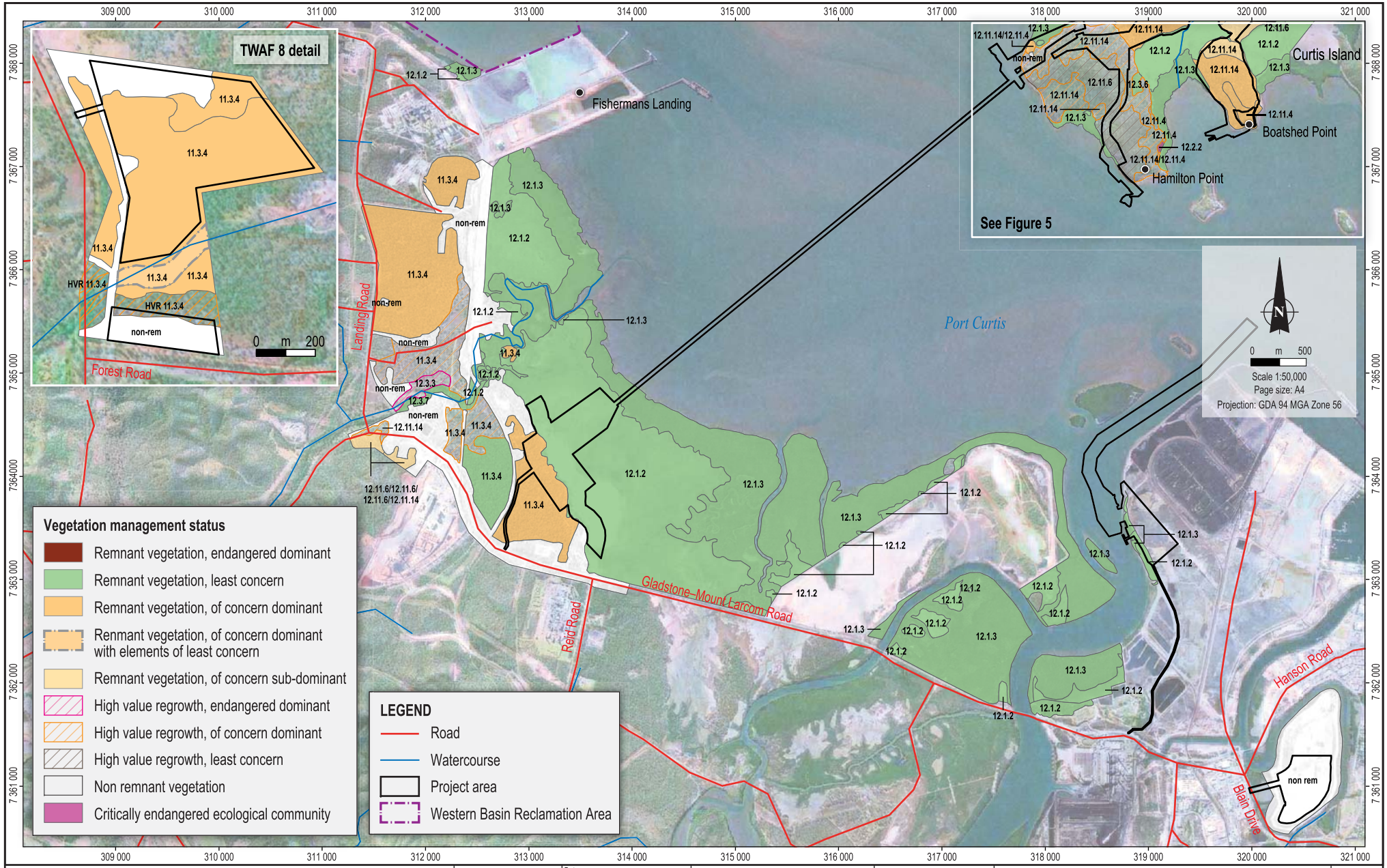
Arrow Energy

Arrow LNG Plant

arrow energy go further

EPBC Act-listed communities and field validated vegetation communities - LNG plant site

Figure No: 5



Source:
Place names, roads and watercourses from DME.
Project area from Coffey Environments.
Vegetation management status (field validated) from Ecosure
Western Basin Reclamation Area from Gladstone Ports Corporation.
Imagery from SPOT (2004-2007).

coffey environments

Date: 25.11.2011
MXD: 7033CA_07_GIS189_v1_6
File Name: 7033_07_ATT4_F006_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

EPBC Act-listed communities and field validated vegetation communities - mainland infrastructure

Figure No: 6

6.1 GBRWHA and Port Curtis National Heritage Place

Approval under the EPBC Act is required for any action occurring within or outside a declared World Heritage property or Natural Heritage place that has, will have, or is likely to have a significant impact on the values of the property or the place.

An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property or Natural Heritage place if there is a real chance or possibility that it will cause:

- One or more of the World Heritage or Natural Heritage values to be lost.
- One or more of the World Heritage or Natural Heritage values to be degraded or damaged. Or
- One or more of the World Heritage or Natural Heritage values to be notably altered, modified, obscured or diminished.

As the Great Barrier Reef was placed on the National Heritage List due to its World Heritage listing and associated values, the potential for impact on World Heritage and National Heritage values are assessed together within this section.

The EPBC policy statement, gives examples of how an action is likely to be deemed to have a significant impact on natural heritage values of a World Heritage property or Natural Heritage place.

Table 6.1 summarises the World Heritage values that may be impacted by the project, and gives examples of key actions that may have an impact upon these values, and result in the impact being deemed as significant.

Table 6.1 Examples of Significant Impact on World Heritage or Natural Heritage Values

World Heritage Value	Actions
Geology or landscape values	• Damage, modify, alter or obscure important geological formations in a World Heritage property or Natural Heritage place. • Damage, modify, alter or obscure landforms or landscape features, for example, by excavation or infilling of the land surface in a World Heritage property or Natural Heritage place. • Modify, alter or inhibit landscape processes, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes, in a World Heritage property or Natural Heritage place. • Divert, impound or channelise a river, wetland or other water body in a World Heritage property or Natural Heritage place. • Substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants in a river, wetland or water body in a World Heritage property or Natural Heritage place.
Biological and ecological values	• Reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property or Natural Heritage place. • Fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property or Natural Heritage place. • Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property or Natural Heritage place. • Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property or Natural Heritage place.
Wilderness, natural beauty or rare or unique environment values	• Involve construction of buildings, roads, or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values. • Introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values.

Table 6.1 Examples of Significant Impact on World Heritage or Natural Heritage Values (cont'd)

World Heritage Value	Actions
Historic heritage values	• Permanently remove, destroy, damage or substantially alter the fabric of a World Heritage property or Natural Heritage place. • Extend, renovate, refurbish or substantially alter a World Heritage property or Natural Heritage place in a manner which is inconsistent with relevant values. • Permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a World Heritage property or Natural Heritage place. • Involve activities in a World Heritage property or Natural Heritage place with substantial and/or long-term impacts on its values. • Involve construction of buildings or other structures within, adjacent to, or within important sight lines of, a World Heritage property or Natural Heritage place which are inconsistent with relevant values. • Make notable changes to the layout, spaces, form or species composition in a garden, landscape or setting of a World Heritage property or Natural Heritage place which are inconsistent with relevant values.

Source: Matters of National Environmental Significance Significant impact guidelines 1.1 (Australian Government, 2009)

The impacts of the project on the World Heritage property and Natural Heritage place values identified within Section 5.1 are assessed in this section, in terms of the technical discipline areas within the EIS which informs this attachment.

Further detailed assessment of the impacts is provided in the chapters and technical reports described in Table 1.1.

6.1.1 Geology or Landscape Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to geology or landscape values, are described below. The impacts are a summary of those assessed in Chapter 11, Geology, Soils and Landforms and Chapter 23, Landscape and Visual of the EIS.

Geology, Landscape Features and Processes

Construction of the LNG plant will involve extensive earthworks to transform a naturally undulating landscape to a series of platforms of elevations between 10 m AHD and 18 m AHD. Ridges will be cut into, while saddles and gullies will be filled to achieve these level platforms.

General impacts associated with the LNG plant construction and operations include erosion, reduction in soil quality and down-system sedimentation. The most significant impact will be the large scale topographic alteration of the project area. The project design avoids most steep slopes or will remove them through earthworks.

The project has been designed to limit the amount of excavation required on Curtis Island as far as is practicable to reduce the topographic impact. General mitigation measures have been developed in accordance with the industry standard management guidelines (International Erosion Control Association Best Practice Erosion and Sediment Control Manual (IECA, 2008), Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines (APIA, 2009)).

The visual and landscape areas in relation to MNES which are likely to be affected during construction and operation activities of the LNG plant include the GBRWHA and the areas listed under the Australian Register of the National Estate; which include The Narrows, Garden Island Conservation Park and Mount Larcom Range.

Construction impacts on designated landscapes are largely associated with the significant clearance of vegetation, particularly on Curtis Island, and the effect this will have on the perception of Curtis Island as a natural landscape.

Garden Island (Australian Heritage Commission Register of the National Estate) will receive the impact of greatest significance during construction out of all of the designated landscapes listed above due to its close proximity to construction works.

Lighting during construction will have a significant impact on landscape and visual receptors. Key light sources on Curtis Island during the construction phase are the perimeter security lights, construction vehicles and lighting associated with the construction camp. The construction camp at Boatshed Point will be a highly visible, lit component in very close proximity to a small handful of sensitive visual receptors, i.e., residents on Tide, Turtle and Witt islands and recreational water vehicles.

For most visual receptors in Gladstone, the majority of the impact of additional light will be an increase in sky glow and the intermittent visual impact of the elevated gas flaring during upset conditions. These receptors are over 4 km from this gas venting. The other three LNG facilities on Curtis Island will provide a lit context against which the lighting associated with the construction activities of the Arrow Energy LNG plant will appear less noticeable.

Mitigation relating to impacts on geology, landscape features and processes will include:

- Limit clearing of vegetated areas to the project area. Areas will be stabilised and progressively rehabilitated to reduce prolonged exposure of soils [C11.05].
- Implement sediment and erosion control measures upslope of watercourses, wetlands and coastal areas or in areas with sodic soils to minimise increases in natural sediment discharge. Measures may include sediment traps, silt fencing, riprap, contour banks, detention dams, sediment ponds and vegetation and diversion berms [C11.11].
- Protect the tip of Boatshed Point from clearing and cutting to preserve areas of vegetation that help screen lower parts of the LNG plant and construction camp [C23.01].
- Where practicable, retain the vegetation along the eastern boundary of the LNG plant site to provide some screening to views from the east [C23.02].
- Consider planting of bands of screening vegetation parallel with the shoreline between elements of the LNG plant if terracing is considered impractical on Curtis Island [C23.17].
- Use industry standards for the construction camp to minimise landscape and visual impacts [C23.13].
- Minimise night-time working and associated lighting impacts for activities (including construction of the LNG plant). Limit construction activities that need to be highly lit to daytime hours (to the greatest extent practical) [C23.20].

Waterbodies

At the LNG plant site, the drainage feature and associated side gullies flowing through the site will be diverted east and west of its current alignment. DERM has advised that this drainage feature is not a watercourse as defined by the *Water Act 2000*. Design of two conceptual routes, one around the north and west of the LNG plant and the other to the north and east of the LNG Plant will be further investigated. The route selection will be based on minimising the overall impact.

Erosion and increases in sediment loads in watercourses will occur during rainfall and runoff events at all project sites as areas are cleared of vegetation and site preparation earthworks are carried out. Runoff from soil stockpiles will also carry sediment into watercourses. Increased erosion and sedimentation will be especially prevalent during heavy rainfall events. Stormwater may become contaminated with hydrocarbon or chemical residues in storage facilities such as bunds.

Runoff may carry oil and grease that has collected on access tracks and hard standing areas into watercourses. Spills of chemicals or fuels are also potential sources of contamination if they enter watercourses at project sites.

All these contaminants have the potential to enter the waterbody of Port Curtis, part of the GBRWHA.

Dredging will have physical impacts in the dredge footprint with elevated turbidity in the form of suspended sediment plumes in the vicinity of the dredge head. Limited dredging will be carried out in Port Curtis to support the construction and operation of Curtis Island and mainland marine infrastructure.

Modeling for the project shows that the rate of plume deposition to the seafloor will be greatest at the dredge location and gradually reduces with distance. Water currents driven by the tidal cycle influence the location at which plumes settle to the seafloor.

The most significant area of dredging will be at the mouth of the Calliope River for the construction of a shipping channel to launch site 1. Approximately 900,000 m^3 of material will be dredged at this site. Dredging at launch site 1 is estimated to take between three and four weeks of effective dredging. At this site, the receiving environment is more confined, leading to a larger area affected by elevated total suspended solids (TSS) levels.

Mitigation relating to waterbodies will include:

- Manage all surface water generated from the LNG plant site by a stormwater treatment system to ensure discharged water complies with regulatory requirements [C13.10].
- Train all relevant personnel in spill response and recovery procedures [C13.13].
- Prior to construction commencing, develop a site drainage plan to define how the civil construction will address site drainage, stormwater management, erosion control and stockpile placement. Risks relating to flood events will also be addressed with appropriate mitigation measures to minimise erosion and surface water quality issues [C11.16].
- Store fuels, chemicals and hazardous wastes in appropriately sized bunded storage facilities (in leak proof sealed containers) [C14.04].
- Develop an emergency response plan for the project and include spill contingency or emergency measures. Make material safety data sheets available at the LNG plant and other project sites to aid in the identification of appropriate spill clean-up and disposal methods [C31.47].
- Where works are required in watercourses, they will be confined to reduced width construction right of ways that preserve, to the extent possible, the integrity of the riparian vegetation and any associated wildlife corridors [C13.22].
- Develop a dredge management plan that considers the appropriate water and sediment monitoring data (e.g., current WBDD Project data) and will include [C15.02]:
  - Requirements for monitoring of water quality [C15.03].

– Actions to be taken to minimise impacts of dredging on sensitive areas should water quality monitoring data show performance criteria are exceeded. Finalise specific actions in the dredge management plan [C15.04].

6.1.2 Biological or Ecological Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to biological or ecological values, are described below. The impacts are a summary of those assessed in Chapter 17, Terrestrial Ecology and Chapter 19, Marine and Estuarine Ecology of the EIS.

Loss or fragmentation of habitat – marine areas

Marine and estuarine habitat (such as mangrove, seagrass and saltmarsh vegetation) will be disturbed by the introduction of some project infrastructure. Adjacent areas will be affected by the lateral spread of construction-induced increases in turbidity (e.g., from dredging) and by sedimentation from construction equipment outside the footprint area.

The maximum direct loss of habitat for each habitat type associated with construction and operation of infrastructure detailed in referral EPBC 2009/5007 is estimated to be less than 6 ha of saltpan vegetation (along the north of Hamilton Point and at launch site 1), 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty site and associated dredging sites), less than 5 ha of mangroves (at the LNG plant site) and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1). It is noted that Arrow Energy's preferred mainland launch site is launch site 1 on the Calliope River.

The design process has sought to reduce the loss of marine habitat where possible, including avoidance of siting marine infrastructure in the Great Barrier Reef Coast Marine Park. Mitigation to reduce the impacts from loss of marine habitat includes:

- Keep dredging activities within the identified dredge footprint area [C19.08].
- Detail the inspection and monitoring procedures to be applied during construction in relevant management plans for the project (including a construction management plan, marine offsets management strategy, dredge management plan, rehabilitation management plan and shipping activity management plan), including:
  - Periodic monitoring of any habitat replaced as a part of the offset strategy.
  - Contributing to existing long term monitoring of turtle nesting.
  - Contributing to Port Curtis-wide monitoring of seagrass habitats.

Arrow has also committed to establishing a marine offsets strategy – in accordance with relevant Queensland legislation – for the project to compensate for the loss of marine and estuarine habitat as a result of the project [C19.02].

Loss or fragmentation of habitat – terrestrial areas.

Vegetation will be cleared by the construction of project infrastructure. This includes 25.7 ha of the 'Endangered' regional ecosystem under the Vegetation Management Act 1999, RE 12.3.3 *Eucalyptus tereticornis* woodland to open forest on alluvial plains which will be cleared in the LNG plant site. No threatened ecological community listed under the EPBC Act, or other endangered regional ecosystems under the Vegetation Management Act will be cleared for the project.

However, vegetation clearance will include an area of vine thicket on Boatshed Point, which contains specimens of an unidentified species of *Cupaniopsis*, thought to be closely related to the threatened flora species, *C. shirleyana*.

Potential impacts from the clearance of vegetation include possible loss of individuals of flora and fauna species of conservation significance, the loss of scattered remnant trees, including hollow-bearing trees utilised by terrestrial fauna species for roosting and nesting and loss of foraging areas, breeding sites and shelter.

Site access and construction activities will clear vegetation possibly used by wildlife as corridors resulting in a loss of connectivity between habitats. If this occurs it will create smaller disconnected patches of vegetation, and possible isolation of flora and fauna populations leading to increased vulnerability to local extinction due to stochastic events (such as fire) and decreased genetic diversity in the long term. Vegetation integrity may be lost particularly along the margins of remaining areas of vegetation as a result of increased light penetration, and possible additional impacts of disease occurrence, altered water flows and weed invasion.

The LNG plant site has been subject to cattle grazing and continued grazing by feral horses and pigs and this pressure has resulted in degraded ecosystems with limited habitat value.

Mitigation to reduce the impacts from loss and fragmentation of terrestrial habitat include:

- Conduct pre-clearance surveys across project areas to be cleared of vegetation. The surveys will aim to determine whether any threatened species are present at each site. Appropriate mitigation measures will be implemented if threatened species are confirmed within the area [C17.25].
- Reduce vegetation clearing where practical and only after all other options such as selective clearing and trimming of vegetation have been considered [C17.27].
- Locate construction equipment, lay-down areas, turn-around areas, stockpiles and working areas within areas of existing disturbance where practical [C17.15].
- Develop fauna relocation protocols as part of fauna management measures including procedures if fauna is found during clearing activities, including in hollows of trees to be felled [C17.07].
- Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present [C17.22].
- A wildlife corridor of 20 m will be established on the eastern side of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the environmental management precinct [C17.04].
- An area of semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained by the project on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of the semi evergreen vine thicket community will be fenced off with a 20 m buffer between the semi-evergreen vine thicket community *(*including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. Do not develop within the fenced area of the retained semi-evergreen vine thicket community. Establish roles and responsibilities for the management of the retained semi-evergreen vine thicket community [C17.03].
- Clearly mark no go zones, where required, including the semi evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the ‘critically endangered’ RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected) [C17.23].

Reduction or loss of marine species or populations

Some aspects of the construction of the Arrow LNG Plant could lead to a reduction or loss of marine species or populations within Port Curtis and the wider GBRWHA.

Vessel activity in Port Curtis and the Queensland coast may lead to the injury and mortality of marine and estuarine fauna of conservation significance. Most vessels within Port Curtis operate in shallow coastal waters; habitats where dugongs, turtles and cetaceans are commonly found. Most vessel movements associated with the project will be low frequency and slow moving vessels, thus reducing the risk of boat strike, although higher speed vessels will be used to transport workers to Curtis Island on a daily basis.

Intense human-generated underwater sounds from activities such as seismic surveys and pile driving have the potential to impact marine fauna, particularly marine mammals that communicate and/or navigate using sound. Much of the pile driving required for construction of marine infrastructure will be in intertidal and shallow subtidal areas, which will reduce the extent of transfer of underwater sound into deeper waters.

Artificial light could modify natural illumination and cause disruption to visual cues of marine organisms and, in particular, disorientate marine turtles and affect the behaviour of nesting adults and emerging hatchlings (Limpus, 1971). The closest turtle-nesting beach is around Southend, approximately 8 km from the LNG plant site in a direct line. Light glow generated by the LNG plant could affect the behaviour of marine turtles, although the project is not the only source of industrial light in the area.

Incidents from spillage or uncontrolled discharge of pollutants or wastes could occur as LNG carriers travel through the GBRMP and surrounding waters. Carriers also have the potential to collide, ground, anchor or sink in the park. These impacts could displace, smother or lead to the mortality of flora and fauna and alter or cause physical damage to habitats.

The indicative route for LNG carriers travelling from Gladstone to Asia uses the recommended outer shipping channel within the Great Barrier Reef Marine Park. The coastal passage to the deep-water channel from Port Curtis can be executed in all weather and visibility.

Mitigation to reduce the impacts to marine species includes:

- Develop a shipping activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port [C28.09].
- Project vessels servicing the LNG plant that originate from overseas ports must comply with Commonwealth and local government ballast water management systems and implement Australian Quarantine and Inspection Service hull hygiene measures [C19.10].
- Contribute to the development of a Port of Gladstone shipping activity strategy and management plan. Comply with all applicable speed limits for the Port of Gladstone-Rodds Bay Zone B dugong protection area as detailed in the management plan [C19.04].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of a boat strike [C19.05].
- Implement soft-start procedures where a sequential build-up of warning pulses will be carried out prior to commencement of full-power pile-driving activities [C19.06].

- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
  - Avoid routine planned maintenance flaring at night during sensitive turtle reproductive periods (where practical) [C17.19].
- Consider use of solar powered LED studs, or similar, in roadways and paths of travel as an alternative to permanent lighting, where practical [C23.22].
- All project vessels must comply with all applicable maritime law, especially when passing through the GBRMP. Project vessels will traverse the marine park via designated navigation routes with pilotage as required within port boundaries [C19.11].

Reduction or loss of terrestrial species or populations

The Arrow LNG Plant has the potential to impact upon terrestrial flora and fauna values through direct loss or disturbance to individual species or populations. This may be as a result of hydrological impacts or pollution, stringing and laying of pipelines with trenches acting as a barrier to fauna movement or entrapping species or disturbance from lighting and noise.

Lighting and noise can have direct and indirect impacts on fauna species, and result in ongoing disturbance to local fauna populations. Increased vehicle movements may cause direct mortality or injury. Impacts include:

- Roadkill or injury to native fauna due to increased traffic around construction sites.
- Disturbance of fauna species in areas immediately adjacent to construction sites, through noise and vibration, personnel and vehicle movements, dust and artificial lighting.
- Attraction to insects which in turn encourage insectivorous species such as frogs and reptiles, microbats and some birds such as frogmouths (*Podargus* sp.) and bush stone curlew (*Burhinus grallarius*) to feed on increased prey concentrations. However, species assemblages may change in an area with less adaptable species being out competed by more adaptable ones.
- Alteration of bird and frog species mating and nesting behaviours through increased lighting. Increased activity by these species depletes energy resources and lighting often disorientates bird species, including nocturnal migratory species.
- Displacement of migratory birds from mudflat areas adjacent to construction sites through increased noise. Birds may be deterred from foraging in areas immediately adjacent to worksites, thus impacting on the fuel reserves of these migratory species.

Mitigation to reduce the impacts to terrestrial species includes:

- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:

  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
  - Avoid routine planned maintenance flaring at night during sensitive turtle reproductive periods (where practical) [C17.19].

- Consider use of solar powered LED studs, or similar, in roadways and paths of travel as an alternative to permanent lighting, where practical [C23.22].

- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].

- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

6.1.3 Wilderness, Natural Beauty or Rare or Unique Environment Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to wilderness, natural beauty or rare and unique environment values, are described below. The impacts are a summary of those assessed in Chapter 16, Marine Water and Sediment, Chapter 21, Air Quality and Chapter 22, Noise and Vibration.

Noise

Construction noise sources are discussed for the LNG plant site, lay down areas and construction camps, marine facilities, feed gas pipeline and dredging activities. The operation of the LNG plant will generate both continuous and intermittent noise. Operation noise sources are classified as either continuous (noise sources which operate continuously over a 24-hour period) or intermittent (noise sources that will only occur for short-term periods). The main continuous noise source during operations will be fixed equipment at the LNG plant (i.e., LNG trains, gas turbines for the mechanical drive option, water facilities, loading systems, substations, etc.).

Project construction and operation activities will comply with project noise criteria assuming implementation of the identified mitigation measures and acoustic treatments.

Mitigation relating to noise includes:

- Ensure that project related noise generated during operations complies with the project noise criteria at all assessment locations [C22.07].

- Where practical, locate noise making equipment to maximise the distance between noise sources (e.g., diesel generators) and sensitive receptors. The use of structures or natural topography to create barriers to noise may be used to lessen the noise impacts on sensitive receptors [C22.02].

- Regularly maintain all machinery and equipment and check for excessive noise generation [C22.04].

- Where noise from a construction activity would exceed the project night time noise criteria of 45 dB(A) at a sensitive receptor, schedule, where practical construction activities to occur between 7:00 a.m. and 10:00 p.m [C22.05].

Air Quality

Emissions to the atmosphere during the construction period will consist of fugitive dust generated during earthworks (due to vegetation and soil removal, and wind erosion of exposed surfaces, soil stockpiles and spoil), together with exhaust emissions (from construction vehicles and earthmoving equipment, operation of a concrete batching plant and minor emissions from welding fumes). These sources will temporarily increase the local concentrations of airborne particulate matter and combustion gases.

Emissions during routine operations and those that occur infrequently due to non-routine events can adversely affect air quality environmental values (i.e., the health and biodiversity of ecosystems, human health and well-being, aesthetics and agricultural use), particularly if air quality criteria are exceeded in sensitive receptor areas. The major pollutants produced during operations are oxides of nitrogen (NO_x) as NO_2 from gas turbine generator emissions from the LNG plant and SO_2 from LNG carriers and the tugs used to assist these carriers.

The design will comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas.

Mitigation relating to air quality includes:

- Design the LNG plant to comply with the air quality assessment criteria which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas [C21.01].
- Where feasible, apply low-emission technology to equipment with high combustion rates (e.g., gas turbines) [C21.02].
- Minimise fugitive emissions from sources such as pumps, seals, valves, connectors and pipe work via the application of the latest proven stage of development processes, facilities and methods of operation. These include using closed drainage, where practicable; minimising the number of flanges; installing dry gas seals on compressors and vapour recovery systems and where applicable, double seals for hydrocarbon pumps [C21.04].
- Maintain construction vehicles and equipment regularly to reduce exhaust emissions [C21.08].
- Where practicable, limit the volume of hydrocarbons flared or vented to the atmosphere from the LNG plant. Ensure that the flare is luminous and bright (i.e., show smokeless combustion at operating design gas flow rate) and the relative density of emitted smoke does not exceed No.1 Ringelmann Number [C21.11].
- Do not vent boil-off gas to the atmosphere; instead route it to the feed gas inlet for reprocessing or sent to the end flash gas compressor for use in the high-pressure fuel gas system [C21.12].

Marine Water Quality and Temperature Changes

Wastewater from the effluent treatment plant will only be discharged under extreme circumstances where the design capacity of the treatment plant is exceeded. When this occurs, wastewater that is discharged to Port Curtis will be from the component of the plant that has been treated and will comply with ANZECC (2000) guidelines. Therefore no impacts are expected to occur from the discharge of this waste stream. Instead, this waste stream and the cooling tower blowdown, demineralisation plant and clean stormwater runoff waste streams will dilute the brine effluent stream

prior to discharge. Modelling scenario 1 (brine discharge only) will cause the greatest impacts to water quality as this scenario results in the highest concentrations of salinity.

From a regulatory standpoint (ANZECC (2000) guidelines and Environmental Protection (Water) Policy 2009 (Qld)) (Queensland Government, 2009), the establishment of a mixing zone is allowed where water quality criteria can be exceeded at the point of discharge and within the mixing zone so long as compliance occurs at the mixing zone boundary.

Modelling shows that the discharge of effluent for all three scenarios will result in localised impacts. Water quality criteria will be achieved within 10 m from the point of discharge under all hydrodynamic and tidal conditions. Similarly, salinity levels will return to a natural range of salinity offshore Boatshed Point within 10 m from the discharge location.

A mixing zone boundary will be set at least 10 m distance from the point of discharge, impacts to water quality and sediment outside of this zone will be negligible.

Water temperatures will return to ambient conditions within 10 m of the discharge point and will therefore not impact on the water quality. Discharges to the environment will be designed and controlled to meet national and international standards.

Mitigation relating to marine water quality includes:

- Develop spill response plans to cover marine activities, including all vessel operations [C16.05].
- Refuel vessels in designated areas where spill response kits are located [C16.06].
- Train all relevant personnel in spill response and recovery procedures [C13.12].

6.1.4 Historic Heritage Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to historic heritage values, are described below. The impacts are a summary of those assessed in Chapter 24, Indigenous Cultural Heritage and Chapter 25, Non Indigenous Cultural Heritage of the EIS.

Indigenous Cultural Heritage

The World Heritage and National Heritage listings pertaining to the Great Barrier Reef acknowledge the presence of Indigenous cultural heritage values within these areas.

Search results from the DERM Indigenous Cultural Heritage Register and Database found Indigenous places are concentrated in the coastal development strip to the north of Gladstone and, given the extent of industrial development in the study area, are relatively low in number.

A number of Indigenous cultural heritage places and objects are situated within, or in close proximity to the project area. While no sites of ‘national significance’ have been identified within the study area, places or objects may hold significance to local Aboriginal parties.

When viewed exclusively from a scientific perspective, the impact of the Arrow LNG Plant on Indigenous cultural heritage is low. Many of the archaeological sites identified in the disturbance footprint can be found elsewhere in the region, and include numerous, directly comparable examples with scientifically low-order sites, many of which offer far more opportunity for detailed investigation and analysis than those currently known to exist within the study area.

Avoidance of Indigenous cultural heritage places and objects is the preferred management measure. The ability to relocate specific elements of the project is limited and some impacts will be unavoidable. If avoidance is not possible, the loss of sites in the study area would be offset by a suitable program of mitigation, which will include:

- Develop an approved CHMP or a native title agreement that addresses Aboriginal cultural heritage in consultation with the endorsed Aboriginal parties for the project [C24.01].
- Comply with the approved CHMP or native title agreement that addresses Aboriginal cultural heritage [C24.02].
- Consider the cultural heritage management principles set out in Section 7.2.3 of the Indigenous Cultural Heritage Impact Assessment completed for the project (Appendix 18 of the EIS) when developing a CHMP or native title agreement that addresses Aboriginal cultural heritage. Agree final principles with the relevant Aboriginal parties/native title parties [C24.03].

Non-Indigenous Cultural Heritage

Non-Indigenous cultural heritage impacts associated with the project generally relate to the clearing of land and earthworks for the construction of the LNG plant and ancillary facilities. A small number of non-Indigenous heritage sites are located in the project area, particularly on the southwestern corner of Curtis Island. None of the sites are listed in any national, state or local council heritage register or heritage list, but may have local significance.

The standard heritage practice measures for managing impacts on non-Indigenous cultural heritage sites encompass avoidance, relocation, salvage, archival recording and interpretation. Other mitigation will include:

- Prepare a heritage management plan prior to construction which specifies how known and unknown heritage sites are to be managed during construction [C25.01].
- Include in the heritage management plan prepared prior to construction, requirements for accidental discovery, and management of cultural heritage items or human remains. Conflict resolution and other contingencies will also be addressed in the plan [C25.06].

6.1.5 Summary of Potential Impact

Impacts on geological values of the GBRWHA from the project are likely to be insignificant, as geological formations will not be affected by the project. The landscape of Curtis Island will be altered as a result of earthworks for the construction of the LNG plant site, involving cut and fill of this area. Mitigation to control erosion and sedimentation will be implemented, and the design of the LNG plant site has been undertaken to lower the infrastructure into the natural landform, and use shielding by retained trees wherever possible. The impact on landscape processes will be localised and largely confined within the industry precinct designated for the LNG plants on Curtis Island.

Impacts from pollutants or contaminants entering waterbodies within the GBRWHA will be insignificant. Stormwater will be managed across all project sites during construction and operation and will assist in controlling the runoff of sediment and other pollutants.

The outfall off Boatshed Point will result in localised impacts. Water quality criteria will be achieved within 10 m from the point of discharge under all hydrodynamic and tidal conditions. Similarly, salinity levels will return to a natural range of salinity offshore Boatshed Point within 10 m from the discharge location. Modelling of dredge plumes has indicated that dredging will have a short term and localised impact on concentrations of suspended sediments in areas adjacent to the dredging activities.

The Arrow LNG Plant will remove regulated vegetation and habitat from the GBRWHA, although the proportions when compared to available habitat within the Gladstone area and bioregion are low. It is not anticipated that the removal of vegetation will reduce the diversity or fragment, isolate or substantially damage remaining habitat for flora and fauna. Arrow will produce an Offsets Plan which will be developed prior to construction, in consultation with DERM and the Department of

Sustainability, Environment, Water, Population and Communities where impacts on ecological assets cannot be avoided or adequately mitigated.

Construction, operations and decommissioning will produce noise and air emissions. Emissions will meet relevant air quality and noise criteria and will not have a significant impact on the values of the GBRWHA.

Historic heritage values within the project area are generally low, with the few Indigenous cultural heritage sites on the registers being of low scientific value, although places or objects may hold significance to local Aboriginal parties. No non-Indigenous sites are listed in any national, state or local council heritage register or heritage list, but sites within the project area may have local significance.

The construction, operation and decommissioning of the Arrow LNG Plant will not lead to any values of the GBRWHA being lost. The project will have minor impacts to values of the GBRWHA on Curtis Island, such as clearance of vegetation and alteration of the landscape.

Within Port Curtis, impacts will be from the loss of marine habitat, and disturbance and displacement of marine fauna species. Dredging has the potential to have a temporary and localised impact on the concentrations of suspended sediments in areas adjacent to dredging activities. Shipping movements may lead to increased boat strike of marine fauna, although vessel speed is typically low, and propeller guards (or equivalent) will be installed on high-speed vessels where feasible, to reduce the impact of injury in the event of a boat strike. Marine infrastructure for the project is not located within the Great Barrier Reef Marine Park.

The GBRWHA has been considered in the assessment of impacts of the project, the development of mitigation measures and the environmental management plan for the project. Potential impacts on the values of the GBRWHA will be further considered in the further development of the design of the project.

6.2 Threatened Ecological Communities

The EPBC Protected Matters Searches, literature review and field surveys identified four threatened ecological communities as being present or potentially present in and adjacent to the project area, based on their likelihood of occurrence according to distribution.

Field surveys confirmed the presence of one threatened ecological community listed under the EPBC Act. This was the ‘critically endangered’ littoral rainforest and coastal vine thickets of eastern Australia. Within the study area this community was represented by small pockets of low microphyll-notophyll vine forest, including a small pocket of vine forest situated on a small Holocene sand dune on the eastern side of Hamilton Point.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.

- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or;
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.
- Interfere with the recovery of an ecological community.

The community is located on the eastern margin of Hamilton Point, and is not within the project area. Therefore, the extent of the community will not be affected, cleared or fragmented as a result of the project. Habitat and abiotic factors within the community will not be altered by the project, and no burning or harvesting will take place.

Although roads and other infrastructure avoid the area on Hamilton Point, the asset could be vulnerable to weed infestation, trampling from increased personnel movement and potentially increased fire frequency. The presence of the critically endangered community was considered in project design, and haul route options at Hamilton Point were routed away from the eastern margin of the headland to avoid the 'Critically Endangered' RE 12.2.2 ('Microphyll/notophyll vine forest on beach ridges') [C17.05].

In addition, the following mitigation will be implemented:

- Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present [C17.22].
- Clearly mark no go zones, where required, including the semi evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the 'critically endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected) [C17.23].
- Develop weed management measures prior to initiation of construction activities in accordance with local and regional management guidelines and best practice advice prescribed in DERM's pest control factsheet series [C17.09].

6.2.1 Summary of Potential Impact

The project is not expected to have a significant impact on threatened ecological communities. Project infrastructure will avoid the area around the community on Hamilton Point, access will be prevented to the area and mitigation measures implemented to prevent weed invasion.

6.3 Protected Species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population.

- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species.
- Reduce the area of occupancy of an important population.
- Fragment an existing important population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of an important population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere substantially with the recovery of the species.

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

As discussed in Section 3.2, the likelihood of a species being present within the study area was assessed within the technical studies. All species with a rating of low to moderate and above (therefore considered possible to occur within the project area) are assessed in the sections below against the relevant significant impact criteria from the EPBC guidance note, and using information from the Species Profile and Threats Database maintained by the Commonwealth Government to provide information about species and ecological communities listed under the EPBC Act. All other species were considered not possible within the project area as a result of a lack of suitable habitat, or being outside of the species normal range, and therefore are not assessed further. The precautionary approach ensures that species that could potentially occur, despite marginal habitat or being known only from the wider region, are considered below.

No terrestrial flora or fauna species listed as critically endangered, endangered or vulnerable under the EPBC Act were identified through field surveys within the study area for the project. However, the following species, based on habitat preference and distribution, may occur within the project area.

Specimens of an unidentified species of *Cupaniopsis*, thought to be closely related to the threatened flora species, wedge-leaved tuckeroo (*Cupaniopsis shirleyana*), were identified within the study area during early field surveys. The recorded specimens were identified by the Queensland Herbarium as *C. shirleyana*, which is currently listed as 'Vulnerable' under both the EPBC Act and Nature

Conservation (Wildlife) Regulation 2006 (Qld). These specimens were recorded within an area of semi-evergreen vine thicket, located on the southern extent of Boatshed Point.

This area was revisited and assessed in detail during later surveys. 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. Initial assessment in August 2010 indicated that the sampled species, herein referred to as *Cupaniopsis* sp. indet. is potentially a new taxon. The results from the Queensland Herbarium are still awaited.

Potential impacts from the project on terrestrial flora and fauna are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

6.3.1 Terrestrial Fauna

A total of 11 terrestrial fauna species identified in database searches were, after further desktop review and field survey, thought to possibly occur within the project area. None of these species were identified in the project area through the course of field surveys for the project.

Australian Painted Snipe

The Australian painted snipe has a 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. Its habitat includes small islands where it prefers to build nests and although more common in southeast Australia and ephemeral wetlands in inland areas, there are records from across Queensland. The species is an infrequent visitor to the Queensland coast. It can be a permanent resident but is more likely to be nomadic, temporarily occupying suitable habitat areas. It can be found in loose colonies, although it is more likely to be found in small polyandrous groups or as breeding pairs.

There are no ephemeral wetlands in or adjacent to the project area for the Arrow LNG Plant. Low lying grassland conducive to water ponding occurs around TWAF 8, but none are present at the site. The species was not recorded in surveys for the Arrow LNG Plant or other LNG projects on Curtis Island.

The Species Profile and Threats database (DSEWPaC, 2011b) lists key threats for the Australian painted snipe as loss and degradation of wetland habitat (including decline in water quality and invasion by noxious weeds) and predation from feral fauna species such as red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) as the species nests on the ground.

The Arrow LNG Plant does not involve removal of suitable wetland habitat for this species, as no freshwater wetlands are impacted by the project. Therefore the loss of wetland habitat will not be an impact of the Arrow LNG Plant. The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement the measures outlined in the pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora on this and other species.

There is no recovery plan for Australian painted snipe.

Significant Impact Criteria – Australian Painted Snipe

1) Lead to a long-term decrease in the size of an important population of a species.

While low lying grassland on the mainland and Curtis Island provides habitat for the species, the habitat in the study area is patchy and the species was not observed in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) notes that it has been mainly recorded in the Murray-Darling region, Southeast Queensland and in the southeastern states.

The likelihood of Australian painted snipe being present in the study area is low, as suitable freshwater wetland habitat is not present. Although patchy marginal habitat is present within the study area, the species is likely to only be present in such areas on a transitory basis on very rare occasions.

Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   The Australian painted snipe was not observed in the study area which contains patchy habitat. The Arrow LNG Plant does not cover suitable habitat for the species. For these reasons, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   The species was not observed in the study area which contains patchy habitat for the species. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The study area contains patchy habitat for the Australian painted snipe which was not observed in surveys carried out for the project. No freshwater wetlands will be removed in the project area. Project activities will not adversely affect habitat critical to the survival of the species because there is a lack of suitable habitat.

5) Disrupt the breeding cycle of an important population.

   As suitable habitat is patchy and will be avoided by construction and operation activities for the Arrow LNG Plant and no birds were observed in the field surveys, project activities will not disrupt the breeding cycle of an important population of the Australian painted snipe.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The Australian painted snipe favours shallow inland wetland habitats, which are either permanently or temporarily filled. Low lying grassland conducive to water ponding occurs around TWAF 8, in cleared and partially cleared farmland. The quality of the habitat is dependent on land use which varies from grazing to horticulture to hobby farms. No ephemeral wetlands will be affected by construction and operation of the Arrow LNG Plant. Consequently, project activities will not cause the species to decline as a result of modification or loss of quality habitat.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive species (both flora and fauna) have been identified as a key threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of

construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

8) Introduce disease that may cause the species to decline.

Disease has not been identified as a main threat to Australian painted snipe. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

No recovery plan is in place for the species. No habitat suitable for the species will be lost as a result of project activities. Therefore, project activities will not interfere with the recovery of the species.

It is unlikely that any impacts from the project upon Australian painted snipe are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of habitat, and will implement measures to reduce the impacts of pest flora and fauna species as a result of the project.

No Australian painted snipe have been identified in the study area for the Arrow LNG Plant. The species is nomadic and typically found on ephemeral wetlands in inland areas, rarely visiting coastal areas. As such, the species is likely to be a very infrequent visitor to the Gladstone region, and should it occur, it will be found in suitable freshwater wetland areas away from the project area. No areas were identified as habitat critical to the survival of the species.

No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this, and other, species. In conclusion, impacts on the Australian painted snipe from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no birds were observed and no suitable freshwater wetland habitat will be removed by the project.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Black-breasted Button-Quail

The black-breasted button-quail populations are small and isolated and in Queensland are confined to restricted habitat in the southeast Queensland Bioregion. Up to 14 groups have been identified with the most significant populations found in the Jimna-Conondale Range, Yarraman-Nanango and Great Sandy regions of Queensland (DSEWPaC, 2011b). It is found to favour 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.

The species' distribution and range is limited by vegetation clearing for forestry and agricultural developments. Other threats include fragmentation of remaining habitat by grazing by cattle, horses and feral pigs, loss of shrubby understorey from frequent fire events and predation by cats, foxes and pigs.

Vegetation clearance for the Arrow LNG Plant is unlikely to result in reduced habitat within the range of the black-breasted button-quail, no large suitable areas of vine thicket or dry rainforest habitat for the species will be removed for the project infrastructure associated with the Arrow LNG Plant.

The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Black-breasted Button-Quail

1) Lead to a long-term decrease in the size of an important population of a species.

   While the small patches of vine thicket found on the mainland in the western half of the study area provide suitable habitat for the species, no birds were observed in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any populations in the Gladstone region, as being of importance for the species.

   Habitat for the species within the study area is sparse with small patches of vine thicket found on the mainland in the western half of the study area. The species is not known from Curtis Island. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species, as it has undergone significant range contraction in the north of its range.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in surveys – described in Section 3 of Appendix 9 to the EIS – for the Arrow LNG Plant.

   Consequently, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by individuals not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. The removal of the small area of vine thicket (RE 12.11.4) on the southern tip of Boatshed Point will not fragment this habitat, and a wildlife corridor will be established on the eastern shore of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the Curtis Island Environmental Management Precinct, although it is unlikely the species is present on Curtis Island.

   Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The species is associated with vine thicket rainforest, such as that found on Boatshed Point or small areas of TWAF 8. The species is not known on Curtis Island, and is unlikely to be present within the Gladstone region, having undergone significant range contraction.

   The black-breasted button-quail was not observed in the study area. Suitable habitat exists only as small isolated patches with no connectivity to large tracts of habitat. As no large suitable areas of vine thicket or dry rainforest habitat for the species will be removed for the project infrastructure associated with the Arrow LNG Plant, project activities will not adversely affect habitat critical to the survival of the black-breasted button-quail.

5) Disrupt the breeding cycle of an important population.

   Important populations occur in the Jimna-Conondale Range, Yarraman-Nanango and Great Sandy regions of Queensland (DSEWPaC, 2011b). No species were identified in the study area which is remote from areas occupied by the 14 main groups in Queensland. Potential suitable habitat occurs as patches not connected to larger tract of similar vegetation. Therefore, project activities will not adversely affect habitat critical to the survival of the species.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The black-breasted button-quail favours vine thicket habitat. Within the study area, the species has been identified as having a low to moderate likelihood of occurrence within RE 12.11.4. The location of this RE within the study area is shown in figures 5 and 6.

   The proportion of vine thicket (RE 12.11.4), proposed to be cleared for the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is described in Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts. Approximately 3 ha of RE 12.11.4 will be cleared for the infrastructure associated with referral EPBC 2009/5007.

   The area of the RE to be cleared as a proportion of the extent of the RE within the Gladstone Regional Council area and Queensland is 0.13% and 0.10% respectively. As the species is not likely to be associated with the small pockets of remnant vegetation, the project will not contribute to cumulative impacts on this species in the Gladstone region.

   Project activities will not modify or remove quality habitat to the extent that it would cause the species to decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   The Species Profile and Threats database (DSEWPaC, 2011b) identifies invasive species (both flora and fauna) as a key threat to the species.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to black-breasted button-quail. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   The project will not exacerbate threatening processes identified in the recovery plan for the species in areas of its range. The Arrow LNG Plant will not contribute towards the loss and fragmentation of habit and the impact from pest flora and fauna will be negligible, as the species is unlikely to be present in the study area.

It is unlikely that any impacts upon black-breasted button-quail are unknown, unpredictable or irreversible.

The species was not identified in the study area in the course of surveys for Arrow Energy or any of the other LNG projects on Curtis Island. Desktop searches indicate that the species is not present in the region having undergone a significant range contraction, although if it does occur, it is likely to be found within vine thicket habitat such as RE 12.11.4.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this species, should it occur in the project area.

No offsets are required for this species, as the project area is outside its known range and suitable habitat (RE 12.11.4) is largely avoided by the Arrow LNG Plant, although approximately 3 ha will be cleared on Boatshed Point. RE 12.11.4 has been identified as a likely area requiring to be offset as a result of vegetation clearance associated with the LNG facility component of the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for this RE will have benefits for this and other species potentially found within this RE, such as the black-breasted button-quail.

In conclusion, impacts on black-breasted button-quail from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no critical habitat has been identified and although a small area of suitable vine thicket or dry rainforest habitat will be removed by the project, it is unlikely to hold the species which is unknown on Curtis Island.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Red Goshawk

The red goshawk is found in northern Australia and eastern Queensland where it requires a very substantial home range covering between 50 and 220 km^2. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley to northeastern NSW. The largest densities of the species have been reported from the Northern Territory and the Kimberley region of Western Australia. It utilises a variety of habitat types including tall open forest, woodland, savannah with scattered trees and the edge of rainforest, favouring areas near rivers and a mosaic of forest types.

Open forest and woodlands of the study area provide suitable habitat for the red goshawk. It is possible the species could be found in the patches of open forest and woodland in the study area.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss (deforestation of lowland and riverine forests), illegal egg collecting and potential threats such as changes in land management, persecution, disease and application of pesticides which may result in shell thinning.

Potential impacts from the Arrow LNG Plant may include loss of foraging habitat through the clearance of eucalypt woodland. However, the loss of the foraging habitat is small in comparison to similar habitat available in adjacent areas, and the habitat within the project area is sub-optimal for the species.

There is no recovery plan for the red goshawk.

Significant Impact Criteria – Red Goshawk

1) Lead to a long-term decrease in the size of an important population of a species.

   Ecological surveys for the Arrow LNG Plant and other LNG projects did not identify the red goshawk in or adjacent to the study area, and there are no records of sightings in the Gladstone region. Consequently, project activities will not lead to a long-term decrease in the size of an important population of the red goshawk.

2) Reduce the area of occupancy of an important population.

   No birds or nests have been recorded or found in surveys carried out for the Arrow LNG Project and other LNG projects on Curtis Island. As similar, more intact foraging habitat (woodland near watercourses) is available in adjacent areas, particularly the Curtis Island Environmental Management Precinct, Targinie State Forest and conservation reserves on Curtis Island, project activities will not reduce the area of occupancy of an important population.

   There is no indication that there are important populations in the Gladstone region.

3) Fragment an existing important population into two or more populations.

   Red goshawk is a highly mobile species with a large territory, which is likely to make local movements within its territory in relation to food and water supply.

   Habitat to be cleared for the Arrow LNG Plant is sub-optimal foraging habitat for the red goshawk. This is reinforced by the lack of evidence of visitation in the study area (mainland and Curtis Island) and adjacent areas on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   Suitable habitat for the red goshawk on the mainland and Curtis Island is sub-optimal which is supported by the lack of sightings of the species in and adjacent to the study area. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any critical habitat or important populations of the species, and there are no records on Curtis Island or the adjacent mainland (Garnett *et al*, 2011). The area of sub-optimal habitat lost as a result of project activities is small in comparison to the area of suitable habitat in adjacent areas including conservation reserves. Consequently, project activities will not adversely affect habitat critical to the survival of the red goshawk.

   The species favours a range of woodland habitats, with a mosaic of vegetation types, large prey populations (birds), and permanent water. No large areas of habitat suitable for the species will be removed for the project infrastructure. The loss of eucalypt woodland habitat on Curtis Island is small in comparison to similar habitat in the surrounding area.

5) Disrupt the breeding cycle of an important population.

   No nests were identified in surveys for the Arrow LNG Plant and other LNG projects. Consequently, project activities will not disrupt the breeding cycle of an important population of the red goshawk.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Construction and operation activities for the Arrow LNG Plant will result in the loss of suitable habitat for the red goshawk. However, the habitat has been assessed as sub-optimal. Clearance

of vegetation (and habitat) for the Arrow LNG Plant will not lead to a decline in the red goshawk because the lack of historic records and sightings indicates it is not known in the area, or a very infrequent visitor.

The species is not associated with any particular RE within the study area, and frequents a variety of woodland habitats, predominantly tall open forest within 1 km of a wetland or waterbody (Garnett *et al*, 2011).

The combined area of the plant and associated facilities will be between 304 and 345 ha, depending on the final site of the marine facilities. The Curtis Island Industry Precinct (including the Arrow LNG Plant and other three LNG plant sites) covers less than 3% of the overall area of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to be in the more extensive habitat of varying quality, in undisturbed areas in the north of the island in the vicinity of wooded watercourses.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   No invasive flora or fauna has been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has been identified as a key threat to the red goshawk, as has the application of pesticides, the effects of which result in thinning of egg shells. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and sub-optimal habitat will be lost to the project, proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for such species as the red goshawk.

It is unlikely that any impacts from the project upon red goshawk are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of critical habitat, and the potential impact from disease will be unlikely due to the implementation of pest and quarantine management plans for the project.

There are no historic records of the species in the Gladstone area and the species was not identified in the study area in the course of surveys for Arrow Energy or any of the other LNG projects. Although it is a secretive species, it is highly unlikely to be present based on the available sub-optimal habitat and adjacent GLNG Project construction activities. The loss of sub-optimal habitat is small in comparison to suitable habitat in adjacent areas including the Curtis Island Environmental Precinct and Targinie State Forest on the mainland. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

In conclusion, impacts on the red goshawk from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as there are no historic records of the species in the area and no individuals were observed in recent surveys. Further, the sub-optimal habitat to be cleared for the project is small in comparison to the potential foraging habitat available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Squatter Pigeon

The squatter pigeon inhabits the grassy understorey of open woodland and is largely found on inland slopes of the Great Dividing Range. The species is nomadic in response to food and water resources.

This species was observed frequently in disturbed pasture grassland and woodland within several kilometres of the mainland section of the study area in surveys for the project. These habitat types occur throughout the study area, and as such it is assessed as highly likely to occur in the study area, including the woodland and grassland habitats around TWAF 8.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include the loss of habitat due to clearing for agricultural or industrial purposes, degradation of habitat by grazing herbivores and excessive predation, particularly from pest fauna such as the red fox and feral cat.

The species could potentially be impacted by habitat loss, fragmentation and edge effects and direct disturbance from increased personnel and vehicle presence. Vegetation clearance for the Arrow LNG Plant is unlikely to result in significantly reduced habitat within the range of the squatter pigeon. The species favours a variety of woodland and grassland habitats, which are widespread in the study area, and the species is mobile and likely to be present in a wide variety of habitats on the mainland, moving in relation to food and water supply.

Squatter pigeon was identified as having a moderate or higher likelihood of occurrence around TWAF 8 in RE 11.3.4, but may also be present in other habitats. The location of this RE within the project area is shown on Figures 5 and 6. Approximately 24 ha of RE 11.3.4 will be cleared for the infrastructure associated with referral EPBC 2009/5007.

However, this loss of habitat is small in comparison to the large extent of similar habitat in the surrounding Gladstone area. Eucalypt woodland vegetation communities to be cleared for the project comprise less than 1% of each of the regional ecosystems locally and in the bioregion. Clearance of RE 11.3.4 comprises 8.09% and 0.26% of clearance in the Gladstone area and bioregion respectively.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for squatter pigeon.

Significant Impact Criteria – Squatter Pigeon

1) Lead to a long-term decrease in the size of an important population of a species.

While eucalypt woodland habitat on the mainland around TWAF 8 is suitable habitat for this species, no individuals were identified in the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any local populations as being especially important to the long-term survival or recovery of the squatter pigeon.

Due to the extent of similar habitat in adjacent areas, and the mobile nature of the species, it is unlikely that the project will result in a long term decrease in the size of the population, even if the local population were an important population.

2) Reduce the area of occupancy of an important population.

No species were observed in the study area. Individuals were observed at sites within several kilometres of the study area. As no individuals were identified, project activities are highly unlikely to reduce the area of occupancy for an important population.

3) Fragment an existing important population into two or more populations.

Squatter pigeon is a mobile species, which is likely to make local movements in relation to food and water supply.

No important population has been identified in the study area, as evidenced by the squatter pigeon not being discovered in the study area in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

There is no indication that the population in the Gladstone region is an important population.

4) Adversely affect habitat critical to the survival of a species.

No areas of critical habitat have been identified on the Species Profile and Threats database (DSEWPaC, 2011b). While individuals were observed adjacent to the study area, none were observed in the study area. Vegetation communities within the study area include the wide range of habitats utilised by the squatter pigeon and it is highly likely the species might utilise the area periodically for foraging. However, as substantial tracts of similar habitat exist in the Curtis Island Environmental Management Precinct, on Curtis Island generally and on the mainland, project activities will not adversely affect habitat critical to the survival of the species.

Around TWAF 8, areas of clearing will be relatively small, and large areas of suitable habitat around the site will be available, such as Targinie State Forest. Clearance will not fragment suitable habitat. A corridor of vegetation along the creek will be retained at this site.

5) Disrupt the breeding cycle of an important population.

There is no indication that the population in the Gladstone region is an important population. No individuals were discovered during surveys for the Arrow LNG Plant and other LNG projects. As no individuals were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the squatter pigeon.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The squatter pigeon favours a variety of woodland and grassland habitats, which are widespread within and adjacent to the study area. The species was identified as having a moderate or higher

likelihood of occurrence in woodland at TWAF 8 in RE 11.3.4, but may also be present in other habitats. The location of this RE within the project area is shown on Figures 5 and 6.

The proportion of RE 11.3.4 proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is 8.09% of the local resource and 0.26% of the resource in the bioregion. Table 6.4 (Section 6.5) provides a detailed list of vegetation (habitat) clearance for the project which is also assessed in Chapter 32, Cumulative Impacts.

The extent and quality of habitat lost as a consequence of project activities is small in comparison to the available habitat in the vicinity of the project area, particularly in the Curtis Island Environmental Management Precinct and Targinie State Forest. The lack of evidence of usage of the available habitat means it is highly unlikely the loss of habitat will result in a decline in the species in the region.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive species (fauna) have been identified as a key threat to the species (DSEWPaC, 2011b), particularly foxes and feral cats.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to squatter pigeon. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest contain similar habitat. Proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for such species as the squatter pigeon.

It is unlikely that any impacts upon squatter pigeon are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of critical habitat, with areas of suitable habitat cleared for the project similar to large areas of available habitat in adjacent areas. The potential impact from pest fauna will be unlikely due to the implementation of a pest management plan (Appendix 10 to the EIS) for the project.

The species is likely to be sparsely distributed in the study area associated with the project. The species is highly mobile, and likely to move in and out of the study area utilising a wide variety of habitats in response to food resource. Although the cumulative loss of RE 11.3.4 within the Gladstone

area and Queensland is 8.09% and 0.26% respectively, the species is expected to be associated with similar grassland and woodland habitats within and adjacent to the study area.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this, and other species. No offsets are required under the EPBC Act for this species. RE 11.3.4 has been identified as a likely area requiring to be offset under the *Vegetation Management Act 1999* (Qld) as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the Vegetation Management Act for this RE will have benefits for species potentially found within this RE, such as the squatter pigeon.

In conclusion, the impacts on squatter pigeon from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no critical habitat has been identified and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat of that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Yellow Chat

The Capricorn race of yellow chat is endemic to the central Queensland Coast. It is known only on Curtis Island and the adjacent mainland coast, where its range is estimated to be 25 km^2. It 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.

An assessment of the habitat types present within the study area reveals that any areas of wet grassland and/or saltmarsh, are generally small and heavily degraded. The stronghold of this species in the region is further north around northern Curtis Island, near the Fitzroy River delta and Torilla Plain (Garnett *et al*, 2011), remote from the study area. Numbers at Curtis Island Marine Plain suggest that this location is no longer used by the species (Garnett *et al*, 2011).

No individual species, breeding sites or nesting sites were observed in the study area.

A recovery plan for yellow chat (Houston and Melzer, 2008) has been produced. It identifies threats to the species from modification to hydrological regimes through flow reductions into catchments and construction of barriers within tidal areas where the subspecies occurs. Exotic pasture grasses could potentially have an adverse affect on the Yellow Chat (Capricorn race) by replacing native plants such as *Paspalum distichum* or *Cyperus alopecuroides*, which are dominant species in some habitat occupied by the chat.

The Arrow LNG Plant is unlikely to result in reduced habitat within the range of the yellow chat, as habitat present within the study area is marginal and degraded.

Impacts on the hydrological regime of the project area will not affect potential habitat of the yellow chat, as they are confined to stream diversions of the ephemeral watercourses that drain the LNG plant site. The ephemeral watercourses drain to intertidal mudflats with negligible suitable habitat. The stream diversions will maintain flows to the intertidal mudflats.

Significant Impact Criteria – Yellow Chat

1) Lead to a long-term decrease in the size of a population.

While the intertidal habitat on Curtis Island provides suitable habitat for the species, no birds or nests were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. While the Species Profile and Threats database (DSEWPaC, 2011b) identifies that populations of the Capricorn subspecies of the yellow chat is located on the Torilla Plain and the Fitzroy River delta, and a third breeding population could persist on northern Curtis Island, these known populations are remote from the study area for the Arrow LNG Plant.

Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of the species.

2) Reduce the area of occupancy of the species.

No individuals, breeding sites or nesting sites were identified in the study area. Degraded intertidal habitat is present along southern parts of Curtis Island and recent research suggesting that the Curtis Island Marine Plain is no longer used by the species (Garnett *et al*, 2011) also indicates that construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of species.

Removal of intertidal habitat on Curtis Island for marine infrastructure will be minimal and limited to rocky substrates and a small area of fringing mangroves and saltpan. This habitat is not part of the range of the yellow chat and as such the project will not reduce the area of occupancy for the species.

3) Fragment an existing population into two or more populations.

No population has been identified in the study area, as evidenced by breeding sites, individual species and nesting sites not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Given this, project activities will not fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

No individuals or nesting sites have been identified in the study area. Vegetation in the study area includes intertidal habitat along the northern side of Hamilton Point in North China Bay, being suitable habitat for this species.

The species favours coastal wetland and grassland habitats, and if it were to occur in the project area, it is likely to be associated with RE 12.1.2, albeit on a transitory basis. The location of this RE within the project area is shown on Figures 5 and 6.

The proportion of RE 12.1.2 proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects in the Gladstone region is described in Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts. Approximately 6 ha of RE 12.1.2 will be cleared for the infrastructure associated with referral EPBC 2009/5007.

However this vegetation along the north shore of Hamilton Point is degraded, and the area already significantly disturbed from industry at adjacent LNG project sites in the Curtis Island Industrial Precinct. Recent research suggests that the Curtis Island Marine Plain is no longer used by the species (Garnett *et al*, 2011). This indicates that project activities will not adversely affect habitat critical to the survival of the species.

The extent of the RE to be cleared by all projects, as a proportion of the extent of the RE within the Gladstone Regional Council area and Queensland, is 0.77% and 0.42% respectively.

However, as discussed, the species is not likely to be present in the project area other than on a transitory basis, and the area of occupancy of the species will not be affected by the project.

5) Disrupt the breeding cycle of a population.

   Breeding and nesting sites were not discovered during surveys for the Arrow LNG Plant and other LNG projects. Given this, project activities will not disrupt the breeding cycle of a population of the yellow chat.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The yellow chat inhabits marine plain wetlands that experience extensive seasonal inundation and fresh and saltwater influences (Garnett *et al*, 2011). 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. The intertidal habitat for the species along the southern parts of Curtis Island is degraded and not known to support populations of this species. Project activities will not lead to a decline of the species through modification or loss of suitable habitat.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

   Exotic pasture grasses which displace native flora species in habitat occupied by the yellow chat have been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the yellow chat. The pest management plan (Appendix 10 the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species.

   A recovery plan for yellow chat (Houston and Melzer, 2008) has been produced. It identifies threats to the species from modification to hydrological regimes through flow reductions into catchments and construction of barriers within tidal areas where the subspecies occurs.

   The project will not result in the threatening processes identified in the recovery plan for the species. Industrial expansion as a result of the project is into areas of habitat not suitable for the species.

It is unlikely that any impacts upon yellow chat are unknown, unpredictable or irreversible. Of the main threats identified to the yellow chat (DSEWPaC, 2011b; Houston and Melzer, 2008), the Arrow LNG Plant will not contribute towards the loss and fragmentation of habitat suitable for the species, and known populations are not present within the study area. The species is not known from within the study area for the Arrow LNG Plant, and is unlikely to be present other than on a transitory basis. The range for the species is to the north of Curtis Island and the adjacent mainland coast, away from proposed works and as such the project will not impact upon the species.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this species.

In conclusion, impacts on yellow chat from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no optimal habitat has been identified and populations are not known within the study area.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Northern Quoll

The northern quoll inhabits a range of open woodland and open forest types. Northern quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. It is distributed across the eastern half of Queensland in fragmented populations with the highest densities occurring in the Mackay-Whitsunday area. Recent surveys throughout Queensland have suggested northern quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and are closer to permanent water (DSEWPaC, 2011b).

Patches of suitable vine thicket and open-forest/woodland habitat (RE 11.3.4) on rocky slopes occur along the Mount Larcom Range which is located to the west of the study area. Eucalypt open-forest/woodland habitat occurs on Curtis Island, although it has low relief in comparison to Mount Larcom Range, and there are limited rocky areas, particularly those containing boulders. The study area is subject to periodic fuel reduction burns and has cane toad infestations. Feral horses and pigs use the study area on Curtis Island.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and in the recovery plan for the species (Hill and Ward, 2010) include habitat loss, weed invasion, inappropriate fire regimes and predation by feral predators, as well as death by ingestion of the toxic cane toad.

The northern quoll was not recorded in field surveys for the project or other LNG projects on Curtis Island. The species is likely to be uncommon in the area based on the lack of records in the area, and if present, it would range widely over a large territory. If present, vegetation clearing, fuel reduction burning and actions that cause an increase in cane toad populations could potentially affect the northern quoll.

The species was assessed as having a moderate or higher likelihood of occurrence in RE 11.3.4 at TWAF 8 (see Figure 6). RE 11.3.4 is not represented in eucalypt open forest and woodland on Curtis Island, although eucalypt woodland on slopes on Curtis Island could provide habitat for this species.

The patch of RE 11.3.4 lost for construction and operation of TWAF 8 is small in comparison to patches adjacent to that site and in and adjacent to the study area. Available habitat is present in adjacent areas to TWAF 8 such as Targinie State Forest.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Northern Quoll

1) Lead to a long-term decrease in the size of a population.

The northern quoll was not identified in surveys – described in Section 3 of Appendix 9 to the EIS – for the Arrow LNG Plant. Suitable habitat in the study area is limited and subject to edge effects from construction in the Curtis Island Industrial Precinct on Curtis Island. The loss of potentially suitable habitat is small in comparison to available habitat in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest on the mainland, near TWAF 8. Project activities will not lead to a long-term decrease in the size of a population.

2) Reduce the area of occupancy of the species.

Northern quoll is a mobile species with large territories. It makes local movements within its territory in relation to food and water supply. The species was not found in the study area and potentially suitable habitat is subject to periodic fuel reduction burns, is used by feral horses and pigs (on Curtis Island) and is exposed to edge effects from current construction activities on Curtis Island. Construction of the Arrow LNG Plant is highly unlikely to reduce the area of occupancy of the species.

The species is not associated with any particular RE type within the project area on Curtis Island and favours a variety of woodland and forest habitats, particularly around rocky slopes. The species was not identified as having a moderate or higher likelihood of occurrence in this area.

The Curtis Island Industry Precinct (including the Arrow LNG Plant and three other LNG plant sites on Curtis Island) covers less than 3% of the overall area of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to be in less disturbed areas in the north of Curtis Island.

The species was identified as having a moderate or higher likelihood of occurrence around TWAF 8 in RE 11.3.4. Approximately 24 ha of RE 11.3.4 will be cleared for the infrastructure associated with referral EPBC 2009/5007.

The proportion of RE 11.3.4 proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is described within Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts.

The area of the RE to be cleared by all projects, as a proportion of the extent of the RE within the Gladstone Regional Council area and Queensland, is 8.09% and 0.26% respectively.

Around TWAF 8, areas of clearing will be relatively small, and large areas of suitable habitat around the site will be retained.

3) Fragment an existing population into two or more populations.

Northern quoll is a mobile species with large territories, which is likely to make local movements within its territory in relation to food and water supply.

The species was not identified in the study area in surveys for the Arrow LNG Plant. Potentially suitable habitat is sub-optimal and adjacent to larger tracts of more intact habitat, particularly in areas of the Curtis Island Environmental Management Precinct and Targinie State Forest. Around TWAF 8, areas of clearing will be relatively small, and large areas of suitable habitat around the site will be retained and the clearance will not fragment suitable habitat. A corridor of vegetation along the creek will be retained at this site.

On Curtis Island, a wildlife corridor will be established on the eastern shore of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the Curtis Island Environmental Management Precinct, although the species has not been recorded in this area.

Project activities are highly unlikely to fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The area of potential suitable habitat to be cleared for the Arrow LNG Plant is sub-optimal for the species, and is small in relation to uncleared areas within the adjacent Curtis Island Environmental Management Precinct and Targinie State Forest. No species were found in surveys for the Arrow LNG Project. Consequently, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population.

   As suitable habitat on the mainland and Curtis Island is sub-optimal and subject to threatening processes and no species were found, it is highly unlikely that the breeding cycle of a population of northern quoll would be disrupted.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Potentially suitable habitat for the northern quoll in the study area is largely sub-optimal and subject to threatening processes including periodic fuel reduction burns, cane toad infestations and edge effects from construction activities associated with the other LNG projects in the Curtis Island Industry Precinct. Clearing of part of the remnant patches of woodland will not decrease the availability or quality of habitat to the extent the species is likely to decline.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

   Invasive species (both flora and fauna) have been identified as a key threat to the species (DSEWPaC, 2011b; Hill and Ward, 2010).

   Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

   Cane toads were widespread and common throughout the study area during field surveys for the project. The species is already widely established in the area. The pest management plan (Appendix 10 of the EIS) includes measures to locally control cane toads although their distribution and reproductive potential limits the effectiveness of any control.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to northern quoll. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species.

The project will not result in threatening processes identified in the recovery plan for the species. Pest and quarantine management plans and control of invasive weeds on Curtis Island will support measures to reduce the decline in the species.

It is unlikely that any impacts upon northern quoll are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b; Hill and Ward, 2010), the Arrow LNG Plant will not contribute towards the loss and fragmentation of habitat suitable for the species, and the impact from pest flora and fauna will be negligible as the species is unlikely to be present in the project area. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

The species is likely to be uncommon within the project area, as the habitat is not optimal on Curtis Island. If present, it would range widely over a large territory. At TWAF 8 the species was identified as having a moderate likelihood of occurrence in RE 11.3.4. None of the surveys undertaken for the Arrow LNG Plant or other LNG projects on Curtis Island located this species.

If the species does occur on Curtis Island, it is likely to be largely within the suitable habitat to the north of the industry precinct, the remaining 97% of the island not covered by the industrial designation.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Suitable habitat (RE 11.3.4) is present at TWAF 8 but no records were found at this site. RE 11.3.4 has been identified as a likely area requiring to be offset as a result of vegetation clearance associated with the LNG facility component of the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for this RE will have benefits for this and other species potentially found within this RE, such as the northern quoll.

In conclusion, impacts on the northern quoll from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no optimal habitat has been identified in the project area and large areas of more suitable habitat are present to the north of the LNG plant in the Curtis Island Environmental Precinct and adjacent to TWAF 8 in Targinie State Forest.

Water Mouse

The water mouse occurs in three discrete populations on the eastern and northern Australian coastline. In central Queensland, it is known to occur in fringing mangroves in the high intertidal zone dominated by *Ceriops tagal* and/or *Bruguiera* spp.

Suitable intertidal habitat occurring along the mainland coastline and the southern section of Curtis Island was found. No individuals were recorded in surveys for the Arrow LNG Plant, although water mouse has been detected in surveys at the Australia Pacific LNG Project site. Consequently, the species was assessed as having a high likelihood of being present in the study area.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and in the recovery plan for water mouse (DERM, 2010) include habitat loss and degradation,

fragmentation, predation from introduced species and herbicides, acid sulfate soils exposure, pesticides and oil pollution.

Water mouse is likely to be present in mangrove habitat across the study area. Loss of areas of mangrove ecosystems, with abundant fallen woody debris and hollow logs, is likely to result in loss of habitat for the water mouse.

Vegetation clearance for the Arrow LNG Plant, requires removal of a small area of mangrove habitat on the northern margin of Hamilton Point with North China Bay. Impacts on the hydrological regime in the project area will be reduced by the implementation of a stormwater management plan by Arrow Energy, and a spill prevention and response plan. Arrow Energy has committed to implementing an acid sulfate soils management plan.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Water Mouse

1) Lead to a long-term decrease in the size of an important population of a species.

   While fringing mangroves along the mainland coastline and the southern section of Curtis Island provide suitable habitat for the species, no nest mounds were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant (see Section 3 of Appendix 9, Terrestrial Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSWEPaC, 2011b) does not identify any nesting sites in the Gladstone region. A small area of mangrove habitat will be removed for infrastructure associated with Referral No. EPBC 2009/5007. However, this comprises 1% of the available habitat within the study area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals or nest mounds were identified in the study area. Individuals were detected at a site adjacent to the study area. As no nest mounds were identified, and a small area of mangrove habitat (5 ha of RE 12.1.3) will be removed for infrastructure associated with Referral No. EPBC 2009/5007 (less than 1% of the RE within the study area), project activities are highly unlikely to reduce the area of occupancy of an important population.

   The locations of REs within the project area are shown on Figures 5 and 6.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by nest mounds not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island.

   The area of mangrove to be cleared along the north shore of Hamilton Point is adjacent to North China Bay, which is heavily disturbed and subject to edge effects from construction of the GLNG Project on Curtis Island. The mangrove habitat to be cleared does not connect to any mangrove habitat to the south along Hamilton Point.

   Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   Regional ecosystems (in Queensland) that are or likely to be essential habitat for the water mouse include RE 12.1.3 (DSEWPaC, 2011b). In central south Queensland, the water mouse has only been captured in the high inter-tidal zone in tall, closed fringing mangrove forest containing only *Ceriops tagal* and/or *Bruguiera spp.*

   While evidence of water mouse was detected adjacent to the study area on the Australian Pacific LNG Project site, none were observed or detected in the study area. Vegetation communities within the study area include the range of habitats utilised by the water mouse and it is highly likely the species might utilise mangrove habitat in the study area periodically for foraging. However, as similar tracts of habitat exist around Port Curtis, project activities will not adversely affect habitat critical to the survival of species.

5) Disrupt the breeding cycle of an important population.

   Nesting sites and mounds were not discovered during surveys for the Arrow LNG Plant and other LNG projects. As no nest mounds were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the water mouse.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The water mouse favours fringing mangroves in the high intertidal zone dominated by *Ceriops tagal* and/or *Bruguiera spp.* The species was assessed as having a moderate or higher likelihood of occurrence in RE 12.1.3. The location of this RE within the project area is shown on Figures 5 and 6.

   A small area (5 ha) of RE 12.1.3 will be removed for the infrastructure associated with referral No. EPBC 2009/5007. Arrow Energy will implement controls on weed and pest management, and to prevent spills, to reduce the risks of impacts to adjacent habitat for water mouse.

   The proportion of RE 12.1.3, proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects in the Gladstone region is described in Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts.

   The amount of the RE to be cleared by all projects as a proportion of the extent of the RE in the Gladstone Regional Council area and Queensland is 0.12% and 0.04% respectively.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b; DERM, 2010). Degradation of habitat by feral pigs and horses has also been identified as a threat to the species.

   Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of adjacent areas of habitat to the project inhabited by water mouse becoming degraded by weed invasion.

   A quarantine management plan will be developed for the project and its implementation will control pest fauna that may threaten the species, being introduced accidentally to areas of mangrove adjacent to the project.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to water mouse. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   The project will not result in threatening processes identified in the recovery plan for the species. A quarantine management plan and control of invasive weeds and pest fauna will support measures to reduce the decline in the species.

It is unlikely that any impacts upon water mouse are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the project will not contribute towards the loss and fragmentation of habitat, as only a small area (5 ha of RE 12.1.3) of mangrove habitat will be cleared, less than 1% of the available habitat in the study area.

No individuals, or nest mounds were identified in the study area, although individuals were detected in surveys on the Australia Pacific LNG Project site. The lack of evidence of visitation indicates it is highly unlikely the species is reliant on the area. It is likely to be uncommon in fringing mangroves around Port Curtis, and although the exact distribution and abundance of the species is unknown, a trapping program is proposed for the Arrow LNG Plant to establish the presence or absence of the species in the project area (see Section 17.7.2 of EIS).

The cumulative loss of RE 12.1.3 within the Gladstone area and Queensland is small, and if present the species is expected to be associated with and find refuge in, adjacent areas of mangrove habitat.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this species.

In conclusion, impacts on water mouse from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as a small area of mangrove habitat will be cleared for the project. This area of mangrove is already disturbed by industrial activity in North China Bay.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Grey-headed Flying Fox

The grey-headed flying fox is distributed along eastern coastal Australia, extending from Rockhampton to Melbourne. Curtis Island and Gladstone are located at the northern limit of its distribution. It is found to favour rainforests, open forests, closed and open woodlands, as well as melaleuca swamps and banksia woodlands. It is also found throughout urban and agricultural areas where food trees exist.

Vegetation communities (regional ecosystems) of the study area provide a wide range of suitable foraging habitat for the grey-headed flying fox. Consequently, the species was assessed as having a high likelihood of being present in the study area.

The grey-headed flying fox was observed at numerous sites adjacent to the study area on the mainland and in the area just south of Graham Creek on Curtis Island. No individuals or colonies were

recorded in the project area, nor were any roosts discovered in that area indicating the habitat available in the project area is not an important foraging resource.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include biological factors (restricted breeding season and one birth per year in context of modern day increase in flying fox mortality), habitat loss and fragmentation, shooting to reduce destruction of fruit at commercial orchards, competition with the black flying fox (*Pteropus alecto*) as this species' range extends further south, pollutants and electrocution on powerlines.

Vegetation clearance and the consequential reduction in foraging habitat may affect the grey-headed flying fox, as the project area is within its range. However, the loss of foraging habitat is small in comparison to the habitat available in adjacent areas, and the lack of sightings and roost sites indicates it is not important foraging or breeding habitat.

There is no recovery plan for the species.

Significant Impact Criteria – Grey-headed Flying Fox

1) Lead to a long-term decrease in the size of an important population of a species.

   While eucalypt woodland on the mainland and Curtis Island provides suitable habitat for the species, no breeding camps or roosts were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any colonies or breeding camps in the Gladstone region. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals, roosts or breeding camps were identified in the project area. Individuals were observed at sites adjacent to the study area. As no colonies or breeding camps were identified, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by breeding camps and colonies not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The study area and project area currently do not support colonies, breeding camps or roosts for the grey-headed flying fox. While individuals were observed adjacent to the study area, none were observed in the project area. Vegetation communities within the study area include the wide range of habitats utilised by the grey-headed flying fox and it is highly likely the species might utilise the area periodically for foraging. However, as substantial tracts of similar habitat exist in the Curtis Island Environmental Management Precinct, on Curtis Island generally and on the mainland, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population.

Breeding camps and roosts were not discovered during surveys for the Arrow LNG Plant and other LNG projects. As no colonies were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the grey-headed flying fox.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The grey-headed flying fox favours a variety of woodland habitats, and more open areas where suitable food trees are present. Spring foraging resources have been identified as critical to the survival of the species.

Within the project area, the species has been identified as having a moderate or higher likelihood of occurrence within REs 11.3.4, 12.3.3, 12.3.6, 12.3.7, 12.11.4, 12.11.6 and 12.11.14. The locations of REs within the project area are shown on Figures 5 and 6.

The extents of the identified REs proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region are detailed in Table 6.2 which is an extract of the information provided in Section 6.5 (Table 6.4) of this attachment and Chapter 32 Cumulative Impacts.

Table 6.2 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Grey-headed Flying Fox

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5007	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	23.91	486.90	9.50	8.09	0.26	0.26
RE 12.11.14 (OC, -) *Eucalyptus crebra, Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	109.43	199.90	61.70	5.72	0.67	0.66
RE 12.11.6 (LC, -) *Corymbia citriodora, Eucalyptus creba* open forest on metamorphics ± interbedded volcanics.	62.67	483.40	14.80	0.52	0.21	0.20
RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics.	3.04	3.90	100.00	0.13	0.13	0.10
RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains.	25.69	202.60	16.00	0.98	0.47	0.47
RE 12.3.6 (LC, -) *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland on coastal alluvial plains.	3.56	3.60	100.00	0.09	0.03	0.01

Table 6.2 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Grey-headed Flying Fox (cont'd)

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5007	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 12.3.7 (LC, -) *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest.	4.21	7.10	59.20	0.08	0.01	0.01

Notes: Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e., 12.11.14/12.11.4 and 12.11.6/12.11.14), the dominant RE area was chosen (in this case, 12.11.14 and 12.11.6 respectively).

1 Regional Ecosystem status: CE = critically endangered, E = endangered, OC = of concern, LC = least concern (Vegetation Management Act, EPBC Act).

2 Projects included APLNG Project, WBDD 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 Island Community Project, Boyne Island Aluminium Smelter Extension of Reduction Lines Project, GLNG Project, QCLNG Project, Yarwun Alumina Refinery Expansion Project.

The amount of each RE to be cleared by all projects as a proportion of the extent of the RE within the Gladstone Regional Council area is less than 1% in all cases, with the exception of RE 11.3.4 and RE 12.11.14, which are 8.09% and 5.72% of the extent of the RE type in the Gladstone Regional Council area respectively. Within Queensland, the proportions of these two REs to be cleared are 0.26% and 0.66% respectively.

The extent and quality of habitat lost as a consequence of project activities is small in comparison to the available habitat in the vicinity of the project area, particularly in the Curtis Island Environmental Management Precinct and Targinie State Forest. The lack of evidence of breeding camps, roosts and colonies means it is highly unlikely the loss of habitat will result in a decline in the species in the region.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   No invasive flora or fauna has been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to grey-headed flying fox. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for the grey-headed flying fox.

It is unlikely that any impacts upon grey-headed flying fox are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss and fragmentation of habitat, however the area that will be lost is small in comparison to the available habitat in adjacent areas.

No grey-headed flying fox roosts have been identified within the project area for the Arrow LNG Plant. The species is highly mobile, and likely to travel large distances in response to food resource. Vegetation communities to be cleared by project activities include the wide range of suitable foraging habitats for the grey-headed flying fox. However, the area of foraging habitat lost is small in relation to areas of woodland within the study area and the Gladstone region.

No individuals, breeding camps or roosts were identified in the project area, although individuals were observed in areas adjacent to the study area. The lack of evidence of visitation in the study area indicates it is highly unlikely the species is reliant on the area. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to

occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

RE 11.3.4 and RE 12.11.14 have been identified as likely areas requiring to be offset under the *Vegetation Management Act 1999* (Qld), as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for these REs will have benefits for the species utilising these REs, including the grey-headed flying fox.

In conclusion, impacts on the grey-headed flying fox from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no colonies, breeding camps or roosts were identified and potential foraging habitat cleared is a small proportion of that available in the wider region.

Brigalow Scaly Foot

The Brigalow scaly-foot is largely restricted to the Brigalow Belt bioregion although it has been recorded on Boyne Island approximately 12 km to the southeast of the study area. The species is found in a wide variety of remnant and non-remnant open forest to woodland habitats. The species is more prevalent in habitats that have few weeds and that consist of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Most records occur in remnant habitats, but the species can also occur in young regrowth (two to three years old) and in modified habitats.

Vegetation communities of the study area provide suitable habitat for Brigalow scaly-foot with similar habitat to that found on Boyne Island, and in areas of Curtis Island. Patches of vine thicket and open-forest/woodland habitat containing leaf litter, hollow logs, crevices in rocks and fallen timber are known to occur throughout the study area and may support this species. There are no records from Curtis Island or the adjacent mainland; consequently, the species was assessed as having a moderate likelihood of being present in the study area.

Key threats listed to the Brigalow scaly-foot on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing and thinning, road widening and maintenance activities and predation by feral animals such as feral cats.

If present within the project area Brigalow scaly-foot is likely to be impacted through unearthing during construction activities, trench fall, loss of habitat including hollow logs, rocks and leaf litter, and edge effects such as weed invasion, changed hydrological regimes and increase in pest fauna species such as cane toads.

Vegetation clearance for the Arrow LNG Plant may result in reduced potential habitat for Brigalow scaly-foot. The project will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. However, this loss of habitat is small in comparison to similar habitat in the surrounding area.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for the species.

Significant Impact Criteria – Brigalow Scaly Foot

1) Lead to a long-term decrease in the size of an important population of a species.

Important Brigalow scaly-foot populations occur in large contiguous areas of remnant vegetation that are suitable for the species, such as the Central Queensland sandstone rises, the Blackwater/Blackdown Tablelands region and the Moura/Theodore region. An important population has been identified at Boyne Island 12 km to the southeast of the study area.

It is unlikely that the project will result in a long term decrease in size of the population, even if the local population were considered as an important population, due to the large areas of suitable habitat adjacent to the project area. This species, if present will be displaced to areas of similar habitat adjacent to the project area.

While eucalypt woodland on the mainland and Curtis Island provides suitable habitat for the species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any populations in the Gladstone region, other than the population on Boyne Island.

Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Removal of vegetation and habitat for the project may reduce the extent of habitat available for the species, however the extent of habitat lost as a proportion of habitat available within the region is small.

   Project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area. The area of habitat lost is small in relation to uncleared areas of eucalypt woodland within the study area and the Gladstone region, and the effect of this loss will be minimal.

   The clearance will take place predominantly on Boatshed Point and the area to the north of the point, and is therefore on the southwestern tip of the island, not preventing movement of the species to other areas of the island, including the Curtis Island Environmental Management Precinct, if present.

   Regular trench inspection and measures to prevent fauna entrapment within the trench will be undertaken to reduce potential impacts upon the species.

4) Adversely affect habitat critical to the survival of a species.

   The Brigalow scaly-foot's core habitat occurs mostly in the Brigalow Belt South bioregion. The species is found in a wide variety of remnant and non-remnant open forest to woodland habitats, under sandstone slabs, surface debris or in grass hummocks. No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. Large areas of suitable habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Therefore project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population.

No populations in the study area are considered to be an important population, although an important population is present on Boyne Island 12 km to the southeast of the project area. Surveys did not discover this species. Habitat is marginal and the species is largely restricted to the Brigalow Belt bioregion.

No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no Brigalow scaly-foot were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Areas of eucalypt woodland suitable for the species will be cleared for the project. Large areas of similar habitat exist in adjacent areas, such as Targinie State Forest and the Curtis Island Environmental Management Precinct. Therefore, project activities will not disrupt the breeding cycle of an important population of the Brigalow scaly-foot.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The species favours a variety of dry woodland habitats favouring leaf litter, hollow logs, crevices in rocks and fallen timber. Within the project area, the species has been identified as having a moderate likelihood of occurrence within RE 11.3.4 and RE 12.11.14. The locations of REs within the project area are shown on Figures 5 and 6.

Clearance within these areas for project infrastructure comprises of 23.91 ha and 109.43 ha respectively, which is a small proportion of cumulative clearance in the region for all projects.

The extents of the identified REs proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region are detailed in Table 6.3 which is an extract of the information provided in Section 6.5 (Table 6.4) of this attachment and Chapter 32 Cumulative Impacts.

The areas of each RE to be cleared by all projects as a proportion of the extent of the RE within the Gladstone Regional Council area is 8.09% and 5.72% of the extent of the RE in the Gladstone Regional Council area respectively. Within Queensland, the proportions of these two REs to be cleared are 0.26% and 0.66% respectively.

Most records occur in remnant habitats of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses, but the species can also occur in young regrowth (two to three years old) and in modified habitats containing dry woodland habitats favouring leaf litter, hollow logs, crevices in rocks and fallen timber.

The habitat lost for the Arrow LNG Plant is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

Habitats that have few weeds are more likely to contain this species, while invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b).

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

Table 6.3 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Brigalow Scaly-Foot

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5007	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	23.91	486.90	9.50	8.09	0.26	0.26
RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	109.43	199.90	61.70	5.72	0.67	0.66

8) Introduce disease that may cause the species to decline.

Disease has not been identified as a main threat to Brigalow scaly-foot. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon Brigalow scaly-foot are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of suitable habitat, although there are no records from Curtis Island or the adjacent mainland, and the loss of habitat is small in comparison to available habitat in adjacent areas.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect. Available habitat is not considered

to be critical habitat for the species, and the nearest record to the project area is over 12 km away. If present, the species is probably present in small numbers.

If present, they are likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increases in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts on this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].
- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

RE 11.3.4 and RE 12.11.14 have been identified as likely areas requiring to be offset under the *Vegetation Management Act 1999* (Qld), as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for these REs will have benefits for the species utilising these REs, including the Brigalow scaly-foot.

In conclusion, impacts on Brigalow scaly-foot from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no individuals were identified and potential foraging habitat cleared is a small proportion of that available in the wider region.

Collared Delma

The collared delma is endemic to southeast Queensland and distributed around central Queensland at Ulam Range (60 km south of Rockhampton) and Expedition National Park (70 km west of Taroom). It 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.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, however rocky and grassy areas in eucalypt woodland within the mainland section of the study area and at the LNG plant site is suitable habitat for the species. Consequently, the species was assessed as having a moderate likelihood of being present.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing, habitat degradation and loss of features such as rocks, predation by feral animals such as feral cats and red foxes and weed invasion.

If present within the project area, collared delma is likely to be impacted through unearthing during construction activities, trench fall, loss of habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increase in pest fauna species such as cane toads.

Vegetation clearance for the Arrow LNG Plant may result in reduced potential habitat for collared delma. The project will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. However, this loss of habitat is small in comparison to similar habitat in the surrounding area.

The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for the species.

Significant Impact Criteria – Collared Delma

1) Lead to a long-term decrease in the size of an important population of a species.

   While rocky and grassy areas in eucalypt woodland on the mainland and Curtis Island provide suitable habitat for the species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. The habitat within the project area is not likely to be habitat critical to the survival of the species. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations for the species in the Gladstone region or the vicinity of the study area. Significant populations are located around the Brisbane and Toowoomba areas in southeast Queensland.

   Implementation of mitigation measures to reduce fauna entrapment in trenches developed for the project, and development of trench inspection procedures will reduce the risk of entrapment of the species impacting on the population size of collared delma in the region. It is unlikely that the project will result in a long term decrease in size of the population, even if the local population were an important population, due to the large areas of suitable habitat adjacent to the project area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Removal of vegetation and habitat for the project may reduce the extent of habitat available for the species, however the extent of habitat lost as a proportion of habitat available within the region is small. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, the area of habitat lost for the construction of the project is small in relation to uncleared areas of eucalypt woodland in the study area and the Gladstone region, and the effect of this loss will be minimal. The clearance will take place predominantly on Boatshed Point and the area to the north of the point, and is therefore on the southwestern tip of the island, not preventing movement of the species to other areas of the island, if present. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. The species normally inhabits eucalypt dominated woodlands. The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30–100 mm thick) appears to be an essential characteristic of the collared delma microhabitat and is always present where the species occurs.

   Large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   The species was not recorded in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. It is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Areas of eucalypt woodland suitable for the species will be cleared for the project, however large areas of similar habitat are available in adjacent areas.

   The species is not associated with any particular RE in the study area. It frequents a variety of woodland habitats. The combined area of the plant and associated facilities will be between 304 and 345 ha, depending on the final site of the marine facilities. The Curtis Island Industry Precinct (including the Arrow LNG Plant and three other LNG projects) covers less than 3% of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to inhabit less disturbed areas in the north of Curtis Island.

   Therefore, project activities will not disrupt the breeding cycle of an important population of the collared delma.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The species favours a variety of dry woodland habitats, predominantly on rocky slopes, favouring leaf litter, hollow logs, crevices in rocks and fallen timber.

   The habitat lost for the project is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas. The Curtis Island Industry Precinct (including the Arrow LNG Plant and three other LNG projects on Curtis Island) covers less than 3% of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to inhabit less disturbed areas in the north of Curtis Island.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b). Weed invasion may also degrade habitat for the collared delma.

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

Disease has not been identified as a main threat to collared delma. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon collared delma are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of suitable habitat, although there are no records of the collared delma from Curtis Island or the adjacent mainland.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect, available habitat is not considered to be habitat critical to the survival of the species. If present, the species is probably present in small numbers.

If present, they are likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increase in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].
- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

In conclusion, impacts on collared delma from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no critical habitat has been identified, no important populations are present and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or

individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Yakka Skink

This endemic skink is found in the Brigalow Belt and northern southeast Queensland where it lives in small colonies, inhabiting burrows it digs in dry open forest and woodland. It can also be found in heaped dead timber and in deep rock crevices.

The dry open forest and woodland habitat that occurs throughout the study area provides suitable habitat for the yakka skink. However, no individuals were observed during the field surveys. The species was assessed as having a moderate likelihood of being present in the study area due to the suitability of the habitat.

Key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing and thinning, road widening and maintenance activities and predation by feral animals such as feral cats. The species exhibits high site fidelity and low fecundity, making it susceptible to population crashes.

Vegetation clearance for the Arrow LNG Plant may result in reduced potential habitat for yakka skink. The project will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. The species is not associated with any particular REs within the study area, but may be present in eucalypt woodland, which is to be cleared by the project. However, this loss of habitat is small in comparison to similar habitat in the surrounding area. Open forest and woodland vegetation communities to be cleared for the project comprise less than 1% of each of the regional ecosystems locally and in the bioregion, with two exceptions RE 11.3.4 (8.09% and 0.26% respectively) and RE 12.11.14 (5.72% and 0.66% respectively). RE 11.3.4 is present at TWAF 8 and there are areas of RE 12.11.14 on Curtis Island.

The core range of this species is in the Mulga Lands and Brigalow Belt South bioregions and as such, the loss of habitat which is outside its preferred range will be insignificant.

There is no recovery plan for the species.

Significant Impact Criteria – Yakka Skink

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry open forest and woodland habitat occurring throughout the study area provides suitable habitat for this species, no species were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations (colonies identified or within 5 km of known records of the species) in the Gladstone region or the vicinity of the study area. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

No important population has been identified in the study area as evidenced by no species or colonies being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, the area of habitat lost for the construction of the project is small in relation to uncleared areas of eucalypt woodland in the study area and the Gladstone region, and the effect of this loss will be minimal. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. Large areas of eucalypt woodland habitat with ground habitat features such as leaf litter, fallen logs and rocks exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   No colonies or individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no colonies were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Large areas of similar habitat exist in adjacent areas. Therefore, project activities will not disrupt the breeding cycle of an important population of the yakka skink.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The yakka skink inhabits burrows in dry open forest and woodland and can also be found in heaped dead timber and in deep rock crevices.

   The habitat lost for the project, is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b). Weed invasion may also degrade habitat for the yakka skink.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to yakka skink. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon yakka skink are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of suitable habitat, although there are no records from Curtis Island or the adjacent mainland and the loss of habitat is small in comparison to available habitat in adjacent areas.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect. Available habitat is not considered to be core habitat for the species. If present, the species is probably present in small numbers.

If present, they are likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increase in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].
- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

In conclusion, impacts on yakka skink from the project (Referral No. EPBC 2009/5007) are not significant, as no critical habitat has been identified, no important populations are present and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.3.2 Terrestrial Flora

Four terrestrial flora species identified in database searches were assessed, after further desktop review and field survey, as possibly occurring within the project area. None of these species were identified in the project area through the course of field surveys for the project, although the unidentified species of *Cupaniopsis* recorded, shares similar characteristics to wedge-leaf tuckeroo (*Cupaniopsis shirleyana*).

Wedge-leaf Tuckeroo

The wedge-leaf tuckeroo is a shrub or small tree growing to 10 m in height which occurs from Maryborough district north to Mount Larcom (west of Gladstone), and has a disjunct distribution in the Carina area in Brisbane. It occurs in dry rainforest and scrubby open forest on steep slopes, scree slope gullies and rocky stream channels at elevations between 60 and 550 m.

Suitable habitat is present and records exist in the vicinity of the study area. Marginal habitat for the species, being dry rainforest and scrubby open forest, occurs in the project area. However no species of the wedge-leaf tuckeroo were observed in the study area during the assessment (Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS).

Key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include clearing and disturbance from activities such as roadworks and other infrastructure works, including associated drainage works. These activities can impact directly on the species and also promote canopy gaps which are readily colonised by weed species, which form dense thickets.

Vegetation clearance for the Arrow LNG Plant will not take place in the marginally suitable habitat for this species in the study area. No specimens were recorded in the study area in surveys for the Arrow LNG Plant or for other LNG projects on Curtis Island. Impacts on the species from the project are highly unlikely.

There is no recovery plan for the species.

Significant Impact Criteria – Wedge-leaf Tuckeroo

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry rainforest and scrubby open forest occurring within the study area provides suitable habitat for this species, no species were identified within the study area. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations (colonies identified or within 5 km of known records of the species) in the Gladstone region or the vicinity of the study area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by no species being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, construction of the project will avoid its preferred habitat which is marginal within the study area. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. No areas of critical habitat for the species have been identified (DSEWPaC, 2011b). Marginally suitable habitat is present on Curtis Island, but the species was not located in field surveys and large areas of suitable habitat exist in adjacent areas. Pre-clearance surveys

will be undertaken prior to works taking place, and if any conservation listed species found, specific mitigation measures developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

No specimens were discovered in surveys carried out for the LNG Plant and other LNG projects on Curtis Island. There is no habitat critical to the survival of the species in the study area.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The vegetation cleared for the project, is unlikely to decrease the availability of habitat to an extent that the species may decline, due to areas of similar habitat being present in adjacent areas. The species favours dry rainforest on moderate to very steep slopes and scree-slope gullies, and is associated with semi-evergreen vine thicket of the Brigalow Belt bioregion. Although Curtis Island is within the southeast Queensland bioregion, semi-evergreen vine thicket is present on Boatshed Point (RE 12.11.4).

The proportion of vine thicket (RE 12.11.4), proposed to be cleared for the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is described in Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts. Approximately 3 ha of RE 12.11.4 will be cleared for the infrastructure associated with referral EPBC 2009/5007.

The area of the RE to be cleared as a proportion of the extent of the RE within the Gladstone Regional Council area and Queensland is 0.13% and 0.10% respectively. As the species is not likely to be associated with the small pockets of remnant vegetation, the project will not contribute to cumulative impacts on this species in the Gladstone region.

There are large areas of more extensive habitat in adjacent undisturbed areas of Curtis Island and the mainland, and the lack of evidence of any individuals of this species means it is highly unlikely the clearance of vegetation will result a decline in the species in the region.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b), as areas are cleared and invasive flora colonises the cleared areas.

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent habitat.

8) Introduce disease that may cause the species to decline.

Disease has not been identified as a main threat to wedge-leaf tuckeroo.

The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

No recovery plan is in place for the species. The loss of habitat is not habitat critical to the species presence in the region, and areas of similar habitat in adjacent areas will be retained.

It is unlikely that any impacts on the wedge-leaf tuckeroo are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area in desktop searches or field surveys. The habitat for the species on Curtis Island is marginal.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species. Pre-clearance surveys will be undertaken for the project, and should the species be identified, specific mitigation measures will be developed, which may include offsets. No offsets under the EPBC Act are currently required for this species as a result of clearance for the project.

Specimens of an unidentified species of *Cupaniopsis*, thought to be closely related to the threatened flora species wedge-leaf tuckeroo, were identified within the study area during early field surveys. The recorded specimens were identified by the Queensland Herbarium as *C. shirleyana*, which is currently listed as vulnerable under both the EPBC Act and Nature Conservation (Wildlife) Regulation 2006 (Qld). These specimens were recorded within an area of semi-evergreen vine thicket located on the southern extent of Boatshed Point.

This area was revisited and assessed in detail during later surveys. The previously identified specimens of *Cupaniopsis* displayed vegetative and reproductive characteristics that were not entirely characteristic of *C.shirleyana*. The same specimens were sampled when in flower and were resubmitted to the Queensland Herbarium for additional analysis. Initial assessment by the Queensland Herbarium in August 2010 indicated that the sampled species, herein referred to as *Cupaniopsis sp.* indet., is potentially a new taxon.

Part of the semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of that part of the semi-evergreen vine thicket community to be retained will be fenced off with a 20 m buffer between the semi-evergreen vine thicket community (including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi-evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. No development will be permitted within the fenced area of the retained semi-evergreen vine thicket community. Roles and responsibilities for the management of the retained semi-evergreen vine thicket community will be established [C17.03].

An offsets strategy is being prepared and will address offset requirements under Queensland and Commonwealth legislation. Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. If this species is confirmed by the Queensland Herbarium to be a new taxon and the species is listed under the EPBC Act, an offset will be provided in accordance with the draft Environmental Offsets Policy under the EPBC Act (see Section 7.2 of this report).

In conclusion, impacts on wedge-leaf tuckeroo from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no important habitat has been identified and the species was not identified in field surveys.

Mount Larcom Silk Pod

This species is a creeping to ascendant climber growing up to 5 m long in subtropical and dry rainforest and adjacent shrublands on cliffs or rocky outcrops of acid volcanic rocks or serpentinites. It is known from Mount Perry, Mount Larcom, Mingga Mountain and Mount Wheeler with disjunct populations on the Byfield Range and at Cape Upstart.

The subtropical, dry rainforest and shrubland habitat that occurs in the study area provides suitable habitat for the Mount Larcom silk pod. However, underlying geology and coarse topographical requirements of cliffs and rocky outcrops are not present.

No individuals were observed during the field surveys, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS. The species was assessed as having a moderate likelihood of being present in the study area, as it has a highly effective wind-blown fruit, resulting in the potential for isolated specimens to become established within the study area.

Key threats identified to the species (DSEWPaC, 2011b) include fire, clearing and disturbance increasing fragmentation and the loss of remnants. The species is thought to be susceptible to fire and incapable of regenerating from underground organs, meaning that the continued existence of the species after fire would depend on regeneration by seed. If fires occurred at a frequency that did not allow the production of sufficient seed for future recruitment, populations would decline.

Vegetation clearance for the project will not take place in the habitat for this species, namely open heathland and shrubland at or near the summits of mountain peaks, or outcrops of acid volcanic rocks and serpentinites.

No specimens were recorded in the study area, in surveys for the Arrow LNG Plant or for the other LNG projects on Curtis Island. Habitat is marginal, as underlying geology and core topographical requirements are not present. Therefore impacts on the species from the Arrow LNG Plant are unlikely.

There is no recovery plan for the species.

Significant Impact Criteria – Mount Larcom Silk Pod

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry open forest and woodland habitat occurring throughout the study area provides marginally suitable habitat for isolated individuals germinated from windblown seeds, the underlying geological requirements are not present. No individuals of the species were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations in the study area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   The species favours cliffs and rocky outcrops. There is no clearing of suitable habitat for Mount Larcom silk pod by other LNG projects on Curtis Island, and it is unlikely that the species will be impacted by other projects within the Gladstone region.

   No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. The species is highly fragmented around the region being tied to suitable habitat, and it is highly unlikely the project will further fragment populations of this species.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area, although there is the small chance that an isolated specimen may become established as the species has a highly effective wind-blown fruit. The species inhabits heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentinites at 350 to 750 m above sea level.

   Pre-clearance surveys will be undertaken prior to works taking place and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Suitable habitat including underlying geology is not present within the study area. Therefore, project activities will not disrupt the breeding cycle of an important population of the Mount Larcom silk pod.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The Mount Larcom silk pod inhabits heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentites at 350 to 750 m above sea level.

   The habitat cleared for the project, is not optimal for this species, although there is the small chance that an isolated specimen may become established as the species has a highly effective wind-blown fruit. Project activities are unlikely to decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b), as areas are cleared and invasive flora takes over.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

Disease has not been identified as a main threat to Mount Larcom silk pod.

The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

No recovery plan is in place for the species. While vegetation will be cleared for the project, the loss of habitat is not habitat critical to the species foothold in the region. The species is found on open heathland and shrubland at or near the summits of mountain peaks, or outcrops of acid volcanic rocks and serpentinites, habitat that is not present in the study area. Surveys failed to locate the species in the study area.

It is unlikely that any impacts upon Mount Larcom silk pod are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, no records have been identified within the study area for the Arrow LNG Plant, and the habitat for the species is marginal. No important population is present within the study area.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.In conclusion, impacts on Mount Larcom silk pod from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no individuals were identified and habitat proposed to be cleared is not optimal habitat for the species.

Quassia

Quassia is a shrub, often suckering from roots, which can be found in dry rainforest, vine thickets and lowland rainforests in disjunct populations north of the Gympie district and occasionally open forests adjacent to vine thicket communities, woodlands and fringing mangrove communities on a variety of geological substrates.

The lowland rainforest, open woodland and vine thicket habitat that occurs in the study area provides suitable habitat for this species. However, this vegetatively distinct species was not observed in the study area during the field surveys, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS.

There are records of this species in similar habitat in close proximity to the study area (<3 km to the northwest on Mount Larcom). The species was therefore assessed as having a low to moderate likelihood of being present in the study area.

The key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include clearing and disturbance from activities such as roadworks and other infrastructure works, inappropriate fire regimes and soil erosion. The response of this species to fire is unknown. However, the spread of lantana and exotic grasses may pose a threat to the quassia.

Vegetation clearance for the Arrow LNG Plant may take place in habitat for this species, in vine thicket, or lowland rainforest communities. However, no specimens were recorded in the project area in surveys for the Arrow LNG Plant or for the other LNG projects on Curtis Island, therefore impacts on the species from the project are unlikely.

There is no recovery plan for the species.

Significant Impact Criteria – Quassia

1) Lead to a long-term decrease in the size of an important population of a species.

   While the lowland rainforest, open woodland and vine thicket habitat within the study area provide suitable habitat for this species, no individuals were identified in the study area in surveys conducted for the Arrow LNG Plant or other LNG projects. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No species were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by no species being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, the loss of its preferred vine thicket habitat for the construction of the project is minimal, being approximately 3 ha on Boatshed Point. A wildlife corridor will be established on the eastern shore of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the Curtis Island Environmental Management Precinct, although it is unlikely the species is present on Curtis Island.

   Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. No areas of critical habitat for the species have been identified (DSEWPaC, 2011b). Quassia commonly occurs in lowland rainforest or on rainforest margins but it can also be found in other forest types, such as open forest and woodland. A small area of vine thicket habitat will be lost for the construction of the project, although no specimens were identified within the study area.

   Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The species favours rainforest habitat and vine thicket. Within the project area, suitable habitat for the species exists, although it is unlikely that the species is present as it was not located in field surveys for the Arrow LNG Plant or other proponents and it is vegetatively distinct.

Within the project area, the species is most likely to occur in RE 12.11.4. The location of this RE within the project area is shown on Figures 5 and 6.

The proportion of RE 12.11.4, proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is described within Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts. Approximately 3 ha of RE 12.11.4 will be cleared for the infrastructure associated with referral No. EPBC 2009/5007.

The area of the RE to be cleared by all projects as a proportion of the extent of the RE within the Gladstone Regional Council area and Queensland, is 0.13% and 0.10% respectively.

The habitat lost for the Arrow LNG Plant, is not optimal for this species, and unlikely to decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b), as areas are cleared and invasive flora takes over.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to quassia.

   The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No population has been identified in the study area and the species was not found in field surveys within the study area.

It is unlikely that any impacts upon quassia are unknown, unpredictable or irreversible.

No records have been identified within the project area for the Arrow LNG Plan. The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, and no records have been identified in the study area for the Arrow LNG Plant. Known populations are located outside the study area.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the project area. Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

In conclusion, the impacts on quassia from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no important habitat has been identified and the species was not identified in field surveys.

(a) Cycad

Cycas megacarpa is a small to medium-sized cycad with an erect trunk, growing to 3 m in height. It grows on margins of, or occasionally within, dry rainforest and in sclerophyll forest and woodland. It is found north from Kilkivan near Gympie to Moonlight Range, west of Rockhampton.

The dry rainforest and sclerophyll woodland habitat that occurs in the study area provides suitable habitat for *Cycas megacarpa*. However, the species is not known within the study area, and no plants were identified in field surveys. This species is usually associated with sloping country, such as Mount Larcom to the west of the study area, and as such was assessed as having a low (to moderate) likelihood of occurrence within the study area.

The recovery plan for the species (Queensland Herbarium, 2007) has identified land clearance, illegal harvesting and fragmentation of remaining populations as threats to the species.

Vegetation clearance for the Arrow LNG Plant is unlikely to take place in habitat for this species. No specimens were recorded in field surveys for the Arrow LNG Plant or for other LNG projects on Curtis Island. Within the region, the species is associated with sloping country of the Mount Larcom Range. Therefore impacts on the species from the project are unlikely.

Significant Impact Criteria – (a) Cycad

1) Lead to a long-term decrease in the size of a population.

   While the dry open forest and woodland habitat occurring throughout the study area provides suitable habitat for this species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment to the EIS. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) and the Queensland Herbarium (Queensland Herbarium, 2007) identified 46 populations of this species.

   Within the Gladstone region, these populations are not located in the vicinity of the project, as it is associated with sloping country. Populations have been found south of Mount Larcom.

   Consequently, construction and operations activities of the proposed project will not lead to a long-term decrease in size of a population of the species.

2) Reduce the area of occupancy of a species.

   Populations for the species in the Gladstone region are unlikely to be located in the vicinity of the project, being found on the slopes of Mount Larcom to the west. Therefore clearance for the project is unlikely to impact upon this species.

No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of a population.

3) Fragment an existing population into two or more populations.

No population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

No individuals were found of this distinctive species, and hence no populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area.

The species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, often on undulating to hilly terrain at an altitude of 40–680 m. Suitable habitat is present in the area to be cleared for the project and large areas are available adjacent to the project area.

Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of a population.

No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Suitable habitat is present within the study area although no known populations were found in the study area. Therefore, project activities will not disrupt the breeding cycle of a population of *Cycas megacarpa.*

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Cycas megacarpa inhabits dry rainforest and is found in sclerophyll forest and woodland, often on undulating to hilly terrain at an altitude of 40–680 m.

Although habitat within the project area on Curtis Island is suitable for the species, vegetation clearance for the Arrow LNG Plant is unlikely to decrease the availability of habitat to an extent that the species may decline, as no known populations are present in the project area on Curtis Island.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.

Invasive flora was not identified as a threat to the species (DSEWPaC, 2011b).

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to *Cycas megacarpa*. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No population has been identified in the study area, and the species was not found in field surveys of the study area.

   While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region. Known populations of the species within the region are centred around Mount Larcom to the west of the study area.

It is unlikely that any impacts upon *Cycas megacarpa* are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, and no records have been identified within the study area for the Arrow LNG Plant. Known populations are located outside the study area.

No specific mitigation is proposed for this species as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

In conclusion, impacts on *Cycas megacarpa* from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no important habitat has been identified and the species was not identified in field surveys.

6.3.3 Marine Fauna

Six marine fauna species identified in database searches were assessed after further desktop review and field survey as possibly occurring within the project area. All of these species are marine turtles.

Potential impacts of the LNG facility on marine fauna are detailed further within Chapter 19, Marine and Estuarine Ecology of the EIS. Impacts include habitat loss, impacts from dredge plumes and wastewater discharge, boat strike and disturbance from noise and light emissions.

Flatback Turtle

The distribution and nesting sites of the flatback turtle are restricted to coastlines along Australian continental shelf waters. They are the dominant species in the Port Curtis region, with an intermediate-sized nesting population of 51 females around Connor Bluff (approximately 5 km north of Southend), Curtis Island (Limpus et al., 2006). The breeding season generally starts in mid-October, with nesting from late November to early December, and hatching between December and March. Foraging habitats for this species are predominantly sedimentary environments.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and within the recovery plan for marine turtles in Australia (Environment Australia, 2003) are commercial and recreational fishing, coastal infrastructure and development, Indigenous harvest, feral animal predation (of nestlings) and climate change.

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. Loss of individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty site and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area of reef habitat than for launch site 1). The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Lighting impacts from construction and operation of the LNG facility may disorientate turtle species nesting at Connor Bluff. As such, mitigation measures will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light source and use of long wavelength lights.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to marine turtles.

Significant Impact Criteria – Flatback Turtle

1) Lead to a long-term decrease in the size of an important population of a species

   While marine environments in Port Curtis and surrounding coastline provide suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) identifies major populations on Curtis Island, and nesting sites on the eastern coast of Curtis and Facing Islands (see Figure 19.2 of the EIS).

   The closest breeding population to the project area is at Connor Bluff, approximately 9 km from the LNG plant site in a direct line, and will not be directly impacted by project activities.

   The proposed mitigation measures (described below) are designed to reduce the likelihood that the project will result in a long term decrease in size of the population.

2) Reduce the area of occupancy of an important population

   No nesting sites were identified in the project area. Individuals were observed at sites adjacent to the study area. As no nesting habitat will be removed and no nesting sites were identified, project activities are unlikely to reduce the area of occupancy of an important population. The nesting

area at Connor Bluff, north of Southend, will not be directly impacted by the project, and marine infrastructure will not affect turtle movements when foraging in Port Curtis.

3) Fragment an existing important population into two or more populations

The project will not fragment flatback turtle populations in Port Curtis. The nesting area at Connor Bluff (north of Southend) identified as a major population (DSEWPaC, 2011b) will not be directly impacted by the project, and marine infrastructure will not affect turtle movements when foraging in Port Curtis.

4) Adversely affect habitat critical to the survival of a species

The project area currently does not support nesting sites for the flatback turtle. The study area includes habitats utilised by the flatback turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and the GRBWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population

The nesting beach at Connor Bluff, north of Southend, will not be physically impacted. Light glow generated by the LNG plant could affect the behaviour of marine turtles, although the project is not the only source of industrial light in the area and mitigation measures will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light sources and use of long wavelength lighting.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The habitat lost for the Arrow LNG Plant, is a small proportion of available habitat within Port Curtis and the wider GBRWHA. Marine turtles forage widely, and it is not anticipated that habitat loss will decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive fauna species such as foxes and dogs have been identified as a key threat to the species (DSEWPaC, 2011b) as they have been found to destroy hundreds of nests in eastern Queensland.

Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

8) Introduce disease that may cause the species to decline

Disease has not been identified as a main threat to flatback turtles.The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species

The project is unlikely to exacerbate threats identified for marine turtles within Australia. The loss of foraging habitat is small in relation to the wider Port Curtis area. Impacts from shipping

movements, dredge plumes and lighting from the LNG plant will be mitigated and monitoring programs established to evaluate their success.

It is unlikely that any impacts upon flatback turtles are unknown, unpredictable or irreversible. The presence of nesting beaches in the region is known and the extent of dredging within Port Curtis defined.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. This includes light from the LNG Plant reaching the nesting beach at Southend, and potentially disturbing nesting turtles at this site.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
  - Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practical) [C17.19].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the flatback turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as the closest breeding population is located at Connor Bluff on the eastern coast of Curtis Island approximately 9 km from the proposed LNG facility. Mitigation measures aim to reduce the impact of light from the LNG plant on this nesting beach, and lighting in the Port Curtis region is already heavily modified by existing industrial and residential development.

Potential foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

The predicted impacts on flatback turtle are not expected to be significant, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Loggerhead Turtle

Loggerhead turtles have a distribution predominantly within subtropical and tropical regions. In eastern Australia, there are approximately 500 nesting females per year (Limpus & Limpus, 2003). The loggerhead turtle nests intermittently within the Port Curtis region although the main breeding areas are located along the southeast Queensland and Mackay coast and within the islands of the Capricorn Bunker Group. Breeding begins in late-October to December, nesting occurs from October to March, and hatching from December to May.

Foraging resources and nesting sites for the loggerhead turtle are primarily located within the GBRMP and the GBRWHA. The species is known to utilise a broad range of habitats as foraging areas including coral and rocky reefs, sandflats, estuaries and seagrass beds.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and within the recovery plan for marine turtles in Australia (Environment Australia, 2003) are commercial and recreational fishing, coastal infrastructure and development, Indigenous harvest, feral animal predation (of nestlings) and climate change.

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. Loss of individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels. Impacts from dredge plumes and disposal of treated effluent off Boatshed Point will be localised in their nature, and comply with legislative requirements.

The project will not remove any areas of loggerhead turtle nesting habitat, which is intermittent within Port Curtis and on sandy beaches to the east of the port when it occurs. The main breeding areas are along the southeast Queensland and Mackay sections of the Queensland coast.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty sites and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1). The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Lighting impacts from construction and operation of the LNG facility may disorientate turtle species nesting near Southend. Mitigation will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light source and use of long wavelength lights.

However this species nests only occasionally on Curtis and Facing Islands and within Queensland nesting is concentrated in the southeast particularly around Bundaberg.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts on marine turtles.

Significant Impact Criteria – Loggerhead Turtle

1) Lead to a long-term decrease in the size of a population

   While marine environments in Port Curtis and surrounding coastline provides suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any nesting sites in the Gladstone region. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of the species.

2) Reduce the area of occupancy of the species

   No nesting sites were identified in the project area. Individuals were observed at sites adjacent to the study area. As no nesting habitat will be removed and no nesting sites were identified, project activities are unlikely to reduce the area of occupancy of a population.

3) Fragment an existing population into two or more populations

   No populations have been identified in the study area, as evidenced by nesting sites not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing population into two or more populations. Intermittent nesting areas will not be directly impacted by the project, and marine infrastructure will not affect turtle movements when foraging in Port Curtis.

4) Adversely affect habitat critical to the survival of a species

   The project area currently does not support nesting sites for the loggerhead turtle. The study area includes habitats utilised by the loggerhead turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and GBRWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population

   Nesting beaches will not be physically impacted. Light glow generated by the LNG plant could affect the behaviour of marine turtles, although the project is not the only source of industrial light in the area and mitigation will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light source and use of long wavelength lights.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

   The habitat lost for the Arrow LNG Plant, is a small proportion of available habitat within Port Curtis and the wider GBRWHA. Marine turtles forage widely, and it is not anticipated that habitat loss will decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Invasive fauna species such as foxes and dogs have been identified as a key threat to the species (DSEWPaC, 2011b).

Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

8) Introduce disease that may cause the species to decline

Disease has not been identified as a main threat to loggerhead turtles. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species

It is unlikely that project activities will exacerbate threats identified for marine turtles within Australia. The loss of foraging habitat is not habitat critical to the species presence in the region, and small in relation to the wider Port Curtis area. Main breeding areas are not located in the Gladstone region. Impacts from shipping movements, dredge plumes and lighting from the LNG plant will be mitigated and monitoring programs established to analyse their success.

It is unlikely that any impacts upon loggerhead turtles are unknown, unpredictable or irreversible. The species only nests intermittently within the Port Curtis region, and away from project infrastructure.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. However, the species nests only sporadically in the Port Curtis region, so impacts upon nesting beaches will be negligible.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:

  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
  - Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practical) [C17.19].

- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].

- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the loggerhead turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no nesting sites have been identified within the study area, and the nearest breeding population is approximately 60 km away at Deepwater National Park. Mitigation measures will reduce the impact of light from the LNG plant on nesting beaches on the east coast of Curtis Island. Lighting in the Port Curtis region is already heavily modified by existing industrial and residential development.

Potential foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

The predicted impacts on loggerhead turtle are not expected to be significant, hence no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Green Turtle

The green turtle has a distribution predominantly within tropical and subtropical regions. The southern Great Barrier Reef region, which encompasses Port Curtis, is known to support approximately 8,000 individuals (DSEWPC, 2011). The species occasionally nests on beaches near Southend, Curtis Island. Breeding for green turtles occurs from September to November, nesting from mid-October to early April, and hatching between December and May. Foraging resources and nesting sites for the green turtle are primarily located within the GBRMP and the GBRWHA. The herbivorous diet of the species limits individuals to shallow benthic foraging areas such as seagrass beds and coral and rocky reef, which support algal mats. Nesting sites for the species are widely distributed across Australia, occasionally including Curtis and Facing Islands (see Figure 19.2 of EIS). This species occasionally nests on beaches on the eastern coast of Curtis and Facing Islands, including near Southend.

The important foraging grounds and juvenile habitat for green turtles in Queensland include the Capricorn and Bunker region of the Great Barrier Reef, the Wellesley Islands, Moreton Bay, Hervey Bay and Sandy Straits, Shoalwater Bay, Cleveland Bay, Princess Charlotte Bay, the inner shelf coral reefs from Howick Reef to Corbett Reef, and the Torres Strait. Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and within the recovery plan for marine turtles in Australia (Environment Australia, 2003) are commercial and recreational fishing, coastal infrastructure and development, Indigenous harvest, feral animal predation (of nestlings) and climate change.

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. Loss of individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty sites and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1).The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Lighting impacts from construction and operation of the LNG facility may disorientate turtle species nesting near Southend. As such, mitigation will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light source and use of long wavelength lights.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to marine turtles.

Significant Impact Criteria – Green Turtle

1) Lead to a long-term decrease in the size of an important population of a species

   While marine environments in Port Curtis and surrounding coastline provides suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) identifies key nesting and inter- nesting sites on the eastern coast of Curtis and Facing Islands. (see Figure 19.2 within EIS).

   The closest breeding population to the project area is near Southend, approximately 8 km from the LNG plant site in a direct line, and will not be directly impacted by project activities.

   The proposed mitigation measures are designed to reduce the likelihood that project activities will result in a long term decrease in size of the population.

2) Reduce the area of occupancy of an important population

   No nesting sites were identified in the project area. Individuals were observed at sites adjacent to the study area. As no nesting habitat will be removed and no nesting sites were identified in the project area, project activities are unlikely to reduce the area of occupancy of an important population. The nesting area near Southend will not be directly impacted by the project, and marine infrastructure will not affect turtle movements when foraging in Port Curtis.

3) Fragment an existing important population into two or more populations

No important populations have been identified in the project area, as evidenced by nesting sites not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations. The occasional nesting area near Southend will not be directly impacted by the project, and marine infrastructure will not affect turtle movements when foraging in Port Curtis.

4) Adversely affect habitat critical to the survival of a species

The project area currently does not support nesting sites for the green turtle. The study area includes habitats utilised by the green turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and the GRBWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population

The occasional nesting beach near Southend will not be physically impacted. Light glow generated by the LNG plant could affect the behaviour of marine turtles, although the project is not the only source of industrial light in the area and mitigation will be developed to reduce the impacts of light from the LNG plant, including lowering of light sources, shielding of light sources and use of long wavelength lighting.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The green turtle favours marine habitat which supports seagrass beds as it is an important foraging resource for the species, and none has been identified within the project area.

The habitat lost for the Arrow LNG Plant is an area of benthic habitat which is a small proportion of available habitat within Port Curtis and the wider GBRWHA. Marine turtles forage widely, and it is unlikely that habitat loss will decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive fauna species such as feral pigs and dogs, and foxes have been identified as a key threat to the species (DSEWPaC, 2011b).

Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

A quarantine management plan will be developed for the project and its implementation will control pest fauna that may threaten the species, being introduced accidentally to areas of mangrove adjacent to the project.

8) Introduce disease that may cause the species to decline

The incidence of fibropapilloma disease has increased in recent years in southern Queensland populations, with approximately 8% of Green Turtles in Moreton Bay having external symptoms of the disease. The impact of the disease on turtle populations is unknown.

A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

9) Interfere substantially with the recovery of the species

The project is unlikely to exacerbate threats identified for marine turtles in Australia. The loss of foraging habitat is small in relation to the wider Port Curtis area. Impacts from shipping movements, dredge plumes and lighting from the LNG plant will be mitigated and monitoring programs established to analyse their success.

It is unlikely that any impacts upon green turtles are unknown, unpredictable or irreversible. The species nests occasionally within the Port Curtis region near Southend, and away from project infrastructure.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. This includes light from the LNG Plant reaching the nesting beach at Southend, and potentially disturbing nesting turtles at this site. However, this species only nests occasionally on Curtis Island and impacts from the LNG plant are likely to be negligible.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
  - Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practical) [C17.19].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].

- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the green turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as the closest sporadic breeding population is on the eastern coast of Curtis Island approximately 8 km from the LNG plant. Mitigation measures aim to reduce the impact of light from the LNG plant on this nesting beach. Lighting in the Port Curtis region is already heavily modified by existing industrial and residential development.

Potential foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

The predicted impacts on green turtle are not expected to be significant, hence no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Leatherback Turtle

The leatherback turtle has a worldwide distribution in tropical and subtropical oceans. The leatherback has the most widespread distribution of all turtles, which extends into northern and southern temperate regions. The species has a limited distribution within Australian waters, with no nesting evidence recorded within the coastal ranges of the Port Curtis region. The leatherback turtle is not known to have any major breeding stocks in Australia with only sporadic nesting recorded in specific coastal sites in southern Queensland and the Northern Territory.

The project will not remove any areas of leatherback turtle nesting habitat. Breeding is sporadic in Australia, and it has not been recorded in the Port Curtis region.

Due to the low incidence of leatherback turtle nesting on Australian beaches, and their pelagic foraging habits, a number of threats faced by other marine turtles, such as coastal infrastructure and development, feral animal predation and indigenous harvest are not significant threats to leatherback turtles in Australian waters. The main threats faced by leatherback turtles in Australia arise from accidental catch or entanglement in commercial fishing operations (DSEWPaC, 2011b; Environment Australia, 2003).

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty sites and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1). The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Impacts from dredge plumes and disposal of treated effluent off Boatshed Point will be localised in their nature, and comply with legislative requirements.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to marine turtles, and will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project (see Chapter 19, Marine and Estuarine Ecology).

Significant Impact Criteria – Leatherback Turtle

1) Lead to a long-term decrease in the size of a population

   While marine environments in Port Curtis and surrounding coastline provides suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any nesting sites in the Port Curtis region. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of the species.

2) Reduce the area of occupancy of the species

   No nesting sites were identified in the study area. As no nesting sites were identified, project activities are unlikely to reduce the area of occupancy of a population.

3) Fragment an existing population into two or more populations

   No population has been identified in the study area, as evidenced by nesting sites not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species

   The study area and project area currently do not support nesting sites for the leatherback turtle. No individuals were observed in the project area. The study area includes habitats utilised by the leatherback turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and the GRBWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population

   The project will not remove any areas of leatherback turtle nesting habitat. Breeding is sporadic in Australia, and has not been recorded in the Port Curtis region.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

   The habitat lost for the Arrow LNG Plant, is a small proportion of available habitat within Port Curtis and the wider GBRWHA. Marine turtles forage widely, and habitat loss will not decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

   No invasive flora or fauna has been identified as a threat to the species (DSEWPaC, 2011b).

A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

8) Introduce disease that may cause the species to decline

Disease has not been identified as a main threat to leatherback turtles. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species

It is not likely that the project will exacerbate threats identified for marine turtles within Australia. The loss of foraging habitat is small in relation to the wider Port Curtis area. Main breeding areas are not located in the Gladstone region. Impacts from shipping movements and dredge plumes from the LNG plant will be mitigated and monitoring programs established to analyse their success.

It is unlikely that any impacts upon leatherback turtles are unknown, unpredictable or irreversible. The species does not nest within the Port Curtis region, and has a limited distribution within Australian waters, and is likely to be uncommon within the Port Curtis region.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%. The species forages widely in a variety of habitats, therefore the impacts from loss of habitat are likely to be low.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. However, the species does not nest in the Port Curtis region, so there will be no impacts on nesting beaches.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the leatherback turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant. Potential foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

The predicted impacts on leatherback turtle are not expected to be significant, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Hawksbill Turtle

Hawksbill turtles are found in tropical, subtropical and temperate waters in all the oceans of the world. Nesting is mainly confined to tropical beaches. The species has a limited distribution within Australian waters, with no nesting evidence recorded along the coastal areas of the Port Curtis region. The hawksbill turtle nesting sites are in northern Queensland in the northern Great Barrier Reef and Torres Strait, and in northern areas of Western Australia. The species could forage in coastal waters in the Gladstone region, and favours rocky reef habitat, and occasionally seagrass beds.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and within the recovery plan for marine turtles in Australia (Environment Australia, 2003) are disturbance and habitat damage due to coastal development, by-catch from fisheries and shark control, predation on nests, boat strikes, entanglement and ingestion of marine debris and unsustainable levels of indigenous harvest in some areas.

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. Loss of individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty sites and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1). The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

The species does not nest within the region therefore the impacts of lighting from the LNG plant will be negligible.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to marine turtles, and will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project (see Chapter 19, Marine and Estuarine Ecology).

Significant Impact Criteria – Hawksbill Turtle

1) Lead to a long-term decrease in the size of an important population of a species

While marine environments in Port Curtis and surrounding coastline provides suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any nesting sites in the Port Curtis region. The nearest major nesting sites in Queensland are in the northern Great Barrier Reef and Torres Strait.

Loss of occasional foraging individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

It is unlikely that the project will result in a long term decrease in size of an important population, as none are present in the Port Curtis region, with nearest breeding grounds being in northern Queensland.

2) Reduce the area of occupancy of an important population

   No nesting sites were identified in the study area. As no nesting habitat will be removed and no nesting sites were identified, project activities are unlikely to reduce the area of occupancy of an important population. Marine infrastructure will not affect turtle movements when foraging in Port Curtis.

3) Fragment an existing important population into two or more populations

   The project will not fragment hawksbill turtle populations as no individuals or nesting sites have been identified within Port Curtis. Marine infrastructure will not affect turtle movements of individuals foraging in Port Curtis.

4) Adversely affect habitat critical to the survival of a species

   The project area currently does not support nesting sites for the hawksbill turtle. The study area includes habitats utilised by the hawksbill turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and the GRBWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population

   The project will not remove any areas of hawksbill turtle nesting habitat. Breeding is concentrated in northern areas of Australia, and has not been recorded in the Port Curtis region.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

   The habitat lost for the Arrow LNG Plant, is small, and no seagrass beds will be lost as a consequence of project activities. A small area (0.3 ha) of rock or reef substrate will be removed, but this is a small proportion of the overall 3,341 ha of reef in Port Curtis and a small proportion of available habitat within the wider GBRWHA. Marine turtles forage widely, and it is not likely that habitat loss will decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive fauna species such as feral pigs have been identified as a key threat to the species (DSEWPaC, 2011b) as they have been found to destroy nests in Queensland. However, the species does not nest in the Port Curtis region and this threat is unlikely to be exacerbated by the project.

Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

8) Introduce disease that may cause the species to decline

Disease has not been identified as a main threat to leatherback turtles. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species

It is not likely that the project will exacerbate threats identified for marine turtles within Australia. The loss of foraging habitat is small in relation to the wider Port Curtis area. Impacts from shipping movements and dredge plumes from the LNG plant will be mitigated and monitoring programs established to evaluate their success.

It is unlikely that any impacts upon hawksbill turtles are unknown, unpredictable or irreversible. The species does not nest within the Port Curtis region, and has a limited distribution within Australian waters, and is likely to be uncommon within the Port Curtis region.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%. The species forages widely in a variety of habitats, therefore the impacts from loss of habitat are likely to be low.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. However, the species does not nest in the Port Curtis region, so there will be no impacts upon nesting beaches.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of

the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].

- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the hawkbill turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant. Potential foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

The predicted impacts on hawksbill turtle are not expected to be significant, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Olive Ridley Turtle

The olive ridley turtle has a worldwide distribution in tropical waters, with migratory movements in some subtropical areas. The species has a limited distribution within Australian waters, with no nesting evidence recorded within the coastal ranges of the Port Curtis region. Isolated, low density nesting occurs in the Northern Territory and on the Cape York Peninsula, but has not been recorded in eastern Australia. The species favours areas of soft benthic habitat when foraging.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and within the recovery plan for marine turtles in Australia (Environment Australia, 2003) are commercial and recreational fishing, coastal infrastructure and development, Indigenous harvest, feral animal predation (of nestlings) and climate change.

Potential impacts from the Arrow LNG Plant are likely to include the loss and degradation of marine habitat and disturbance of marine turtles through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. Loss of individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

The species does not nest within the region therefore the impacts of lighting from the LNG plant will be negligible.

The maximum direct loss of habitat for each habitat type is estimated to be 5.3 ha of benthic zone and intertidal mudflats (at the Boatshed Point MOF, LNG jetty sites and associated dredging sites), and 0.14 ha of reef habitats (based on launch site 4N, which is a larger area than for launch site 1).

The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to marine turtles, and will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project (see Chapter 19, Marine and Estuarine Ecology).

Significant Impact Criteria – Olive Ridley Turtle

1) Lead to a long-term decrease in the size of a population

   While marine environments in Port Curtis and surrounding coastline provides suitable habitat and nesting beaches for the species, no known nesting sites were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant (see Appendix 12, Marine and Estuarine Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any nesting sites in the Port Curtis region.

   Loss of occasional foraging individuals will be minimised through compliance with speed limits set for Port Curtis, as detailed in the shipping activity management plan, and the use of propeller guards where feasible on high speed vessels.

   Consequently, construction and operations activities of the proposed project will not lead to a long-term decrease in the size of a population of the species.

2) Reduce the area of occupancy of the species

   No nesting sites were identified in the project area. As no nesting habitat will be removed and no nesting sites were identified, project activities are unlikely to reduce the area of occupancy of a population.

   Impacts from dredge plumes and disposal of treated effluent off Boatshed Point will be localised in their nature, and comply with legislative requirements.

3) Fragment an existing population into two or more populations

   The project will not fragment olive ridley turtle populations as none have been identified within Port Curtis. Marine infrastructure will not affect turtle movements of individuals foraging in Port Curtis.

4) Adversely affect habitat critical to the survival of a species

   The project area currently does not support nesting sites for the olive ridley turtle. The study area includes habitats utilised by the olive ridley turtle and it is highly likely the species might utilise the area periodically for foraging. However, as similar areas of marine habitat exist in the Port Curtis and the GRBWHA, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population

   The project will not remove any areas of olive ridley turtle nesting habitat. Breeding occurs at low densities in northern Australia, and has not been recorded in the Port Curtis region, or the east Australian coast.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The potential habitat lost for the Arrow LNG Plant is a small proportion of available habitat within Port Curtis and the wider GBRWHA, with 5.3 ha of benthic habitat lost for marine infrastructure and dredging. Marine turtles forage widely, and it is not likely that habitat loss will decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

   Invasive fauna species such as feral pigs, foxes and dogs have been identified as a key threat to the species (DSEWPaC, 2011b) as they have been found to destroy nests. However, the species does not nest in the region and this threat is unlikely to be exacerbated by the project.

   Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

8) Introduce disease that may cause the species to decline

   Disease has not been identified as a main threat to olive ridley turtles. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species

   The project is unlikely to exacerbate threats identified for marine turtles within Australia. The loss of foraging habitat is small in relation to the wider Port Curtis area. Main breeding areas are not located in the Gladstone region. Impacts from shipping movements and dredge plumes from the LNG plant will be mitigated and monitoring programs established to analyse their success.

It is unlikely that any impacts upon olive ridley turtles are unknown, unpredictable or irreversible. The species does not nest within the Port Curtis region, and has a limited distribution within Australian waters, and is likely to be uncommon within the Port Curtis region.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of foraging habitat. Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%. The species forages widely in a variety of habitats, therefore the impacts from loss of habitat are likely to be low.

Increased noise and lighting from the project in Port Curtis are likely to disturb marine fauna or modify their behaviour. However, the species does not nest in the Port Curtis region, so there will be no impacts upon nesting beaches.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop a construction management plan which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values [C19.01].

- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the olive ridley turtle from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna. [C19.02]

The predicted impacts on olive ridley turtle are not expected to be significant, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

6.3.4 Summary of Potential Impact

Terrestrial fauna species are likely to be impacted primarily through vegetation clearance and loss of habitat. The occurrence of large areas of similar suitable habitat to that cleared within the Gladstone area is likely to reduce the impacts on these species, as the proportion of regulated vegetation cleared within the region is low.

For most fauna species, field surveys and desktop reviews as part of the EIS and supporting studies have demonstrated that there is not habitat critical to the survival of the species present within the project area for the conservation listed species assessed. Pre-clearance surveys will be undertaken across project areas to be cleared, and appropriate mitigation measures will be implemented if any EPBC listed species are confirmed within the project area.

The establishment and effective management of a retained area of *Cupaniopsis sp* indet. in a fenced area on Boatshed Point on Curtis Island is likely to protect this species from habitat fragmentation, introduced pest species, pollution effects and an altered fire regime.

For marine species, the main impact that will occur during the construction phase of the project is dredging and clearing of sea bed habitat for the construction of marine facilities. Direct impacts include the loss and degradation of marine habitat and disturbance of marine fauna through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. The implementation of proposed mitigation measures will reduce the significance of impacts on marine fauna and their habitat. This includes fauna spotting functions where practical, the use of propeller guards or equivalent on high speed vessels to reduce the risk of boat strike (where practical) keeping dredging activities within the identified footprint.

Lighting impacts from construction and operation of the LNG facility may disorientate turtle species (flatback and occasionally green) nesting near Southend. Light generated from the LNG facility can be

reduced through use of sensitive lighting techniques or shielded from the nesting beach to reduce the significance of impacts.

6.4 Protected Migratory Species

An action will require approval if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species listed below are also listed as threatened species. Species listed as threatened which are also listed as migratory (such as marine turtles and painted snipe) are addressed in Section 6.3 of this attachment. The criteria below are relevant to migratory species that are not threatened.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

As discussed in Section 6.3, the likelihood of a species being present within the study area was assessed within the technical studies.

All species with a rating of moderate and above likelihood (therefore possible to occur within the project area) are assessed below against the relevant significant impact criteria from the EPBC guidance note. All other species were assessed as not possible within the project area as a result of a lack of suitable habitat, or being outside of the species normal range, and therefore are not considered. The precautionary approach ensures that species that could potentially occur, despite marginal habitat or being known only from the wider region, are assessed below.

Species identified in the EPBC referral and through the course of further database searches and desktop review in the technical study, can be categorised into four groups; migratory shorebirds, other migratory wetland birds, terrestrial migratory birds and migratory marine fauna.

6.4.1 Migratory Shorebirds

Migratory shorebirds breed in the northern hemisphere and migrate to non breeding grounds of Australia along the East Asian-Australasian flyway, from the breeding grounds in Siberia southwards through east Asia to New Zealand and Australia. Migratory shorebirds depart from their breeding grounds in July to October and begin arriving in Australia from late August. Return migration occurs from around March to early June.

Habitat used in Australia varies across the species present. Intertidal habitats including coastal estuaries and mudflats are generally considered to provide the most important sites.

Thirty-six international migratory shorebird species regularly visit Australia each year. These species are listed as migratory under the EPBC Act. Species relevant to the study area are detailed in Section 5.4. Listed migratory species are a ‘matter of national environmental significance’.

The EPBC Act Policy Statement 3.21 ‘Significant Impact Guidelines for 36 Migratory Shorebird Species’ (Australian Government, 2009) provides the framework for the assessment of potential impacts upon migratory shorebird species from the Arrow LNG Plant. The policy statement builds on

the information and explanations in EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance.

The policy statement is designed to help determine the impacts of proposed actions on migratory shorebird species, and to provide mitigation strategies to reduce the level or extent of those impacts. The policy aim is to promote ecologically sustainable development that allows for the continued ecological functioning of important habitat for migratory shorebirds.

Using these guidelines, a site is considered to provide important habitat for migratory shorebirds if:

- The site is identified as internationally important.
- The site supports at least 0.1 per cent of the flyway population of a single species.
- The site supports at least 2000 migratory shorebirds.
- The site supports at least 15 shorebird species.

Latham's snipe does not commonly aggregate in large flocks or use similar habitat to many other coastal species. Consequently, habitat important to Latham's snipe is not regularly identified using the process outlined above. A different method for identifying important habitat for Latham's snipe is described below.

Important habitat for Latham's snipe occurs at sites that have previously been identified as internationally important for the species, or sites that:

- Support at least 18 individuals of the species, and
- Are naturally occurring open freshwater wetland with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland).

The migratory shorebird policy statement outlines four principal threats to shorebirds within Australia. These threats are sourced from the criteria that should be considered when assessing impacts on migratory shorebirds from a project.

Habitat Loss

The loss or degradation of sites that support large numbers of migratory shorebirds can cause disproportionate declines in shorebird populations, as displaced birds are unable to find suitable replacement habitat. Similarly, the incremental loss of smaller sites affects the broader conservation of habitat availability. In Australia, the loss of important habitat reduces the availability of foraging and roosting sites, affecting the ability of birds to build up the energy stores necessary for successful migration and breeding. Some sites are also important year-round for juvenile birds, with loss of these habitats affecting the future breeding populations of these species.

Habitat may be lost due to a variety of activities that make the habitat unavailable to shorebirds. These may include direct loss through clearing, inundation, infilling or draining (for example, for buildings or marine services, such as harbours, marinas, ports, oil terminals) or indirect loss through changes to hydrology, water quality or structural changes near some roosting sites (for example, increased cover, encroachment of buildings).

Habitat Degradation

Migratory shorebirds are sensitive to subtle changes to their habitat. In particular, many have specialised feeding techniques making them susceptible to slight changes to prey sources and their foraging environments. Any activity that reduces the ability of shorebirds to use an area for roosting or foraging, or reduces the availability of food, degrades habitat. These activities include (among others):

- Substantial loss of marine or estuarine vegetation, which is likely to alter the dynamic equilibrium of sediment banks and mudflats, as well as providing organic matter to support the invertebrates on which migratory shorebirds feed.
- Invasion of intertidal mudflats by weeds such as cord grass (*Spartina* species).
- Water pollution and changes to the water regime.
- Artificial changes to hydrological regimes that affect the productivity of the feeding environment (for example, changes in water depth).
- Exposure of acid sulfate soils changing the chemical balance of the site.

Disturbance

Disturbance is emerging as a major conservation issue for migratory shorebirds. Certain activities may interrupt migratory shorebirds during their limited foraging periods, such as during low tide, and prevent them from foraging effectively. Disturbance can also affect roosting birds and cause them to waste energy stored for migration.

Disturbance can result from residential and recreational activities such as four-wheel-drive vehicles, jet- and water-skiing, power boating, fishing, walking, wind-surfing, kite-surfing, walking dogs, noise and night-lighting. While some activities may result in only low-levels of disturbance, it is important to consider the combined effects of disturbance with other threats when determining the level of potential impact of an action. Roosting and foraging birds are most sensitive to discrete, unpredictable disturbances such as sudden loud noises (for example, from demolition activities) and from objects that approach them from the water (for example, boats). High and sustained levels of disturbance can prevent shorebirds from using all or parts of the habitat.

Direct Mortality

Direct mortality of birds may occur due to a variety of reasons. Activities that may result in direct mortality may include development of wind farms in migration or movement pathways, bird strike caused by aeroplanes, and chemical or oil spills.

The impact criteria above are applied to migratory shorebirds as a whole, and then separately to Latham’s snipe as the policy statement recommends.

Potential impacts from the project on migratory shorebirds are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

The loss of shorebird habitat is small, an area to the north of Hamilton Point on the margins of North China Bay. Less than 5 ha of RE 12.1.3 (mangrove vegetation), and less than 6 ha of RE 12.1.2 (saltpan vegetation on clay plains) will be lost for construction of infrastructure associated with referral 2009/5007 for the Arrow LNG Plant. This comprises less than 0.5% of the REs in the Gladstone region.

The saltpan between Boatshed and Hamilton Point also has the potential to provide habitat for foraging shorebirds, and may be disturbed by the Arrow LNG Plant. It is unlikely that this site is used by significant numbers of shorebirds, as the saltpan is not optimal habitat.

There is a network of shorebird sites around Port Curtis. Areas of key shorebird foraging habitat and shorebird roosts within Port Curtis are identified in the Curtis Coast Regional Coastal Management

Plan, 2003 (Queensland Government, 2003), and do not include the saltpans on Curtis Island adjacent to the project area.

Ecosure identified that 11 migratory species of shorebird were recorded within Port Curtis either during surveys for the Arrow LNG Plant or surveys for other LNG proponents (Section 5.4 of this attachment, Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment to the EIS). The identified species are:

- Bar-tailed godwit.
- Common greenshank.
- Eastern curlew.
- Great knot.
- Grey-tailed tattler.
- Lesser sand plover.
- Pacific golden plover.
- Red-necked stint.
- Sharp-tailed sandpiper.
- Terek sandpiper.
- Whimbrel.

An additional 17 migratory shorebird species were identified during the course of the EPBC Protected Matters search for Referral No EPBC 2009/5007, and were found by Ecosure to have potential to occur within the study area based on habitat preferences and distribution. The species identified through the EPBC Protected Matters search are:

- Australian painted snipe.
- Black-tailed godwit.
- Broad-billed sandpiper.
- Common sandpiper.
- Curlew sandpiper.
- Double-banded plover.
- Greater sand plover.
- Grey plover.
- Latham's snipe.
- Little curlew.
- Marsh sandpiper.
- Oriental plover.
- Oriental pratincole.
- Red knot.
- Ruddy turnstone.
- Sanderling.
- Wood sandpiper.

All of the species migrate to Australia during the southern hemisphere summer, having bred in Siberia and high Arctic regions, with the exception of the double-banded plover which is a trans-Tasman migrant and visits Australia during the winter months.

Considering the data reviewed and these guidelines, it is unlikely for the saltpans on Curtis Island adjacent to the project area to be classified as important habitat for migratory shorebirds. Significant numbers (over 0.1% of a flyway population or at least 2000 migratory shorebirds) are not likely to use this site, and the site is unlikely to support at least 15 migratory species.

Further shorebird field survey work will be conducted prior to construction. A monitoring program will be undertaken at sites where impacts to migratory shorebird habitat have been identified, such as the mainland tunnel launch site and tunnel spoil disposal area (addressed in Referral No. EPBC 2009/5008). It is unlikely that the Arrow LNG Plant on Curtis Island will impact significantly on shorebird habitat. Requirements for further monitoring will be determined after an initial study to establish usage of the project area by migratory shorebirds and, if required, appropriate management measures formulated.

Significant Impact Criteria: Migratory Shorebirds

1) Habitat loss.

   Less than 5 ha of RE 12.1.3 (mangrove vegetation), and less than 6 ha of RE 12.1.2 (saltpan vegetation on clay plains) will be lost for construction of infrastructure associated with referral 2009/5007 for the Arrow LNG Plant. The greater balance of the area of saltpan vegetation comprises an extensive bare estuarine mudflat. The loss represents less than 0.5% of both vegetation types within the Gladstone local government area.

   Shorebird habitat removed on the coastal margins of Curtis Island for project marine infrastructure is of low value, consisting predominantly of a rocky substrate, not the muddy or sandy substrates favoured by foraging migratory shorebirds. As such, the direct impacts on shorebird habitat on Curtis Island are insignificant.

   No shorebird roost sites or significant shorebird foraging habitat are present within the project footprint, as identified in the Curtis Coast Regional Coastal Management Plan, 2003 (Queensland Government, 2003) (Figure 3).

   This loss of potential foraging habitat would not significantly decrease the foraging habitat available for shorebirds within the wider Port Curtis area.

2) Habitat degradation.

   The project has the potential to impact on areas of shorebird habitat through sediment mobilisation as a result of exposure of the ground surface and reduced water quality, leading to loss of habitat condition in adjacent areas and decline in water quality, loss of vegetation integrity as a result of increased altered water flows and weed invasion, pollution from project use of petroleum based products or poor waste management causing runoff and spills, or release of leachates as a result of acid sulfate soil mobilisation.

   Mitigation measures implemented for the project will control these impacts on areas of intertidal habitat in adjacent areas to the project used by shorebirds. These include implementing sediment and erosion control measures upslope of watercourses, wetlands and coastal areas to prevent sediment discharge, implementation of an acid sulfate soils management plan, training all relevant personnel in spill response and recovery procedures, storing fuel, oil and chemicals in appropriate, bunded storage facilities and measures in the Pest Management Plan to control invasive plant species that may colonise the saltpan and degrade remaining habitat.

   As such, it is not likely that the project will significantly degrade areas of shorebird habitat in Port Curtis.

3) Disturbance.

   Construction activity has the potential to displace birds from adjacent areas of mudflat preventing them from foraging, thus impacting on the fuel reserves of these migratory species. Loud, discontinuous construction noise has been identified as a major disturbance factor in shorebirds

adjacent to industrial sites, although birds do become habituated to regular vehicle movements and lower levels of operational background noise, often returning to feed close to disturbed areas, with displacement solely from areas immediately adjacent to the noise source.

The saltpans either side of Boatshed Point at the LNG plant site has been identified as possible shorebird feeding habitat although no shorebird roost sites or significant shorebird foraging habitat are present within the project footprint. The area may provide habitat for migratory waders between October and April, with a peak in November to March. Smaller numbers may also over winter around Port Curtis. However, the area of available habitat is small, and other more suitable areas are present nearby in Port Curtis, therefore it is anticipated numbers using these saltpans will be low.

Displacement of birds is likely from the immediate area adjacent to works during construction. This may disrupt foraging and jeopardise the ability of birds to lay down fat reserves for the northward migration or to refuel after their southern migration.

During operation, shorebird species are likely to return to use the intertidal areas for foraging as habituation takes place. Some birds may be displaced from a small area immediately adjacent to project infrastructure and fragmentation from other areas of the mudflats may take place.

The saltpan at North China Bay is a small proportion of a large network of shorebird feeding and roosting sites around Port Curtis (Port Curtis covers an area of approximately 200 km^2) and the area of saltpan to be lost is of low value and a small proportion of that present in the Gladstone area (less than 0.5%). North China Bay is already significantly disturbed by industrial activity and it is unlikely this site will be of importance to migratory shorebirds.

Mitigation on Curtis Island will include consideration (in the design process) of techniques such as lowest possible luminescent globes, light shielding and sensitive light placement. Access will be prohibited to the saltpans and fringing mangroves outside the footprint of the LNG plant site to reduce disturbance to adjacent areas.

As such, it is not likely that the project will significantly disturb areas of shorebird habitat in Port Curtis.

4) Direct mortality.

There are few mechanisms that will result in direct mortality of shorebirds as a result of the project. Bird strike will not be an issue in construction works, and it is likely birds will be temporarily displaced from areas immediately adjacent to construction to other areas in Port Curtis.

The potential for spills is covered in point 2 above. There is potential for the project to aid the introduction of terrestrial pest species (such as rats, cats and foxes) into the project area, which may predate shorebird species. Measures to reduce the likelihood of this issue will be detailed in the project quarantine management plan.

As such, the project is unlikely to result in the direct mortality of shorebirds in Port Curtis.

It is unlikely that any impacts upon migratory shorebirds are unknown, unpredictable or irreversible. The area of habitat lost for construction of infrastructure associated with referral 2009/5007 is low, being less than 5 ha of mangrove vegetation and less than 6 ha of saltpan vegetation on clay plains. This represents less than 0.5% of both vegetation types within the Gladstone local government area. The area is not identified as key shorebird foraging habitat as in the Curtis Coast Regional Coastal

Management Plan, 2003. The area around North China Bay is already heavily disturbed as a result of other LNG projects on Curtis Island, therefore the usage of this site by shorebirds is likely to be low.

Construction activity has the potential to displace birds from adjacent areas of mudflat preventing them from foraging, thus impacting on the fuel reserves of these migratory species. However, the usage of the shorebird habitat in North China Bay is likely to be low, and therefore the impacts on migratory shorebirds unlikely to be significant.

The cumulative impact contribution of the loss of shorebird habitat for the Arrow LNG Plant and other projects within the region is less than 1% for both mangrove habitat and saltpan vegetation. The largest element of saltpan vegetation loss for the Arrow LNG Plant is discussed in the MNES attachment for Referral No. EPBC 2009/5008.

Mitigation measures for the project that will reduce the impacts upon migratory shorebirds are:

- Include measures in the pest management plan to control invasive plant species that may colonise the mudflats and degrade remaining habitat [C17.13].
- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practicable, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].
- Design lighting around the perimeter of the LNG plant to minimise impacts on roosting shorebirds, where practical. Lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal zones, where practical [C17.20].

Latham's Snipe

Latham's Snipe is a non-breeding visitor to southeastern Australia. The species favours soft wet ground associated with mainly open, freshwater wetlands, as well as flooded paddocks and seepage below dams.

Suitable disturbed grassland habitat, conducive to water ponding, in the mainland section of the study area around TWAF 8 provides suitable foraging habitat for Latham's snipe. Consequently, the species was assessed as having a moderate likelihood of being present in the study area.

No Latham's snipe were identified in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is unlikely to be impacted by the project, as no suitable wetland habitat or wet grassland will be cleared for project infrastructure.

Historically, the greatest threats to Latham's snipe in Australia have been a loss of habitat caused by the drainage and modification of wetlands, and excessive mortality due to hunting. The Arrow LNG Plant will not permit hunting to take place unless for pest control purposes (not applicable to Latham's Snipe) and construction of the project will not result in the loss of any suitable wetland habitat.

Significant Impact Criteria: Latham's Snipe

1) Habitat loss.

   No habitat suitable for the species will be removed for the project infrastructure. The species favours freshwater wetlands and flooded grassland, and this habitat is not present within areas of project infrastructure.

Ephemeral habitat could be created in open areas of the project site, but this is likely to be short-lived and not provide key habitat for the species. Any presence would be short term in nature.

The project will not result in significant habitat loss for the species.

2) Habitat degradation.

No habitat suitable for the species will be degraded as a result of the project. The species favours freshwater wetlands and flooded grassland, and this habitat is limited within the study area.

Potential impacts on any freshwater wetlands within the study area from accidental spills will be mitigated by implementing appropriate materials handling procedures and spill prevention and response plans.

The project will not significantly degrade areas of Latham's snipe habitat in Port Curtis.

3) Disturbance.

The species is unlikely to be present in areas of project infrastructure, or immediately adjacent areas in significant numbers.

As such, the project will not significantly disturb areas of Latham's snipe habitat in Port Curtis.

4) Direct mortality.

The potential for spills is covered in significant impact criterion 2 (habitat degradation) above. There is potential for the project to aid the introduction of terrestrial pest species (such as rats, cats and foxes) into the project area, which may predate on the species. A pest management plan has been developed for the project (Appendix 10 to the EIS) and will detail the measures to prevent the introduction and spread of pest flora and fauna which may impact upon the species.

As such, the project will not result in the direct mortality of Latham's snipe in Port Curtis.

It is unlikely that any impacts from the project on Latham's snipe are unknown, unpredictable or irreversible. The species is typically found on freshwater wetlands. There are no suitable freshwater wetlands within the project area. Consequently, the project will not impact upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

In conclusion, impacts on the Latham's snipe from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no areas of habitat likely to hold the species were identified in the project area. Suitable areas of wetland habitat within the study area will not be impacted by the project.

6.4.2 Other Migratory Wetland Birds

In addition to the migratory shorebirds discussed in Section 6.4.1, database searches and field surveys identified eight species of birds listed as migratory under the EPBC Act that are associated with wetlands and marine habitats that occur, or have the potential to occur, in the study area:

- Caspian tern.

- Cattle egret.
- Cotton pygmy-goose.
- Eastern osprey.
- Eastern reef egret.
- Great egret.
- Little tern.
- White-bellied sea-eagle.

Of these species, Caspian tern, eastern osprey, great egret and white-bellied sea eagle were recorded in surveys for the project or for other LNG proponents.

Cotton pygmy goose is typically associated with freshwater lakes and swamps. Both great egret and cattle egret are common and widespread in a variety of wetland habitats. Eastern reef egret favours rocky shorelines, but it is also occasionally found in areas of mudflat. Both osprey and white-bellied sea-eagle occur on coastal and inland waterbodies. Little tern occurs in sheltered coastal areas and on ocean beaches, and Caspian tern occurs in coastal waters but also on large inland waterbodies.

Habitat loss is listed as a threat for many of the species listed above (DSEWPaC, 2011b). Invasive fauna species are also identified as a threat, preying on eggs and young. Habitat loss and degradation from invasion by pest flora species is also identified as a threat to wetland migratory species.

Potential impacts from the project on migratory wetland birds are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

There are no recovery plans in place for any of the listed species.

The significant impact criteria are applied for these species as follows:

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No freshwater wetland habitat within the study area suitable for the cotton pygmy goose will be impacted by the project.

   The remaining species are associated with coastal waters, or partly associated with coastal waters. The study area contains suitable foraging and roosting habitat for these species. The suitable habitat potentially impacted by the project is small, compared to the extent of similar suitable habitat within the wider Port Curtis area. It is unlikely that the area potentially impacted by the project would be considered important habitat for these species.

   Most will range widely within a suitable range of habitats in the Port Curtis and Gladstone area. The project will not involve the removal or disturbance of large areas of these habitats.

   The project will not result in significant habitat loss for any of the above species.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   A pest management plan has been developed for the project (Appendix 10 to the EIS) and a quarantine management plan will be developed for the project. Implementation of the plans will reduce the potential for diseases that will threaten the species to be introduced as a result of the

project activities. This will include the control of feral fauna species through the pest management plan.

The project will also liaise with Biosecurity Queensland and Gladstone Regional Council on project pest management programs. This will include the control of invasive flora species which may degrade wetland habitats suitable for the above listed species.

The project will not result in invasive species harmful to the identified migratory species, being introduced to the area.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The project will not significantly disrupt the lifestyle of a migratory species within the area. All species listed above are found in a range of habitats present in the study area, and removal of these habitats is small in comparison to available habitat in adjacent areas. Therefore, the breeding, feeding, migration or resting behaviour of any of the listed species is not likely to be affected by the project.

The colonial nester, little tern is vulnerable to disturbance which leads to the colony being abandoned. No nesting sites were identified within the study area and these are more likely on the sandy beaches on the eastern side of Curtis Island.

A likely white-bellied sea eagle nest was identified on Hamilton Point, although away from the project area. The nest will be inspected for activity during the breeding season prior to construction activities commencing. If active, appropriate management measures will be formulated, including avoiding clearing activities in the breeding season, should the Hamilton Point MOF option be pursued.

As such, it is highly unlikely the project will significantly disrupt the lifestyle of migratory species within the area.

It is unlikely that any impacts from the project upon other migratory wetland birds are unknown, unpredictable or irreversible. The species listed are typically found either on freshwater wetlands or in a range of estuarine and coastal habitats. This habitat is represented by the small saltpans on Curtis Island, although the species are likely to be found in suitable wetland areas away from the project footprint, as they are wide ranging around Port Curtis. Foraging habitat lost as a result of the project is a small proportion of that available in the wider region.

The mitigation measures for migratory shorebirds, as identified in Section 6.4.1 are applicable to these species.

In conclusion, impacts on wetland migratory species from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no important habitat or populations have been identified and feeding habitat cleared is a small proportion of that available in the wider region around Port Curtis. Freshwater wetlands will not be impacted by the project.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.4.3 Terrestrial Migratory Birds

In addition to the migratory species discussed in Sections 6.4.1 and 6.4.2, database searches and field surveys identified eight species of birds listed as migratory under the EPBC Act that are predominantly associated with terrestrial habitats as occurring, or having the potential to occur, in the study area. The identified terrestrial migratory species are:

- Barn swallow.
- Black-faced monarch.
- Fork-tailed swift.
- Rainbow bee-eater.
- Rufous fantail.
- Satin flycatcher.
- Spectacled monarch.
- White-throated needletail.

Of these species, all were recorded in surveys for the project or for other LNG proponents bar the two species of monarch, and barn swallow.

Both monarchs, rufous fantail, rainbow bee-eater and satin flycatcher are species primarily associated with a variety of woodland habitats, although they may also occur in mangroves within the study area. All are insectivorous species, and Ecosure identified suitable habitat as being present throughout the study area.

Barn swallow, fork-tailed swift and white-throated needletail are aerial foraging species, which will potentially forage in air space over the entire study area.

Habitat loss is listed as a threat for many of the species listed above (DSEWPaC, 2011b). The invasive fauna species, the cane toad, has been identified as a threat to the rainbow bee-eater, preying on eggs and competing for nesting holes.

Impacts from the project are likely to primarily relate to loss of habitat and fragmentation of existing habitat, as well as associated edge effects such as increased weed invasion (and habitat degradation) and predation.

There are no recovery plans in place for any of the listed species.

The significant impact criteria are applied for these species as follows.

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Most species will range widely within a range of suitable habitats in the Port Curtis and Gladstone area. Removal or disturbance of large areas of these habitats is not proposed. The habitat within the area to be cleared is small in comparison to the available habitat in adjacent areas.

   The project will not result in significant habitat loss for any of the above species.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   Of these species only rainbow bee-eater is likely to be significantly affected by invasive species. Feral fauna such as cane toads, red fox and feral cats may prey on eggs and young, as the species nests in burrows on the ground. A pest management plan has been prepared and is

appended to the EIS, as Appendix 10. A quarantine management plan will be developed for the project and its implementation will reduce the potential for diseases to be introduced as a result of project activities.

Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project pest management programs. This will include the control of invasive flora species which may degrade woodland and grassland habitats suitable for the above listed species.

The project will not result in invasive species harmful to the identified migratory species, being introduced to the area.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The project will not significantly disrupt the lifestyle of a migratory species within the project area. All species listed above are found in a range of habitats present in the study area, and removal of these habitats is small in comparison to available habitat in adjacent areas. Therefore, the breeding, feeding, migration or resting behaviour of any of the listed species is not likely to be affected by the project.

It is unlikely that any impacts from the project upon terrestrial migratory species are unknown, unpredictable or irreversible. The species listed are found in a range of terrestrial habitats, not specific to one RE type. The cumulative loss of habitats for all projects within the Gladstone region is small, in comparison to the overall habitat available within the region. Available habitat in adjacent areas to the project includes the Curtis Island Environmental Management Precinct on Curtis Island and Targinie State Forest on the mainland.

No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

In conclusion, impacts on terrestrial migratory species from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no important habitat or populations have been identified and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.4.4 Migratory Marine Fauna

In addition to the migratory turtles discussed in Section 5.3, database searches and field surveys identified four species of marine fauna listed as migratory under the EPBC Act as occurring, or having the potential to occur, in the study area.

Saltwater Crocodile

The saltwater crocodile inhabits coastal swamps, rivers, estuaries and open sea along the Queensland coast from the Northern Territory border, around Cape York Peninsula to as far south as Rockhampton.

Patches of suitable estuarine habitat occur in the study area along the mainland coastline and southern section of Curtis Island. However, no individual species were observed during the field surveys (Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment) and no critical habitat has

been identified within the study area. The species was assessed as having a moderate likelihood of being present in the study area due to the suitability of the habitat.

Combined with the effects of the other LNG projects on Curtis Island and other industry, a total loss of 11,702 ha of marine habitat will occur, of which the Arrow LNG Plant will contribute 67 ha or 0.57%.

Key listed threats to the saltwater crocodile on the Species Profile and Threats database include incidental mortality from fishing nets and habitat destruction (DSEWPaC, 2011b).

Potential impacts from the Arrow LNG Plant include the loss of foraging habitat, and potential boat strike.

There is no specific recovery plan for the species.

Significant Impact Criteria – Saltwater Crocodile

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No individuals or nests were found during field surveys in the study area. No habitat within the study area is critically important habitat for the species and the project will not involve the removal or disturbance of large areas of suitable habitat for this species. Consequently, the construction and operation of the project will not substantially modify, destroy or isolate an area of important habitat for the saltwater crocodile.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   No invasive species likely to be present in the Gladstone region have been identified as a threat to saltwater crocodile.

   A quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease and invasive species.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   No significant breeding area for this species has been identified in the study area, and Port Curtis is to the south of its known distribution. As such, it is not likely that the project will significantly disrupt the lifestyle of saltwater crocodile, if they were to occur in the study area.

   Arrow Energy will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project (see Chapter 19, Marine and Estuarine Ecology).

It is unlikely that any impacts upon saltwater crocodile are unknown, unpredictable or irreversible. The species is infrequent and scarce within the Port Curtis region, and is likely to be uncommon within the Port Curtis region. The species, if present, will range widely within a suitable range of habitats in the Port Curtis area, therefore the impacts from loss of habitat are likely to be minor.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

The fauna spotting function, enforcement of marine speed limits and installation of propeller guards, where feasible, will reduce the magnitude of impacts upon this species.

Foraging habitat cleared is a small proportion of that available in the wider region. Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

This assessment has determined that, were losses to occur, they wouldn't be a significant impact, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].

In conclusion, impacts on the saltwater crocodile from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as no critical habitat has been identified within the region, and the species is at the southernmost limit of its range and not common in the region.

Dugong

Dugong is listed as a protected migratory species under the EPBC Act. Large populations (estimated at 14,000 individuals) have been observed within the GBRMP, and their presence has attributed to the area being listed as World Heritage Area and the designation of the Zone B dugong protection area. The entire study area falls within the dugong protection area.

Dugongs are known to feed on the seagrass beds within Port Curtis during their migration along the Queensland coast. They can feed in large herds of approximately 140 individuals, grazing in a single location for four weeks or longer. Feeding aggregations tend to occur in wide, shallow protected bays, wide, shallow mangrove channels and in the lee of large inshore islands. These areas are coincident with sizeable seagrass beds. The long lifespan and low reproduction rate of the dugong means the species population recovery is potentially slow, and the animals are vulnerable to both natural and anthropological factors, including boat strike, underwater noise, Indigenous hunting, commercial fishing or trawling and destruction or fragmentation of habitat.

Main threats to the dugong include incidental mortality from entanglement in fishing nets and habitat destruction and degradation of preferred seagrass beds foraging habitat (DSEWPaC, 2011b). Other threats include boat strike, noise pollution and chemical pollution of coastal waters frequented by the species.

Potential impacts from the Arrow LNG Plant include loss of foraging habitat, although combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%. There are no known seagrass beds within the project footprint for Referral No. EPBC 2009-5007.

Disturbance of dugong through increased noise and turbidity may also occur. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements.

Vessel activity in Port Curtis and the Queensland coast may lead to the injury and mortality of dugongs. Most vessel movements associated with the project will be low in frequency and slow moving vessels, thus reducing the risk of boat strike, although higher speed vessels will be used to transport workers to and from Curtis Island on a daily basis. Intense human-generated underwater sounds from activities such as pile driving have the potential to interfere with the behaviour of dugongs. Much of the pile driving required for construction of marine infrastructure will be in intertidal and shallow subtidal areas, which will reduce the extent of transfer of underwater sound into deeper waters.

A spill or discharge of oil, chemicals, sewage, grey or black water and ballast water could occur as LNG carriers travel through the GBRMP and surrounding waters. They also have the potential to generate garbage and collide, ground, anchor or sink in the park. These impacts could displace dugong, or smother or lead to the mortality of seagrass habitats.

Mitigations will be implemented to reduce project risks to dugong. This will include compliance with all applicable speed limits set for the Port of Gladstone-Rodds Bay Zone B dugong protection area, installation (where feasible) of propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of a boat strike, and undertaking fauna observations prior to and during pile-driving and dredging activities to check for the presence of dugongs. Should dugong be spotted within the area of the works, then procedures will be implemented to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area.

There is no recovery plan for dugong. Arrow Energy will develop a construction management plan, outlining specific mitigation measures, and management actions required to reduce impacts to dugongs and other marine fauna.

Significant Impact Criteria – Dugong

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

   No areas of seagrass will be removed within areas required for project infrastructure, therefore it is not anticipated that direct habitat loss for the species will be significant as a result of the project.

   The wastewater outfall off Boatshed Point will result in localised impacts. Water quality criteria and salinity levels will return to a natural range within 10 m from the discharge location. The nearest seagrass bed is approximately 500 m from Boatshed Point.

   Modelling of dredge plumes has indicated that dredging will have a short term and localised impacts on concentrations of suspended sediments in areas adjacent to the dredging activities. Impacts on areas of seagrass will be negligible.

   Project activities will not result in significant impacts on dugong habitat. Areas may be indirectly affected by dredging activities and the resulting increases in turbidity. The offsets strategy will aim to compensate for the loss of habitat as a result of the project.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species

   No invasive species have been identified as a threat to dugong.

   Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   A quarantine management plan will be developed and implemented for the project to control the introduction and spread of pest fauna that may threaten the species.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

   While seagrass beds within Port Curtis provide suitable habitat for the species, no areas of seagrass will be removed or disturbed for construction of project infrastructure, and mitigation measures will be implemented to reduce any effects on dugongs from vessel movement, underwater noise, and increase turbidity and salinity levels.

   It is unlikely that the project would seriously disrupt the lifecycle of an ecologically significant proportion of the population of dugong.

   Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

   The project does not take place in the immediate vicinity of any known seagrass beds within Port Curtis, an important foraging resource for the species.

   Arrow Energy will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project [C19.02] (see Chapter 19, Marine and Estuarine Ecology).

It is unlikely that any impacts upon dugong are unknown, unpredictable or irreversible. The species is likely to be present in areas of seagrass beds throughout Port Curtis and the entire marine study area falls within the dugong protection zone.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Test and treat all discharges to Port Curtis to meet water quality criteria, as required, prior to discharge [C16.04].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].
- Contribute to the development of a Port of Gladstone shipping activity strategy and management plan. Comply with applicable speed limits for the Port of Gladstone-Rodds Bay Zone B dugong protection area, as detailed in the management plan [C19.04].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of

the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].

- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on the dugong from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as the proportion of habitat lost as a result of dredging is minimal and no areas of seagrass have been identified within areas of project infrastructure,

Effective implementation of proposed mitigation measures means that it is unlikely that the Arrow LNG Plant will have a significant impact on the species.

Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

This assessment has determined that, were losses to occur, they wouldn't be a significant impact, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Dolphins

Two species of dolphin likely to be found in the study area are the Australian snubfin dolphin and the Indo-Pacific humpback dolphin. Both species are recognised as near threatened under the IUCN Red List. The Indo-Pacific humpback dolphin is thought to be endemic to Australian waters and the Australian snubfin dolphin is restricted to similar regions with some extension into southern Papua New Guinea waters. Both species have been known to occur in waters from north Western Australia to southeast Queensland.

Their habitat, which is predominately shallow coastal waters in or adjacent to near modified environments such as dredged channels, breakwaters and river mouths, exists within the study area and can be found along the majority of the Queensland coastline. This habitat appears to support foraging and mating activities for the species.

Key listed threats to these species of dolphin on the Species Profile and Threats database (DSEWPaC, 2011b) include incidental mortality from entanglement in fishing nets and habitat destruction and degradation of foraging habitat and overfishing of prey species. Other threats include boat strike, noise pollution and chemical pollution of coastal waters. The continued development of coastal areas of preferred habitat can have implications on the species survival, including impacts from gill netting activities, pollution, vessel traffic and overfishing.

Potential impacts from the Arrow LNG Plant include a loss of foraging habitat, although combined with the effects of the other LNG projects on Curtis Island and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat within Port Curtis, of which the Arrow LNG Plant contributes 67 ha or 0.57%. There are no known seagrass beds within the project footprint. In addition, both species of dolphin inhabit a wide variety of coastal zone habitats having been reported in a variety of coastal habitats from coastal lagoons and enclosed bays with mangrove forests and seagrass beds through to open coastal waters with rock

and/or coral reefs (DSEWPaC, 2011b). Given this, they are likely to move widely around Port Curtis and the GBRWHA.

Disturbance of dolphins through increased noise and turbidity may also occur. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is small as a percentage and in absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. However both species of dolphin are capable of detecting high speed, high frequency marine vessels and have the ability for rapid avoidance actions.

There is no recovery plan for either species.

Significant Impact Criteria – Dolphins

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any particular area of important habitat for the species (DSEWPaC, 2011b). The species is primarily found in shallow waters less than 20 m deep, close to the coast or close to river and creek mouths and in the proximity of seagrass beds.

   No areas of seagrass have been identified within areas of project infrastructure, therefore it is not anticipated that direct habitat loss for the species will be significant as a result of the project.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

   No invasive species have been identified as a threat to either species of dolphin.

   A pest management plan has been developed for the project (Appendix 10 to the EIS) and a quarantine management plan will be developed for the project. Implementation of the plans will reduce the potential for diseases that will threaten the species to be introduced as a result of project activities.

   Arrow Energy will also liaise with Biosecurity Queensland and Gladstone Regional Council on project pest management programs.

   It is unlikely that the project will result in invasive species harmful to dolphins, being introduced to the area.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

   No significant breeding area for this species has been identified in the study area.

   Vessel activity in Port Curtis and the Queensland coast may lead to injury and mortality to dolphins. Most vessel movements associated with the project will be low frequency and slow moving vessels, thus reducing the risk of boat strike, although higher speed vessels will be used to transport workers to Curtis Island on a daily basis.

   Intense human-generated underwater sounds from activities such as seismic surveys and pile driving have the potential to interfere with the behaviour of dolphins. Much of the pile driving required for construction of marine infrastructure will be in intertidal and shallow subtidal areas, which will reduce the extent of transfer of underwater sound into deeper waters.

A spillage or discharge of oil, chemicals, sewage, grey or black water and ballast water could occur as LNG carriers travel through the GBRMP and surrounding coastal waters. They also have the potential to generate garbage and collide, ground, anchor or sink in the park. These impacts could displace dolphin from areas of Port Curtis.

Mitigation measures will be implemented to reduce project risks to cetaceans including dolphins.

It is unlikely that the project would seriously disrupt the lifecycle of an ecologically significant proportion of the population of either species of dolphin.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact on marine habitat (i.e., loss or disturbance) equates to a total loss of 11,702 ha, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

It is unlikely that any impacts upon dolphins are unknown, unpredictable or irreversible.

Both dolphin species are primarily found in shallow waters less than 20 m deep, close to the coast or close to river and creek mouths and in the proximity of seagrass beds. There are no known seagrass beds in the vicinity of project infrastructure associated with Referral No. EPBC 2009/5007. Seagrass beds within Port Curtis are an important foraging habitat for both species.

Arrow Energy has committed to establishing a marine offsets strategy following the principles outlined in the Commonwealth offsets policy (Section 19.5.1 of EIS) to address the impacts on marine ecosystems that provide foraging habitat for marine fauna [C19.02].

This assessment has determined that, were losses to occur, they wouldn't be a significant impact, hence, no offsets are required under the EPBC Act for this species. However, the marine offsets strategy required under relevant Queensland legislation will be beneficial for this listed species.

Both dolphin species are likely to be present throughout Port Curtis, and inhabit a wide variety of coastal zone habitats and will move widely around Port Curtis and the GBRWHA, and it is unlikely that the project will result in significant impacts upon dolphin habitat.

An increase in shipping traffic is likely to cause an increase in boat strike, which has the potential to injure or kill marine fauna. However both species of dolphin are capable of detecting high speed, high frequency marine vessels and have the ability for rapid avoidance actions.

Mitigation measures for the project that will reduce the impacts on the Australian snubfin dolphin and the Indo-Pacific humpback dolphin are:

- Test and treat all discharges to Port Curtis to meet water quality criteria, as required, prior to discharge [C16.04].
- Develop spill response plans to cover marine activities, including all vessel operations [C16.05].
- Develop a dredge management plan that considers the appropriate water and sediment monitoring data (e.g., current WBDD Project data) and will include [C15.02]:
  - Requirements for monitoring of water quality [C15.03].
  - Actions to be taken to minimise impacts of dredging on sensitive areas should water quality monitoring data show performance criteria are exceeded. Finalise specific actions in the dredge management plan [C15.04].
- Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike [C19.05].

- Implement soft-start procedures where a sequential build-up of warning pulses will be carried out prior to commencement of full-power pile-driving activities [C19.06].
- Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area [C19.07].
- Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away [C19.09].
- Keep dredging activities within the identified dredge footprint area [C19.08].

In conclusion, impacts on dolphins from the Arrow LNG Plant (Referral No. EPBC 2009/5007) are not significant, as the proportion of habitat lost as a result of dredging is minimal and no areas of seagrass have been identified within areas of project infrastructure associated with this referral. Effective implementation of proposed mitigation measures means that it is unlikely that the Arrow LNG Plant will have a significant impact on these species.

6.4.5 Summary of Potential Impact

There were no areas of habitat critical to the survival of the species identified for migratory species within the project area, or significant areas likely to be disturbed or degraded as a result of the project. The area of potential shorebird habitat on Curtis Island adjacent to the LNG plant site is small, and not likely to be used by significant numbers of shorebirds. Habitat lost for the marine infrastructure is not optimal foraging habitat, being largely rocky substrate.

Impacts on marine migratory species are likely to consist of disturbance from dredging and construction of marine infrastructure, although no key areas of habitat are likely to be affected. The proportion of habitat lost as a result of dredging is minimal and no areas of seagrass have been identified within areas of project infrastructure,

Effective implementation of proposed mitigation measures such as a dredge management plan, soft start marine piling procedures and a fauna spotting function means that it is unlikely that the Arrow LNG Plant will have a significant impact on listed marine migratory species.

6.5 Cumulative Impacts

A summary of cumulative impacts related to MNES and the Arrow LNG Plant are presented below.

6.5.1 Marine Environment

Cumulative impacts to the marine environment will occur to both physical (water quality) and biological values (marine and estuarine ecology).

Project dredging activities that could occur concurrently with other dredging activities in Port Curtis are limited to Stage 2 of the Western Basin Dredging and Disposal (WBDD) Project dredging at Laird Point. The dredge management plan for the Arrow LNG Plant will consider the locations and timing of all dredging activities in Port Curtis (project and non-project) and additional modelling work may be necessary to determine the likely extent of any dredge plume interaction and associated impacts.

Impact on Marine Fauna

Increases in vessel frequency and varying navigation routes used by each project could interfere with the feeding and movement of marine fauna species within Port Curtis. Dugongs, turtles and some species of cetaceans, e.g., dolphins, will be susceptible to boat strike and underwater noise. In addition, the increase in lighting has the potential to modify the behaviour of some species of marine fauna, in particular turtles.

Boat Strike

The cumulative impacts of boat strike on large marine organisms such as dugongs, marine turtles and cetaceans are related to increasing marine vessel movements from all port activities, to which the Arrow LNG Plant will likely be a relatively small contributor. The main shipping channels are away from the seagrass feeding areas and the zones of impact risk are not increased, although the level of risk to animals that cross shipping channels will increase relative to increased shipping activity.

The greatest potential for boat strike will occur where construction of all projects occurs concurrently, resulting in the greatest number of vessel movements occurring at the same time. Boat strike is mostly associated with faster vessels such as fast passenger ferries, RoPax ferries and some support vessels. The total vessel movements in Port Curtis during the construction and operation phases for all projects are indicative only. While third-party LNG carrier movements are known, other vessel numbers and movements are not available. Vessel movements for all projects are likely to become available during the detailed design phase of the Arrow LNG Plant.

Reduced speed and vigilance are the most effective mitigation against boat strike. Additional measures such as propeller guards and hull design can reduce the severity of injury from accidental collision. These measures will only be effective if they are implemented as part of an overall management strategy for the Port of Gladstone. Consequently, cumulative impacts will be identified and managed as part of the development of a joint Port of Gladstone shipping activity strategy and management plan, which will include adherence to speed limits. Details are provided in Chapter 19, Marine and Estuarine Ecology of the EIS.

Underwater Noise

The cumulative impact of underwater noise from vessel movements and pile-driving activities will depend on the construction schedule for the contributing projects and proximity of activities to each other. For example, the Arrow LNG Plant launch site 1 is adjacent to the Wiggins Island Coal Terminal Project. If construction activities at these locations occur at the same time, cumulative impacts may occur. Note, however, that these construction schedules are not currently predicted to overlap. The distance between launch site 1 and Curtis Island is such that cumulative impacts will not arise from concurrent Arrow LNG Plant construction activities.

Prolonged impacts may arise if all activities happen sequentially, and an intensity effect may occur if activities all take place simultaneously. Zones of potential physiological harm are within tens of metres from sources; cumulative effects will remain restricted to relatively small areas, with no overlap with other projects.

Lighting

Light generated by all proposed projects could affect the behaviour of marine turtles. The closest turtle-nesting beach to the Arrow LNG Plant site is 8 km away at Southend. Of the proposed projects, the Arrow LNG Plant site has closest proximity to and a direct line of view to Southend. Light generated from the Arrow LNG Plant will be similar to existing and proposed industrial sources of light around Port Curtis.

The other LNG projects and port operations are expected to cause an indirect glow from light emissions during the construction, operation and decommissioning of each facility, which will be visible from Southend. Cumulative impacts will be low, given the distance from source and assuming the implementation by other LNG projects of similar mitigation measures to those proposed by the Arrow LNG Plant.

Loss of Marine and Estuarine Habitat

If all proposed projects are approved and constructed, an unavoidable direct and indirect loss of marine habitat will occur in Port Curtis. This loss will add to any previous loss caused by existing marine infrastructure.

The WBDD Project and the Fishermans Landing Northern Expansion Project in Port Curtis are expected to generate some of the highest potential loss or disturbance of marine and estuarine habitat (accounting for 54.25% and 40.87% respectively) of the cumulative area of impact.

Combined with the effects of the LNG projects and other industry, the direct and indirect cumulative impact (i.e., loss or disturbance) equates to a total loss of 11,702 ha of marine habitat, of which the Arrow LNG Plant contributes 67 ha or 0.57%.

Arrow Energy will establish a marine offsets strategy for the Arrow LNG Plant to compensate for the loss of marine and estuarine habitat as a result of the project [C19.02] (see Chapter 19, Marine and Estuarine Ecology of the EIS). Other projects have been conditioned to provide offsets to reduce the residual impacts associated with loss of these habitats.

6.5.2 Landscape and Visual

The cumulative impact assessment considered impacts on landscape and visual amenity and of lighting from the increased number of developments planned and under construction in the Gladstone region (see Appendix 17, Landscape and Visual Impact Assessment). The method described in Chapter 23, Landscape and Visual Impact Assessment of the EIS, was also used to assess cumulative impacts and adopted a qualitative approach consistent with established impact assessment guidelines. The impact assessment in Chapter 23 has already taken into account the QCLNG and GLNG projects on Curtis Island.

Landscape and Visual Cumulative Impacts

Large-scale industrial development is anticipated to expand in the Gladstone region over the next 30 years and is likely to be accompanied by large-scale supporting infrastructure. The Arrow LNG Plant will be situated within the Gladstone State Development Area, which is increasingly being characterised by industrial development.

Twelve other projects were considered in the assessment. It is possible, albeit unlikely, that construction of all projects will take place concurrently. During the construction phase there will be major, albeit short-term, cumulative impacts on landscape character, views and visual amenity. As some projects pass from the construction to the operational phase, their impacts will diminish, e.g., underground pipelines, whereas the impacts of others may increase, e.g., operational LNG plant. Key cumulative impacts will include:

- Contrast with the current local landscape character from the presence of construction traffic and crews, construction compounds, large-scale machinery including tall cranes, and exposed soil due to cut-and-fill activities. These construction activities are likely to be perceived adversely by sensitive viewer groups.

- Changes to the landscape character and views from the mainland as the forested Curtis Island is cleared and uncharacteristic construction equipment is introduced. The Arrow LNG Plant and APLNG, GLNG and QCLNG projects will have a noticeable impact on landscape character and views.

While still significant, the cumulative impacts described above of construction on the character of the mainland will be perceived to be lower, as this area is already significantly developed for industry and zoned for further development associated with the Gladstone State Development Area.

During the operation phase, the character of a large area around Gladstone is expected to change significantly, as many of the proposed developments are located on undeveloped sites. Although industrial development is already a key characteristic of the Gladstone area, the proposed developments will be highly visible.

Appendix 17, Landscape and Visual Impact Assessment, identified several landscape character types (LCTs) in the Gladstone region (see Figure 23.2) and the impacts described below generally relate to impacts on these areas. Key cumulative impacts during operation will include:

- Considerable intensification and extension to the area of LCT 5: Industrial or extractive industries, with associated loss of some of the more 'natural' character areas including LCT 2: Undulating or flat forest, LCT 7: Coastal or estuarine plain, and LCT 8: Waterscape. This alteration in character is consistent with the proposals for the Gladstone State Development Area.
- Substantial alteration of the character of the Curtis Island landscape from a natural to industrial landscape. This change is significant for visual amenity of many vantage points located in Gladstone and for impacts on designated landscapes, particularly The Narrows. The proposal by Arrow Energy to construct a tunnel beneath Port Curtis means the Arrow LNG Plant will not contribute to cumulative visual impacts on The Narrows.

There will be significant impacts on a large number of landscape and visual receptors should the majority of the developments considered in the cumulative assessment take place. Key receptors to be impacted include:

- Designated landscapes including the Great Barrier Reef World Heritage Area, areas listed on the Australian Heritage Commission Register of National Estate (The Narrows, Garden Island Conservation Park) and significant landscapes of the Curtis Coast Regional Coastal Management Plan (Islands and Offshore Features: Curtis Island; Coastal Wetlands: Curtis Island and The Narrows, and Coastal Mountain Ranges: Curtis Island strike ridge and Mount Larcom Range) (see Figure 23.1).
- Three landscape character types, LCT 1: Forested mountain or ridge, LCT 2: Undulating or flat forest, and LCT 7: Coastal or estuarine plain.
- Nine viewpoints (Viewpoints 1, 2, 4, 6, 7, 8, 10, 11 and 12) (see Figure 23.3).

The impacts on visual receptors are likely to be more significant than those on landscape resources due to the large extent of prominent industrial development proposed. This development will affect many views of the Port Curtis landscape. The four LNG projects will extend industrial development from the mainland to the island. Even though some of the character of Port Curtis is influenced by existing industrial development on the mainland, Curtis Island is currently viewed as an inherently natural landscape feature and cumulative impacts on views of the island, including to the prominent strike ridge, will be significant.

In noting the above, the construction of the other LNG projects on Curtis Island commenced in 2011. Construction of the Arrow LNG Plant is not planned until 2014. The cumulative visual impact of the Arrow LNG Plant will be low, as construction activities within the Curtis Island Industry Precinct become a familiar sight to residents of Gladstone over the next three years.

Opportunities to mitigate cumulative impacts to landscape and visual values are limited, and are confined to mitigating impacts directly associated with the Arrow LNG Plant as described in Chapter 23, Landscape and Visual of the EIS.

Lighting

Impacts from lighting are associated with the changes to the night-time visual landscape. Many of the proposed developments considered in the cumulative impact assessment will introduce light into inherently darker landscapes. These projects will substantially increase overall artificial light levels and lead to an increase in the overall levels of sky glow, glare and light trespass throughout the Port Curtis area. Sky-glow impact may extend into areas some distance from the facilities themselves.

As with impacts to landscape and visual values, mitigation measures for cumulative impacts of lighting are limited to mitigating impacts directly associated with the Arrow LNG Plant. These mitigation measures are described in Chapter 23, Landscape and Visual of the EIS.

6.5.3 Terrestrial Environment

This section describes cumulative impacts to the terrestrial environment, specifically the landform within which the project sits and terrestrial and freshwater ecology. The assessment is based on information in Appendix 2, Geology, Soils and Landform Impact Assessment, and Appendix 9, Terrestrial Ecology Impact Assessment.

Similar impacts on terrestrial ecology values in the Gladstone region were identified by most of the projects considered in the cumulative assessment. These included vegetation clearance, habitat fragmentation and disturbance to wildfire corridors, introduced flora and fauna, altered hydrology and pollution.

Specific impacts include an increase in the loss of habitat, particularly on Curtis Island, with reduced availability of habitat for species displaced by construction projects.

The combined clearing of regulated vegetation across all projects is likely to have the most significant cumulative impact on the flora and fauna of region. Table 6.4 details the cumulative impact of clearing regulated vegetation within the Gladstone region and within Queensland, as a result of current and approved projects within the Gladstone region.

Table 6.4 shows that, of the overall area of regional ecosystems in the Gladstone Regional Council area, the proportion to be cleared as a result of identified projects is generally low, being less than or equal to 1.0% in most cases.

Regional Ecosystem 11.3.4 (of concern), *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains, will be the most significant loss of a regional ecosystem type within the Gladstone Regional Council area. The loss as a result of all projects in the cumulative assessment will be approximately 8.1%. At a state level, this loss is approximately 0.26%.

Regional Ecosystem 12.11.14 (of concern), *Eucalyptus crebra*, *Eucaplyptus tereticornis* woodland on metamorphics with or without interbedded volcanics, will be reduced by approximately 5.7% within the Gladstone Regional Council area, and 0.66% at a state level.

The endangered Regional Ecosystem 12.3.3, *Eucalyptus tereticornis* woodland to open forest on alluvial plains, will be reduced by approximately 0.47% at a state level.

The following impacts are likely to be more apparent within these ecosystems as a result of cumulative losses:

- Reduced existing habitat patches including the loss of habitat function 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 required by a wide range of terrestrial fauna species for shelter and breeding, including arboreal mammals, microbats, owls, parrots and ducks. This could result in impacts on several threatened species, including the powerful owl, glossy black-cockatoo and several species of listed microbat.
- The cumulative loss of mangrove habitat, which supports several species of threatened fauna. Increased fragmentation of the coastal mangrove corridor may increase impacts to the water mouse and several species of migratory and non-migratory shorebird (including eastern curlew and beach stone-curlew).

Overall, the cumulative impact of the Arrow LNG Plant on habitat loss is considered low. In the case of LNG projects, development will take place within the Curtis Island Industry Precinct, which covers less than 3% of Curtis Island and lies adjacent to an Environmental Management Precinct. The Curtis Island National Park lies further to the north. These undeveloped areas provide alternative habitat opportunities. Similarly, on the mainland, most industrial development is proposed along the coastal strip and typically away from heavily forested areas.

Arrow Energy will provide environmental offsets for unavoidable impacts arising from the development of the Arrow LNG Plant. Similar conditions have been placed upon other LNG projects on Curtis Island. Areas requiring offsets will be further defined in consultation with regulatory agencies following completion of the Arrow LNG Plant front end engineering and design and prior to the commencement of construction (see Chapter 17, Terrestrial Ecology of the EIS).

Table 6.4 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5007	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
11.11.15 (LC, -) *Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics.	0	149.30	0.00	0.38	0.03	0.03
11.11.18 (E, -) SEVT on old sedimentary rocks with varying degrees of metamorphism and folding.	0	0.80	0.00	0.04	0.02	0.02
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	23.91	486.90	9.50	8.09	0.26	0.26
RE 12.1.2 (LC, -) Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains.	5.61	121.10	49.10	0.77	0.42	0.42
RE 12.1.3 (LC, -) Mangrove shrubland to low closed forest on marine clays and estuaries.	4.68	20.48	28.30	0.12	0.04	0.04
RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	109.43	199.90	61.70	5.72	0.67	0.66

Table 6.4 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state (cont'd)

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5007	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 12.11.6 (LC, -) *Corymbia citriodora, Eucalyptus creba* open forest on metamorphics ± interbedded volcanics.	62.67	483.40	14.80	0.52	0.21	0.20
RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics.	3.04	3.90	100.00	0.13	0.13	0.10
RE 12.2.2 (OC, CE) Microphyll/notophyll vine forest on beach ridges.	0	0.4	0.00	0.02	0.01	0.01
RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains.	25.69	202.60	16.00	0.98	0.47	0.47
RE 12.3.6 (LC, -) *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland on coastal alluvial plains.	3.56	3.60	100.00	0.09	0.03	0.01
RE 12.3.7 (LC, -) *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest.	4.21	7.10	59.20	0.08	0.01	0.01

Notes: Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e., 12.11.14/12.11.4 and 12.11.6/12.11.14), the dominant RE area was chosen (in this case, 12.11.14 and 12.11.6 respectively).

1 Regional Ecosystem status: CE = critically endangered, E = endangered, OC = of concern, LC = least concern (Vegetation Management Act, EPBC Act).

2 Projects included APLNG Project, WBDD 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 Island Community Project, Boyne Island Aluminium Smelter Extension of Reduction Lines Project, GLNG Project, QCLNG Project, Yarwun Alumina Refinery Expansion Project.

7. OUTLINE OF ENVIRONMENTAL MANAGEMENT PLAN

Environmental management and mitigation measures specific to EPBC listed species and communities are set out below. Further details are provided in Attachment 6, Environmental Management Plan.

7.1 Structure of Environmental Management Plan

The environmental management plan (EMP) details environmental values, issues and impacts, and associated management measures for Arrow Energy to implement during construction, operation and decommissioning of the project. The plan has been developed in accordance with the project terms of reference and addresses environmental issues identified during the environmental impact assessment process. While the EMP is part of the EIS it is designed as a stand-alone document for reference and use during the project. As such, the plan is a 'living' document intended to be updated as the project proceeds through construction to operation and finally to decommissioning.

The key objectives of the EMP are:

- To document acceptable environmental management strategies and control actions and environmental protection commitments to manage identified potential impacts on the environment as a result of proposed activities, and in doing so, help the administrating authority decide on the conditions of the environmental authority for the project.
- To develop the project with minimal adverse impacts on the environment by selecting and applying mitigation measures that reduce impacts to levels that are as low as reasonably practical.
- To address any other matters required under a local, state or federal environmental protection policy or regulation.
- To provide a document that can be referred to during the design of the LNG plant and ancillary facilities, and form the basis in preparing construction planning and standard operating procedures.
- To provide the community with evidence that the environmental management of the project is acceptable.

The environmental protection commitments of the EMP are based on the preferred project options, derived from site-specific environmental assessments from specialists, environmental best practices and proven research where available.

7.1.1 Environmental Management Plan Scope

The EMP describes Arrow Energy's approach to the management of environmental impacts associated with the planning, construction, operation and decommissioning/ rehabilitation of the project. Broadly the EMP describes the following:

- Arrow's Health, Safety and Environmental Management System (HSEMS).
- Existing and proposed activities associated with the project.
- Existing environment of the project area and surrounds, including relevant environmental values.
- Potential impacts of project activities on identified environmental values.
- Environmental management measures for each of the following environmental elements to minimise the identified potential environmental impacts:

- Climate and climate change.
- Greenhouse Gas
- Geology, landform and soils.
- Land contamination and acid sulfate soils.
- Surface water hydrology and water quality.
- Groundwater.
- Coastal processes.
- Marine water quality and sediment.
- Terrestrial ecology.
- Freshwater ecology.
- Marine and estuarine ecology.
- Greenhouse gas.
- Air quality.
- Noise and vibration.
- Landscape and visual.
- Indigenous cultural heritage.
- Non-Indigenous cultural heritage.
- Social
- Economic
- Traffic and transport.
- Hazard and risk.
- Land use and planning.
- Waste management.
- Decommissioning and rehabilitation.

Each element of the plan provides a short summary of the existing environment and impacts pertaining to that discipline. Management measures for all project-related activities from design and planning through to decommissioning are detailed for each element, under the following structure:

- Environmental objectives.
- Performance criteria.
- Implementation strategy.
- Inspection and Monitoring.
- Auditing.
- Reporting.
- Corrective action.

7.2 Environmental Offsets

Environmental offsets are applied at the federal and state level where impacts on ecological assets cannot be avoided or adequately mitigated. Offsets could be direct, indirect, or both. Direct offsets are preferred under the majority of offset policies as they are more likely to deliver conservation outcomes.

Direct offsets may encompass securing in perpetuity existing habitat, restoring and securing degraded habitat or re-establishing habitat. Indirect offsets might include contributions to research programs, implementing recovery plan actions, removing threatening processes or contributing to trust funds for consolidated purchase and restoration of strategic habitat.

The level of offsets required for the project has not been specified at this stage. An Offsets Strategy will be developed for the project. Areas where offsets may be required will be further defined in

consultation with DERM and the Department of Sustainability, Environment, Water, Population and Communities and other government stakeholders prior to commencement of construction [C17.02].

Table 7.1 describes those terrestrial ecological values which may require an offset and the likely difficulty of finding a suitable offset receiving site. This table refers to infrastructure associated with both this referral and Referral No. EPBC 2009/5008 (feed gas pipeline) and will be further refined during FEED and the development of the offset strategy for the project as the project footprint is refined.

Table 7.1 Potential offset requirements and degree of difficulty of replacement

Value	Regional Ecosystem and Status	Area to be Cleared (ha)	Likely Offset Policy Trigger	Degree of Difficulty in Replacing
Regional Ecosystem	RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	46.4	Policy for Vegetation Management Offsets	Low
Regional Ecosystem	RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics	123.38	Policy for Vegetation Management Offsets	Low/Medium
Regional Ecosystem	RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics	3.91	Policy for Vegetation Management Offsets	Medium/High
Regional Ecosystem	RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains	25.69	Policy for Vegetation Management Offsets	Medium/High
High Value Regrowth	RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	8.03	Regrowth Vegetation Code	Low
Essential Habitat	For koala/coastal sheathtail bat	46.4	Policy for Vegetation Management Offsets	Low
Cupaniopsis sp. indet	Status pending		Biodiversity Offsets Policy (Qld) and/or EPBC Act	High

Notes: Regional Ecosystem Status (VMA) E = Endangered, OC = Of Concern.

A marine offsets strategy will be established for the project to compensate for the loss of marine and estuarine habitat as a result of the project. Offsets developed under the strategy will follow the principles outlined under the Commonwealth offsets policy and may include:

- Rehabilitation of ‘like-for-like’ habitats that demonstrate ecological equivalence in the Gladstone region.
- Creation of artificial habitats that provide as-similar-as-possible ecological functions as the area that is to be lost in the Gladstone region.
- Facilitate, or otherwise manage under agreement, unprotected habitat and actively manage and protect the habitat as a conservation area. The habitat must demonstrate ecological equivalence to the area that is to be lost. Habitat should be purchased in the Gladstone region if possible; however, if this is not feasible, greater conservation value may come from locating offsets elsewhere.

Arrow Energy will comply with environmental and legal criteria of the Queensland Government environmental offsets policy as the overarching framework for a specific-issue offset policy (see Fish

Habitat Management Operational Policy FHMOP 005). The policy follows similar principles to the Commonwealth policy and provides specific information on fish habitat areas.

Locations for offsets have not yet been identified and will require further assessment based on environmental suitability for ecological equivalence, feasibility and stakeholder engagement responses. The specific details of the offsets for the project will be provided in the marine offsets strategy.

8. APPROVALS AND CONDITIONS

In accordance with the Commonwealth Minister's decision, as well as the Coordinator General declaring the project a 'significant project', the Arrow LNG Plant will be assessed under a bilateral agreement between the Queensland and Commonwealth governments. Under this agreement, the Commonwealth Government has accredited the Queensland SPDWO Act and EIS process to meet the impact assessment requirements under Commonwealth legislation.

Pursuant to this agreement, the EIS will be coordinated by the Queensland Department of Employment, Economic Development and Innovation (DEEDI). Relevant Commonwealth, Queensland and local government authorities have been invited to participate in the EIS process as advisory agencies.

The following section details the principle project approvals required for the construction and operation of the LNG plant.

8.1 Principal Project Approvals

The principal project approvals required for the construction and operation of the LNG plant include the following:

- Petroleum Facility Licence. The project requires a petroleum facility licence under the Petroleum and Gas (Production and Safety) Act 2004 (Qld) (P&G Act) for the proposed LNG plant.
- Petroleum Survey Licence. The project requires a petroleum survey licence under the Petroleum and Gas (Production and Safety) Act to provide for investigative survey work to be conducted in relation to the petroleum facility.
- Environmental Authority. Under the Queensland Environmental Protection Act 1994 (Qld), petroleum activities are classified as either level 1 or level 2 chapter 5A activities for which an environmental authority is required. The project (with the exception of the environmental authority to support the petroleum survey licence) requires a level 1 chapter 5A environmental authority for petroleum activities to provide for the proposed LNG plant along with other environmentally relevant activities (ERAs) associated with the project.
- Material Change of Use of Premises. The LNG plant will be constructed on land within the Curtis Island Industry Precinct as identified in the Development Scheme for the Gladstone State Development Area (GSDA). Additional material change of use of premises and development permits may be required for the accommodation facilities, the LNG jetty and any associated infrastructure as specified under the SP Act and the SDPWO Act.
- Major Hazard Facility. The project requires a major hazard facility development permit as specified under the Sustainable Planning Act 2009 (SP Act) and the Dangerous Goods Safety Management Act 2009 (Qld).

8.2 Additional Environmental Permits and Approvals

In addition to the principal project approvals, other permits and approvals will need to be obtained before certain aspects the project can proceed. These will include but are not limited to:

- A Native Title Agreement may be required under the Native Title Act 1993. Arrow will need to seek agreements with relevant Aboriginal groups to conduct petroleum activities on land where native title may exist.

- A cultural heritage management plan will need to be developed and approved in accordance with the Aboriginal Cultural Heritage Act 2003 (Qld).
- A number of approvals will be required under the Coastal Protection and Management Act 1995 (Qld) (CPMA). This may include approval to damage vegetation on state coastal land, as well as approval for the placement or removal of quarry material below the high water mark.
- Dredged material disposed of within the Western Basin Reclamation Area will be covered under existing approvals held by the Gladstone Ports Corporation and will be carried out in accordance with the dredge management plan for the site. Additional approval will be required under the CPMA for disposal of dredged material at alternative locations.
- An operational works permit will be required under the Fisheries Act 1994 (Qld) to remove, destroy, or damage marine plants in the event that Arrow needs to establish waterway barrier works to carry out activities through watercourses.
- A clearing permit is required to take or move protected plants under the Nature Conservation Act 1992 (Qld). For these purposes, protected plants include any plant prescribed under the act as threatened, rare or near threatened that is in the wild.
- Approval to take seawater will be required under the Water Act 2000 (Qld) for the construction of the LNG Plant, as well as for the operation of the reverse osmosis plant on Curtis Island.
- A licence is required to store flammable and combustible liquids under the *Dangerous Goods Safety Management Act 2001* (Qld). The Dangerous Goods Safety and Management Act sets standards for the storage and handling of substances (such as flammable and combustible liquids).
- A rehabilitation permit under Division 6 of the Nature Conservation (Wildlife) Regulation 2006 (Qld) may be required to allow the movement of wildlife in instances not otherwise authorised under the Nature Conservation Act. Such a permit may be required to allow relocation of wildlife accidentally trapped during construction.

A list of Commonwealth, Queensland and regional legislation, regulations, policies, strategies, guidelines, international treaties, protocols and accepted codes of practice that will guide and direct the approval of the project is provided in Attachment 1 (Relevant Legislation, Policies and Approvals).

9. ENVIRONMENTAL RECORD

Arrow is committed to the sound management of health, safety and the environment throughout all of its business activities. The company maintains a comprehensive and integrated Health, Safety and Environmental Management System (HSEMS) based on the principles of the International Standard for Environmental Management Systems - AS/NZS ISO 14001(AS/NZS, 2004) and the Australian Standard for Occupational Health and Safety Management System - AS/NZS 4801:2000 AS/NZS, 2001.

Arrow Energy Holdings Pty Ltd (Arrow) and/or its subsidiaries have received two penalty infringement notices (PINs) relating to non-compliances with Environmental Authority conditions issued under the Queensland Environment Protection Act 1997. The PINs related to:

1. Unauthorised clearing of a Category B Environmentally Sensitive Area; and
2. Unauthorised release of coal seam gas water to land.

Arrow is not aware of any other fines or prosecutions for breaches of environmental legislative requirements in the past five years.

10. CONCLUSIONS

The MNES components likely to be affected by the project have been assessed. The mitigation measures proposed to address these impacts have been identified. A summary of impacts and their significance on MNES are discussed below.

GBRWHA and Port Curtis National Heritage place

Activities within the GBRWHA, such as dredging and vegetation clearance are unlikely to have a significant effect on the health and functioning of the ecosystem within the GBRWHA and Port Curtis, or cause any values of the GBRWHA to be lost, degraded or damaged.

Various attributes of the GBRWHA within Port Curtis will be modified as a result of the project, but with successful mitigation, the impacts on the GBRWHA and Port Curtis Natural Place from the project are not significant.

Threatened Ecological Communities

The critically endangered community "*Littoral rainforest and coastal vine thickets of eastern Australia*" is not likely to impacted by clearance of vegetation. It is vulnerable to introduced pest flora and fauna species as a result of increased traffic to surrounding areas.

By prohibiting access to vehicles and workers, and implementation of pest control measures, this critically endangered community will be protected and the impacts from the project will not be significant.

Listed Threatened Species

Terrestrial fauna species are likely to be impacted primarily through vegetation clearance and loss of habitat. The occurrence of suitable habitat within the Gladstone area is likely to reduce the impacts on these species, as the proportion of regulated vegetation cleared within the region is low.

The establishment and effective management of a retained area of *Cupaniopsis* sp indet. in a fenced area on Boatshed Point on Curtis Island is likely to protect this species from habitat fragmentation, introduced pest species, pollution effects and an altered fire regime.

For marine species, the main impact that will occur during the construction phase of the project is dredging and clearing of sea bed habitat for the construction of marine facilities. Direct impacts include the loss and degradation of marine habitat and disturbance of marine fauna through increased noise and turbidity. The effects of construction activities will be unavoidable; however the actual extent of habitat loss is low in both percentage and absolute terms. The likelihood of boat strike will be proportional to the frequency of vessels movements. The implementation of proposed mitigation measures will reduce the significance of impacts on marine fauna and their habitat.

Lighting impacts from construction and operation of the LNG facility may disorientate turtle species nesting at Southend. Light generated from the LNG facility can be reduced through use of sensitive lighting techniques or shielded from the nesting beach to reduce the significance of impacts.

Listed Migratory Species

There were no areas of critical habitat identified for migratory species within the project area, or areas likely to be disturbed or degraded as a result of the project.

Potential impacts from the Arrow LNG Plant include disturbance of migratory bird species adjacent to the LNG plant site, although the area is not key shorebird habitat within the Regional Coastal Plan.

Impacts on marine migratory species are likely to consist of disturbance from dredging and construction of marine infrastructure, although no critical areas of habitat are likely to be affected.

Effective implementation of proposed mitigation measures means that it is unlikely that the Arrow LNG Plant will have a significant impact on listed migratory species.

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APPENDIX 1 COMMITMENTS RELATING TO MANAGEMENT OF IMPACTS ON MNES

Table A1 Mitigation measures applied to the management of impacts on MNES

No.	Commitment
Geology, Landform and Soils	
C11.01	Prior to construction, carry out detailed geotechnical ground investigations to assess site specific ground conditions and provide recommendations on slope placement, geometry and drainage.
C11.04	Design the tunnel spoil placement area to minimise adverse impacts associated with ground compaction, erosion and surface water runoff such that a self sustaining landform is achieved. Incorporate appropriate drainage measures into the design.
C11.05	Limit clearing of vegetated areas to the project area. Areas will be stabilised and progressively rehabilitated to reduce prolonged exposure of soils.
C11.07	Manage surface runoff to reduce concentration of surface flow, particularly in erodible soils. Provide drainage channels with suitable design features to minimise erosion where surface runoff is disrupted by roads, tracks, fencing and buildings. Place structures within drainage channels to reduce flow velocity where appropriate. Common with Chapter 13, Surface Water Hydrology and Water Quality.
C11.11	Implement sediment and erosion control measures upslope of watercourses, wetlands and coastal areas or in areas with sodic soils to minimise increases in natural sediment discharge. Measures may include sediment traps, silt fencing, riprap, contour banks, detention dams, sediment ponds and vegetation and diversion berms. Common with Chapter 13 Surface Water Hydrology and Water Quality.
C11.14	For pipeline trenching activities reinstate soil profiles to pre-disturbance orientation, where practical, using excavated topsoil.
C11.16	Prior to construction commencing, develop a site drainage plan to define how the civil construction will address site drainage, stormwater management, erosion control and stockpile placement. Risks relating to flood events will also be addressed with appropriate mitigation measures to minimise erosion and surface water quality issues. Common with Chapter 13, Surface Water Hydrology and Water Quality.
C11.22	Design and construct a barrier and sediment control pond to trap sediment leaving the LNG plant site before it enters the Port Curtis marine environment or other surface waters.
C11.29	Re-profile and reinstate topsoil, vegetation and re-establish a stable surface, where practical, during decommissioning and rehabilitation of the LNG plant site. Common with Chapter 13, Surface Water Hydrology and Water Quality.
Land Contamination and Acid Sulfate Soils	
C12.01	Prior to construction, the extent of contamination will be further defined where required, and mitigation measures will be refined as appropriate.
C12.11	Chemicals and fuel use or storage: Construct facilities in accordance with relevant Australian standards.
C12.13	Future chemicals and fuel use or storage: Immediately clean up any spills and conduct investigations into any relevant releases.
C12.17	Develop an ASS management plan prior to construction work. In the plan, specify how onsite ASS disturbances should be managed in accordance with SPP2/02 and the methods set out in Queensland acid sulfate soil technical manual soil management guidelines (Dear et al., 2002). Common with Chapter 14, Groundwater.
Surface Water Hydrology and Water Quality	
C13.07	Keep the footprint of the mainland tunnel entry shaft and tunnel spoil disposal area to a minimum of 500 m clear of Boat Creek. Common with Chapter 18, Freshwater Ecology.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Surface Water Hydrology and Water Quality (cont'd)	
C13.08	Treat stormwater generated from TWAF 7, TWAF 8, launch site 1, the tunnel shaft entry site and tunnel spoil disposal area in temporary sediment basins located at each site.
C13.10	Manage all surface water generated from the LNG plant site by a stormwater treatment system to ensure discharged water complies with regulatory requirements. Common with Chapter 31, Waste Management.
C13.11	Provide secondary containment for any fuel, oil or chemicals in above ground storage facilities in accordance with applicable Australian standards.
C13.12	Develop appropriate spill prevention and response plans to cover project activities and the types and quantities of fuel, oil and chemicals held at each site. Common with Chapter 14, Groundwater and Chapter 31, Waste Management.
C13.13	Train all relevant personnel in spill response and recovery procedures. Common with Chapter 31, Waste Management.
C13.15	Do not abstract freshwater from watercourses, or dispose of effluent directly into freshwater watercourses, except clean stormwater. Common with Chapter 18, Freshwater Ecology.
C13.16	Where waterway crossings are necessary, cross ephemeral streams in preference to permanent streams, where practical. Where pipeline waterway crossings are necessary, approach stream crossings perpendicular to the stream where possible, to reduce bank erosion risk and minimise the footprint within the bed and riparian zone. Common with Chapter 18, Freshwater Ecology.
C13.22	Where works are required in watercourses, they will be confined to reduced width construction right of ways that preserve, to the extent possible, the integrity of the riparian vegetation and any associated wildlife corridors. Common with Chapter 18, Freshwater Ecology.
C13.24	Treat all surface water and stormwater generated within the LNG plant site in a stormwater system to ensure discharged water meets regulatory requirements.
C13.25	Collect contaminated stormwater for treatment before discharge.
Groundwater	
C14.01	Design the facility drainage system such that accidental releases of hazardous substances are collected to reduce the chance of contamination seeping into the groundwater system.
C14.02	Prepare a materials handling and waste management plan to manage any potential contaminants, soils or materials that might result in impacts to shallow groundwater through either short term or long term leaching.
C14.04	Store fuels, chemicals and hazardous wastes in appropriately sized, bunded storage facilities (in leak proof sealed containers). Common with Chapter 31, Waste Management.
Coastal Processes	
C15.02	Develop a dredge management plan that considers the appropriate water and sediment monitoring data (e.g., current WBDD Project data) and will include:
C15.03	• Requirements for monitoring of water quality.
C15.04	• Actions to be taken to minimise impacts of dredging on sensitive areas should water quality monitoring data show performance criteria are exceeded. Finalise specific actions in the dredge management plan. Common with Chapters 16, Marine Water Quality and Sediment and Chapter 19, Marine and Estuarine Ecology.
C15.05	Implement management measures from the dredge management plan to address impacts from maintenance dredging.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Marine Water Quality and Sediment	
C16.03	Prior to discharge to Port Curtis, test and treat excess water at the mainland tunnel launch site in an on-site water treatment plant to meet water quality criteria.
C16.04	Test and treat all discharges to Port Curtis to meet water quality criteria, as required, prior to discharge.
C16.05	Develop spill response plans to cover marine activities, including all vessel operations.
C16.10	Store on board wastes produced by vessels that cannot be discharged under the MARPOL Convention and then transfer to an approved onshore facility for treatment, reuse, recycling or disposal.
C16.11	Where practical, schedule the timing of maintenance dredging to coincide with the most favourable climatic conditions for minimising impacts to water quality and sediment (i.e., during neap tides when water currents are weakest or periods of calm winds and waves).
Terrestrial Ecology	
C17.01	Prepare construction and operations environmental management plans. These documents are to include detailed information about significant flora and fauna species and their management and ongoing conservation. Include site-specific mitigation and details of monitoring and inspection to be undertaken, in the environmental management plans consistent with advice provided by government.
C17.02	Determine areas (if any) requiring to be offset in consultation with DERM and DSEWPC and other government stakeholders prior to commencement of construction. This is likely to include the two areas of 'endangered' (Vegetation Management Act) remnant vegetation (RE 12.3.3; Assets 27 and 31) within the LNG plant site, and the *Cupaniopsis* sp.indet population.
C17.03	An area of semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained by the project on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of the semi-evergreen vine thicket community will be fenced off with a 20-m buffer between the semi-evergreen vine thicket community (including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi-evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. Do not develop within the fenced area of the retained semi-evergreen vine thicket community. Establish roles and responsibilities for the management of the retained semi-evergreen vine thicket community.
C17.05	Route the haul road for the Hamilton Point MOF option away from the eastern margin of the headland to avoid the 'critically endangered' RE 12.2.2 (Microphyll/notophyll vine forest) on beach ridges.
C17.06	Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works.
C17.07	Develop fauna relocation protocols as part of fauna management measures including procedures if fauna is found during clearing activities, including in hollows of trees to be felled.
C17.10	Liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Notify Gladstone Regional Council of any new declared or notifiable pest species. These programs should particularly focus on the boundaries of the project site with the Environmental Management Precinct.
C17.13	Include measures in the pest management plan to control invasive plant species that may colonise the mudflats and degrade remaining habitat.
	Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
C17.16	Shield/direct the light source onto work areas where practical. Common with Chapter 19, Marine and Estuarine Ecology and Chapter 23, Landscape and Visual.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Terrestrial Ecology (cont'd)	
C17.17	Use long-wavelength lights, where practicable, including use of red, orange or yellow lights. Common with Chapter 19, Marine and Estuarine Ecology.
C17.18	Lower the height of the light sources as far as practical. Common with Chapter 19, Marine and Estuarine Ecology.
C17.19	Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practicable). Common with Chapter 19, Marine and Estuarine Ecology.
C17.20	Design lighting around the perimeter of the LNG plant to minimise impacts on roosting shorebirds, where practical. Lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal zones, where practical.
C17.21	Design construction lighting on the causeway at the mainland tunnel entry shaft and tunnel spoil disposal area to minimise impacts on roosting shorebirds. The lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas, where practical.
C17.22	Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present.
C17.23	Clearly mark no go zones, where required, including the semi evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the 'critically endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected).
C17.24	Prohibit access to the saltpans and fringing mangroves (RE 12.1.2 and 12.1.3) outside the planned area of disturbance of the mainland tunnel entry shaft and tunnel spoil disposal area.
C17.25	Conduct pre-clearance surveys across project areas to be cleared of vegetation. The surveys will aim to determine whether any threatened species are present at each site. Appropriate mitigation measures will be implemented if threatened species are confirmed within the area.
C17.27	Reduce vegetation clearing where practical and only after all other options such as selective clearing and trimming of vegetation have been considered.
C17.34	Undertake all handling and management of fauna in compliance with permits issued by DERM.
C17.35	Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access).
C17.36	Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench.
C17.38	Identify areas to be rehabilitated and develop procedures for restoration and maintenance.
Freshwater Ecology	
C18.01	Implement strategies and protocols relevant to the protection of freshwater aquatic communities, habitat and processes, as detailed in the Australian Pipeline Industry Association Code of Environmental Practice: Onshore Pipelines (APIA, 2009) as part of the project.
Marine and Estuarine Ecology	
C19.01	Develop a construction management plan, which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values.
C19.02	Establish a marine offsets strategy for the project to compensate for the loss of marine and estuarine habitat as a result of the project.
C19.04	Contribute to the development of a Port of Gladstone shipping activity strategy and management plan. Comply with applicable speed limits for the Port of Gladstone-Rodds Bay Zone B dugong protection area, as detailed in the management plan.
C19.05	Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Marine and Estuarine Ecology (cont'd)	
C19.06	Implement soft-start procedures where a sequential build-up of warning pulses will be carried out prior to commencement of full-power pile-driving activities.
C19.07	Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area.
C19.08	Keep dredging activities within the identified dredge footprint area.
C19.09	Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away.
C19.10	Project vessels servicing the LNG plant that originate from overseas ports must comply with Commonwealth and local government ballast water management systems and implement Australian Quarantine and Inspection Service hull hygiene measures.
C19.11	All project vessels must comply with all applicable maritime law, especially when passing through the GBRMP. Project vessels will traverse the marine park via designated navigation routes with pilotage as required within port boundaries.
Greenhouse Gas	
C20.01	Develop and implement a greenhouse gas standard as part of Arrow's HSEMS.
Air Quality	
C21.01	Design the LNG plant to comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas.
C21.07	Reduce exposure time of bare soils on the ground surface as far as practicable, and undertake revegetation of bare surfaces as soon as practical following construction.
C21.08	Maintain construction vehicles and equipment regularly to reduce exhaust emissions.
C21.09	Where practical, use low-sulfur diesel fuel in diesel-powered equipment (i.e., not more than 0.01% sulfur by mass).
C21.11	Where practical, limit the volume of hydrocarbons flared or vented to the atmosphere from the LNG plant. Ensure that the flare is luminous and bright (i.e., show smokeless combustion at operating design gas flow rate) and the relative density of emitted smoke does not exceed No.1 Ringelmann Number.
C21.12	Do not vent boil-off gas to the atmosphere; instead route it to the feed gas inlet for reprocessing or sent to the end flash gas compressor for use in the high-pressure fuel gas system.
C21.13	Use low-sulfur fuel in diesel-powered generators will (not more than 0.01% sulfur by mass).
C21.14	Maintain equipment in accordance with manufacturer specifications in order to minimise fugitive emissions.
Noise and Vibration	
C22.01	Identify during the detailed design of the LNG plant, specific acoustic treatment to be applied to each noise source.
C22.04	Regularly maintain all machinery and equipment and check for excessive noise generation.
C22.07	Ensure that project related noise generated during operation complies with the project noise criteria at all assessment locations.
Landscape and Visual	
C23.01	Protect the tip of Boatshed Point from clearing and cutting to preserve areas of vegetation that help screen lower parts of the LNG plant and construction camp.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Landscape and Visual (cont'd)	
C23.02	Where practical, retain the vegetation along the eastern boundary of the LNG plant site to provide some screening to views from the east.
C23.03	Consider potential landscape and visual impacts where there are options for the siting of infrastructure.
C23.06	Investigate opportunities for further planting of a forested landscape buffer around the eastern, southern and western boundaries of the LNG plant site, using bush regeneration techniques and endemic tree species of local provenance consistent, to the greatest extent, with the bushfire strategy.
C23.07	Select materials that are sensitive to the site context where plant operability is not impacted.
C23.08	Use a colour palette for built form that blends with the predominant background colours and which reflects natural hues from the surrounding landscape where plant operability is not impacted.
C23.19	Undertake planting rehabilitation works at the earliest opportunity to minimise erosion and the presence of areas of bare soil (except where technical studies indicate an alternative approach).
C23.20	Minimise night-time working and associated lighting impacts for activities (including construction of the LNG plant). Limit construction activities that need to be highly lit to daytime hours (to the greatest extent practical).
Indigenous Cultural Heritage	
C24.01	Develop an approved CHMP or a native title agreement that addresses Aboriginal cultural heritage in consultation with the endorsed Aboriginal parties for the project.
C24.02	Comply with the approved CHMP or native title agreement that addresses Aboriginal cultural heritage.
Non-indigenous Cultural Heritage	
C25.01	Prepare a heritage management plan prior to construction and which specifies how known and unknown heritage sites are to be managed during construction.
Traffic and Transport	
C28.09	Develop a shipping activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port. Common with Chapter 29, Hazard and Risk.
C28.10	Operators of project vessels, Arrow Energy staff and contractors, to comply with the Gladstone port procedures manual, which details LNG operating parameters.
C28.11	Ensure that operators of project vessels, Arrow Energy staff and contractors comply with the LNG marine operations maritime safety management plan if/when this plan is agreed between Maritime Safety Queensland, Gladstone Ports Corporation and the other LNG proponents. Common with Chapter 29, Hazard and Risk.
Waste Management	
C31.01	Implement employee training and other programs that encourage employees to reduce waste.
C31.02	Ensure that contractors comply with Arrow's Health, Safety and Environmental Management System (HSEMS) and implement a waste management plan in accordance with the procedure.
C31.28	Design the effluent treatment plant package units to meet the final effluent discharge requirement.
C31.30	Monitor treated effluent and reroute any discharge that is off-specification back to the effluent treatment plant for retreatment.
C31.31	Make alternative storage and disposal options available during times of system failure and in conditions preventing discharge to land such as rain events. Distribute the effluent treatment plant discharge to tanks for re-use on site. The tanks can be by-passed and the treated effluent discharged to the marine outfall if necessary.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Waste Management (cont'd)	
C31.47	Develop an emergency response plan for the project and include spill contingency or emergency measures. Make material safety data sheets available at the LNG plant and other project sites to aid in the identification of appropriate spill clean-up and disposal methods.
C31.48	Ensure that specific spill prevention procedures cover the unloading and loading activities at the LNG jetty and MOF in accordance with applicable international standards and guidelines. Spill prevention procedures will specifically address advanced communications and planning with the receiving terminal.

Arrow CSG (Australia) Pty Ltd

Arrow LNG Plant

Matters of National Environmental Significance

Referral No. EPBC 2009/5008 - Feed gas pipeline

March 2012

CR 7033_7_v3

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1. INTRODUCTION

This report identifies potential impacts to matters of national environmental significance (MNES) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The report has been prepared, as required by the final terms of reference for the Arrow LNG Plant, to describe the environmental values of MNES and assess the potential impacts of the project on these matters.

The EPBC Act provides for the protection of the environment, especially MNES. Under the act, actions likely to have a significant impact on MNES trigger assessment under the EPBC Act. MNES include:

- World Heritage properties.
- National Heritage places.
- Wetlands of international importance.
- Listed threatened species and communities.
- Listed migratory species.
- Protection of the environment from nuclear actions.
- Commonwealth marine environment.
- Protection of the environment from actions involving Commonwealth land.
- Protection of the environment from Commonwealth actions.
- Commonwealth Heritage places outside the Australian Jurisdiction.

1.1 EPBC Referrals

In May 2009, the then project proponent, Shell CSG (Australia) Pty Ltd (now as Arrow CSG (Australia) Pty Ltd (Arrow Energy)) submitted an initial advice statement to the Coordinator-General of the State of Queensland (Coordinator-General) to request the Arrow LNG Plant be designated as a 'significant project' for which an EIS is required. On 12 June 2009, the Coordinator-General declared the project a 'significant project' under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act).

The Coordinator-General based their decision on:

- Details of the project provided in the initial advice statement.
- Relevant planning schemes or policies as specified by local, state or Commonwealth governments.
- The project's potential effects on the environment and on relevant infrastructure.
- The employment opportunities that will be provided by the project.
- Investment necessary for Arrow Energy to carry out the project.
- The local, region and state strategic significance of the project.

In July 2009, referrals were submitted to the Commonwealth Minister for the Department of Sustainability, Environment, Water, Population and Communities. The referrals were made to determine whether the project constituted a controlled action under s.75 of the EPBC Act. The referrals were for the LNG plant on Curtis Island (Referral No. EPBC 2009/5007), and the high pressure feed gas pipeline from Gladstone City Gate to Curtis Island (Referral No. EPBC 2009/5008).

On 21 August 2009, Department of Sustainability, Environment, Water, Population and Communities determined the project was a 'controlled action' for which assessment and approval is required under the EPBC Act. The assessment and approval of a 'controlled action' involves

the evaluation of the impacts the project may have on matters of national environmental significance. The matters of national environmental significance that are considered in the EIS include:

- World Heritage Properties (section 12 and 15A).
- National Heritage places (section 15B and 15C).
- Listed threatened species and communities (section 18 and 18A).
- Listed migratory species (section 20 and 20A).

Since these referrals were made, Arrow Energy has sought a variation to the scope of both referrals to clarify infrastructure associated with the establishment and operation of mainland facilities (Referral No. 2009/5007) and the nature of activities associated with installation of the feed gas pipeline (Referral No. 2009/5008).

In accordance with the Commonwealth Minister's decision, as well as the Coordinator-General declaring the project a 'significant project', the Arrow LNG Plant will be assessed under a bilateral agreement between the Queensland and Commonwealth governments. Under this agreement, the Commonwealth Government has accredited the Queensland SPDWO Act EIS process to meet the impact assessment requirements under Commonwealth legislation.

Pursuant to this agreement, the EIS will be coordinated by the Queensland Coordinator-General. Relevant Commonwealth, Queensland and local government authorities have been invited to participate in the EIS process as advisory agencies.

This report assesses potential impacts to MNES relevant to Referral No. EPBC 2009/5008, for the high pressure feed gas pipeline from Gladstone City Gate to Curtis Island (including the mainland tunnel launch site and tunnel spoil disposal area). This attachment has been developed as a standalone report, in accordance with the requirements of the Terms of Reference. It is based on the information and assessments contained in the technical specialist's reports that support the EIS and should be read in conjunction with the environmental impact assessment undertaken for the Arrow LNG Plant.

Table 1.1 identifies EIS chapters (and their supporting appendices) that are relevant to the assessment of impacts on MNES. Each EIS chapter is structured similarly, to provide a consistent discussion of the potential impacts for each of the environmental aspects, with information on the existing environment pertinent to the subject area, potential impacts from project activities and mitigation measures to reduce potential impacts to as low as reasonably practicable, based on the hierarchy of avoid, minimise, manage and offset.

This document and the EIS on which it is based provide the information required by the Australian Government to assess potential impacts on MNES and decide whether or not to approve the project.

Table 1.1 Guide to supporting information on the assessment of MNES

EPBC Referral 2009/5008	
MNES	**Chapter**
World Heritage Properties (Sections 12 and 15A)	• Chapter 13, Surface Water Hydrology and Water Quality (Appendix 5 Surface Water Impact Assessment, Appendix 6 Stormwater Quality Impact Assessment) • Chapter 16, Marine Water Quality and Sediment (Appendix 8 Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment) • Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment) • Chapter 21, Air Quality (Appendix 14 Air Quality Impact Assessment) • Chapter 22, Noise and Vibration (Appendix 16 Noise and Vibration Impact Assessment) • Chapter 23, Landscape and Visual (Appendix 17 Landscape and Visual Impact Assessment) • Chapter 24, Indigenous Cultural Heritage (Appendix 18 Indigenous Cultural Heritage Impact Assessment) • Chapter 25, Non-Indigenous Cultural Heritage (Appendix 19 Non-Indigenous Cultural Heritage Impact Assessment) • Chapter 32, Cumulative Impacts
National Heritage Place (Sections 15B and 15C)	• Chapter 13, Surface Water Hydrology and Water Quality (Appendix 5 Surface Water Impact Assessment, Appendix 6 Stormwater Quality Impact Assessment) • Chapter 16, Marine Water Quality and Sediment (Appendix 8 Coastal Processes, Marine Water Quality, Hydrodynamics and Legislation Assessment) • Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment) • Chapter 21, Air Quality (Appendix 14 Air Quality Impact Assessment) • Chapter 22, Noise and Vibration (Appendix 16 Noise and Vibration Impact Assessment) • Chapter 23, Landscape and Visual (Appendix 17 Landscape and Visual Impact Assessment) • Chapter 24, Indigenous Cultural Heritage (Appendix 18 Indigenous Cultural Heritage Impact Assessment) • Chapter 25, Non-Indigenous Cultural Heritage (Appendix 19 Non-Indigenous Cultural Heritage Impact Assessment) • Chapter 32, Cumulative Impacts
Listed threatened species and communities (Sections 18 and 18A)	• Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine and Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment)
Listed migratory species (Sections 20 and 20A)	• Chapter 17, Terrestrial Ecology (Appendix 9 Terrestrial Ecology Impact Assessment) • Chapter 19, Marine And Estuarine Ecology (Appendix 12 Marine and Estuarine Ecology Impact Assessment)

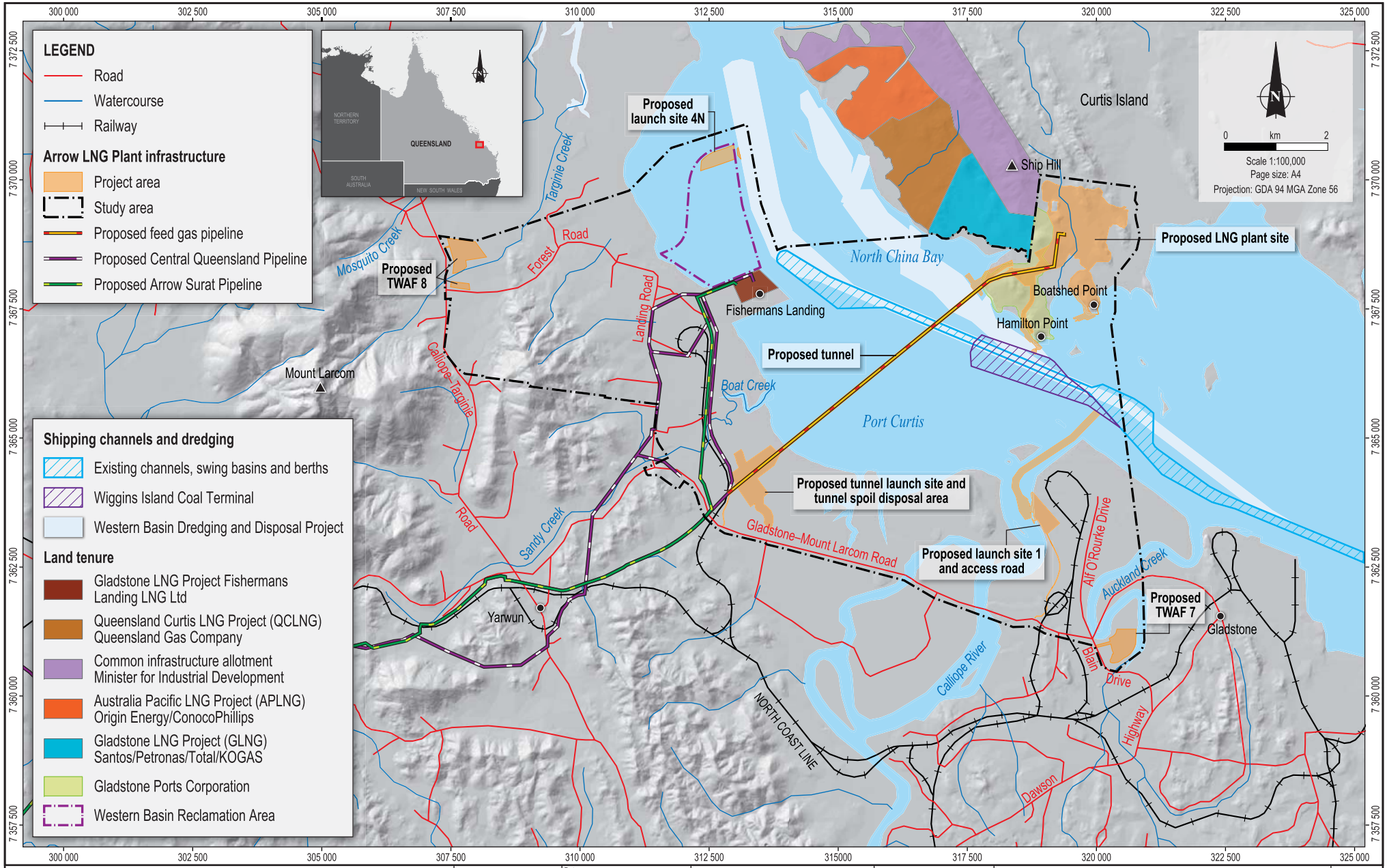
1.2 Project Overview

Arrow Energy proposes to develop a liquefied natural gas (LNG) plant on Curtis Island on the central Queensland coast, near Gladstone (Figure 1). The project, is known as the Arrow LNG Plant, and aims to meet growing export gas market opportunities.

The project comprises three components: the LNG plant and ancillary infrastructure, a feed gas pipeline, and dredging and disposal works. Major infrastructure required to develop the project will include LNG trains, LNG storage tanks, LNG jetty and loading lines (cryogenic pipelines), a seawater inlet for desalination and stormwater outlet pipelines, water and wastewater treatment, a 110 m high flare stack, power generators, administrative buildings and workshops.

The project site forms part of the 1,500 ha Curtis Island Industry Precinct of the Gladstone State Development Area in the southwestern part of Curtis Island gazetted for industrial development by the Queensland Government in July 2008. Arrow Energy has been granted an exclusive right by the Queensland Government to investigate this site for the development of the project. The site is adjacent to the 4,500 ha Environmental Management Precinct established by the Queensland Government in July 2008 to protect and maintain areas of ecological significance of southern Curtis Island.

An environmental management plan (EMP) has been developed for the project (Attachment 6), and will be implemented at all stages of the project. Specific commitments in the EMP include measures to address potential impacts to MNES at the construction, operations and decommissioning phases. This will ensure that impacts are adequately managed based on the current environmental issues and risks.



Source:
Place names, roads, watercourses and railways from DME.
Proposed pipelines from Arrow Energy.
Proposed feed gas pipeline, project area, land tenure proponents and digital elevation model from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.

coffey environments

Date: 13.12.2011
MXD: 7033CA_07_GIS034_v1_6
File Name: 7033_07_ATT4_F001_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Site locality

Figure No: 1

2. DESCRIPTION OF THE PROPOSED ACTION

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 feed gas pipeline from Gladstone City Gate to Curtis Island is described in terms of its key infrastructure components. The project description reflects the current design status of the project and will be further refined during the front-end engineering design (FEED) and detailed design stages, which may result in further changes to the project description and aspects of this MNES attachment.

Aspects relating to the LNG plant and ancillary infrastructure and dredging activities (Referral No. EPBC 2009/5007) are assessed in a separate MNES impact assessment within this attachment.

The proposed route of the feed gas pipeline from Gladstone City Gate to Curtis Island is illustrated on Figure 2.

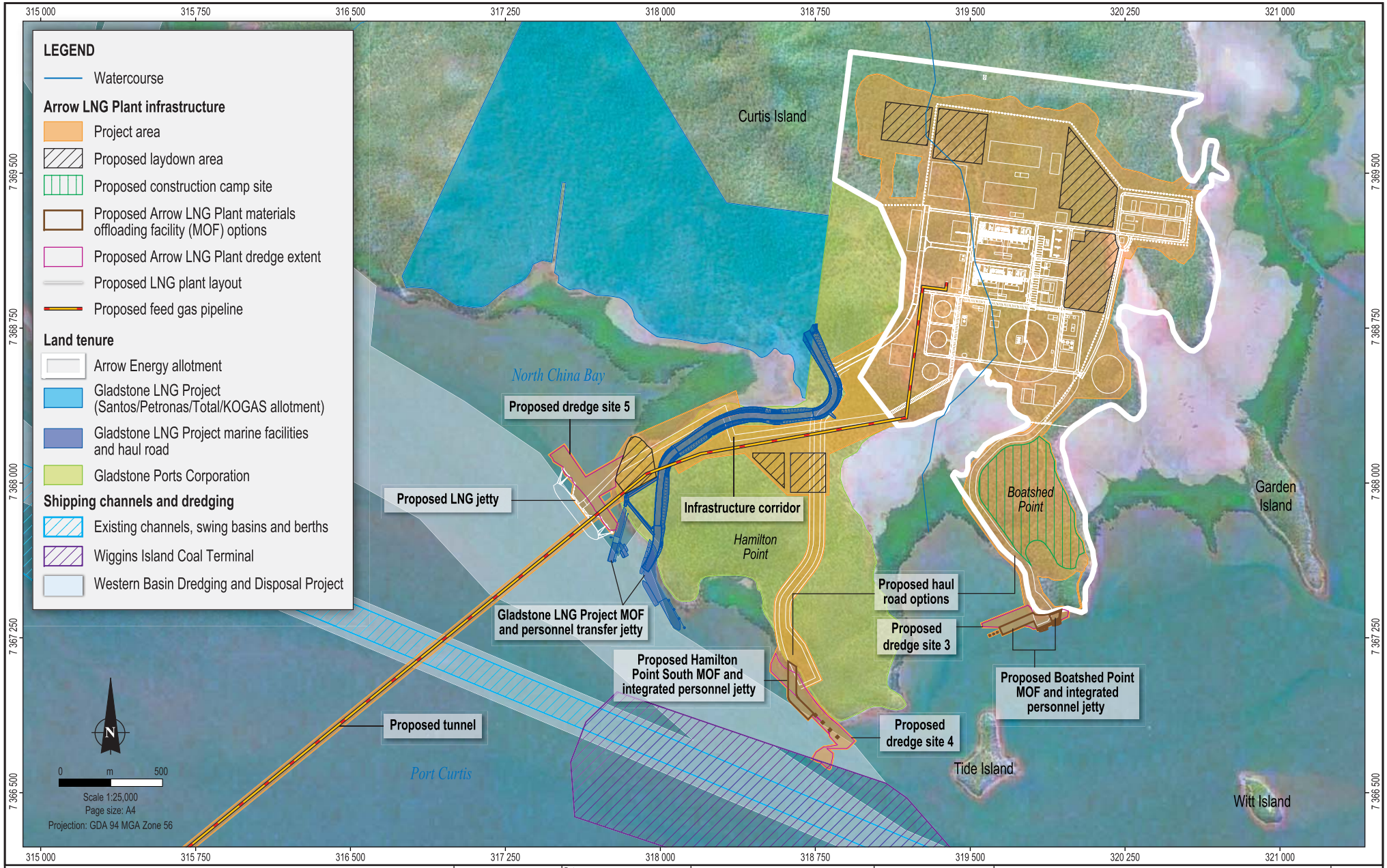
2.1 Feed Gas Pipeline

An approximately 9 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 launch shaft to a reception 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 treated as required and deposited in a spoil placement area established within engineered containment walls constructed adjacent to the launch shaft.
- From the tunnel reception shaft on Hamilton Point, the remaining section of the feed gas pipeline will run underground to the LNG plant, parallel to the above ground LNG loading lines. This section will be constructed using conventional open-cut trenching methods within a 40 m wide construction right of way.

Should one of the electrical plant power options be chosen, 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.



Source:
Place names and watercourses from DME.
Proposed LNG plant layout, ancillary facilities and marine infrastructure from Arrow Energy.
Proposed feed gas pipeline, project area and land tenure proponents from Coffey Environments.
Western Basin Dredging Master Plan and Disposal Project from Gladstone Ports Corporation.
Imagery from SPOT (2004-2007).

coffey environments

Date: 07.12.2011
MXD: 7033CA_07_GIS035_v1_8
File Name: 7033_07_ATT4_F002_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

LNG plant and ancillary facilities

Figure No: 2

3. ASSESSMENT METHOD

This section describes the method used in this assessment of impacts from the project on MNES.

3.1 EPBC Guidance

The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009) provides the framework for the assessment of potential impacts upon MNES from the Arrow LNG Plant.

What is a significant impact?

> "A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. You should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance."

When is a significant impact likely?

> "To be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility. If there is scientific uncertainty about the impacts of your action and potential impacts are serious or irreversible, the precautionary principle is applicable. Accordingly, a lack of scientific certainty about the potential impacts of an action will not itself justify a decision that the action is not likely to have a significant impact on the environment."

The policy statement provides guidance on determining whether an action is likely to have a significant impact on a MNES. The following measures should be considered:

- Whether there are any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?
- Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities and infrastructure), whether there is potential for impacts, including indirect impacts, on matters of national environmental significance?
- Whether there are any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?
- Whether any impacts of the proposed action on matters of national environmental significance are likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

This attachment assesses only whether an impact on a MNES is likely to be significant or not. Impacts upon relevant MNES are assessed within the EIS and the relevant technical studies, where a detailed assessment of the likely impacts of the project on the existing environment has

been undertaken. This assessment formed the basis of whether an impact on MNES was considered to be significant or not.

Significance assessment was adopted for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment. For example, an understanding of the sensitivity of ecosystems in their current state provides a sound basis for determining the severity of potential impacts. Potential impacts that arise through the management of materials and substances (e.g., waste) are more appropriately assessed using the principles of risk management. Compliance assessment was adopted for environmental aspects regulated by statutory guidelines, e.g., air quality, noise and vibration. Chapter 9 Impact Assessment Method provides a more detailed description of the methods used to undertake the impact assessment, including of MNES.

The magnitude and significance of the impacts has been quantified in the EIS. Priority in the development of mitigation measures was given to impacts with a high significance of impact.

3.2 Identifying and Assessing MNES

An EPBC Protected Matters search was undertaken in July 2009 to support the referrals for the project. The search identified 31 threatened species, 34 migratory species and 3 ecological communities to be potentially present in or within 5 km of the project area.

MNES identified in the EPBC Act referral submitted to the Australian Government in July 2009 were investigated and assessed in the EIS. Technical studies were commissioned to describe the existing environment, identify environmental values, assess potential and residual impacts and propose mitigation and management measures, and inspection and monitoring.

Technical studies relevant to the assessment of MNES include:

- Terrestrial Ecology Impact Assessment (Appendix 9 of EIS).
- Freshwater Ecology and Water Quality Impact Assessment (Appendix 11 of EIS).
- Marine and Estuarine Ecology Impact Assessment (Appendix 12 of EIS).
- Indigenous Cultural Heritage Impact Assessment Report (Appendix 18 of EIS).
- Non-Indigenous Heritage Report (Appendix 19 of EIS).

Further desktop searches and field surveys were undertaken by technical specialists to determine the presence of MNES in or adjacent to the project area. Details of the desktop searches and field survey methodology and survey effort are described in Chapter 17 Terrestrial Ecology (Section 17.2), Chapter 18 Freshwater Ecology (Section 18.2) and Chapter 19 Marine and Estuarine Ecology (Section 19.2), with further information provided in the relevant technical reports listed above.

Desktop searches included additional EPBC Protected Matters Searches as part of the terrestrial ecology impact assessment study and freshwater ecology impact assessment study to identify any new species listed since the original search in 2009, and to include the most up to date project area. Desktop research undertaken included searches of:

- DERM Wildlife Online database (Wildnet).
- DERM Biodiversity Planning Assessment GIS database.
- DERM WetlandInfo database.
- Queensland Herbarium HerbRECS database.
- Queensland Museum Collection database.
- Birds Australia Atlas GIS database.

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 and supplementary surveys in September 2010 and February 2011.

All flora 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). A floral inventory was compiled for the study area and relative abundance assessed within each stratum of the community. DERM mapped regional ecosystems were validated in the field and where required, the boundaries of vegetation types were mapped in the field using a hand-held GPS and/or aerial photograph interpretation.

Ancillary information such as areas of weed infestation, habitat areas for rare and threatened species and regional connectivity were also recorded and described.

The review of existing desktop information pertaining to fauna within the study area, allowed the prioritisation of habitat areas and locations for the field survey program, to enable broad habitat types within the study area to be sampled. The fauna survey methods were developed to undertake targeted surveys for species listed under the EPBC Act and *Nature Conservation Act 1992* (Qld) identified from the review of existing information as potentially occurring within the study area.

A faunal inventory was produced representing the vertebrate fauna assemblages present at selected survey sites and the study area as a whole. The habitat values of selected survey sites and the study area as a whole were assessed in relation to fauna presence and distribution.

Faunal survey effort included diurnal and nocturnal searches, call playback, ultrasonic microchiropteran call detection, trapping and gathering of inferential evidence such as fauna tracks, scats and scratches.

The likelihood of a species listed under the Protected Matters search being present within the study area was assessed within the technical studies, through field study and further literature review. The following criteria was used:

- Very Low - the study area is outside the species normal range, habitat does not exist.
- 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.
- 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.
- High - the species is known to occur in the local area and critical habitat exists in the study area.

- Recorded - the species was recorded in the study area as part of field surveys.

The Species Profile and Threats database (DSEWPaC, 2011b) includes a profile on listed species and communities. The profile includes information on the location of 'important populations' of species and communities. Reference to important populations in this attachment is as defined and described in the Species Profile and Threats Database (DSEWPaC, 2011b). Where not identified in the Species Profile and Threats Database (DSEWPaC, 2011b), the following definition of an important population was adopted.

Important populations are defined by evidence of colonies, breeding pairs/camps and multiple roosts i.e., congregations of the species, as this is the basis for information provided in the Species Profile and Threats database. Where possible, this information has been correlated with that observed by Ecosure in their surveys, and the observations from other ecological surveys and desktop analyses undertaken for the study area.

The profiles within the Species Profile and Threats database often include information on core habitat for species. The terms core and critical habitat are used interchangeably in the profiles. This report adopts the term used by DSEWPaC in the profile for the relevant species. Where not defined in DSEWPaC (2011b), the following definition for critical habitat has been adopted.

Critical habitat is defined as habitat containing colonies, breeding pairs/camps and multiple roosts, as well as an area around the species site. The actual area will be dependent on information provided by Ecosure and in literature on EPBC Act listed species, as it relates to the viability of the species. No critical habitat was identified by Ecosure or the other proponents in the study area.

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4. LEGISLATIVE CONTEXT

The following sections describe the project specific Commonwealth policies and legislation to be enforced to protect the listed threatened and migratory species. Internationally protected areas are identified which occur within and in close proximity to project infrastructure and which may be affected by construction, operation and decommissioning of the project.

4.1 International Conventions

Matters of international significance including internationally protected areas must be considered during the construction, operation and decommissioning of the project. One convention is relevant to the project for MNES.

The Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention) (UNESCO, 1971) provides for the protection of cultural and natural heritage and aims to protect outstanding heritage around the world for current and future generations. Australia was one of the first signatories to the convention, in 1974.

The Great Barrier Reef supports a large diversity of fauna, flora and coral reef habitats and was proclaimed as a World Heritage Area in 1981. Port Curtis and the study area are both located within the Great Barrier Reef World Heritage Area (GBRWHA), which commences at the low water mark on the mainland side of The Narrows and includes Curtis Island. The offshore areas east of Curtis Island are included within the Mackay/Capricorn section of the Great Barrier Reef Coast Marine Park (GBR Coast MP) (GBRMPA, 1998). Protected species and communities as well as the ecological functioning of the world heritage area must be preserved during project construction, operation and decommissioning phases.

4.2 Commonwealth Legislation

The Commonwealth legislation that is relevant to the construction and operation phases of the project, in relation to the protection of threatened species and ecological values, includes:

- *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act establishes an Australian Government administered environmental assessment and approval system. This operates in addition to but separate from state and territory systems. The EPBC Act determines impacts upon matters of national environmental significance as the primary trigger for Australian Government involvement in environmental protection.

  In accordance with the requirements of the EPBC Act, the project was referred to the Department of Environment, Water, Heritage and the Arts (DEWHA) now known as the Department of Sustainability, Environment, Water, Population and Communities. Two EPBC referrals (EPBC 2009/5007 and EPBC 2009/5008) have been submitted to DEWHA by Arrow Energy. Both referrals proposed the project as a controlled action as it is likely to impact MNES.

  Referral No. EPBC 2009/5008 (Feed Gas Pipeline) concerns the clearance of vegetation causing habitat loss and fragmentation where threatened fauna, flora and migratory species may occur.

- *Great Barrier Reef Marine Park Act 1975*. The act is the predominant legislative measure to protect and conserve environmental values, biodiversity and heritage values within the Great

Barrier Reef region. While the project is not located within the boundaries of the Great Barrier Reef Marine Park (GBRMP), it is close (within 2 km at the closest point).

The indicative route for LNG carriers travelling from Gladstone to Asia uses the recommended outer shipping channel within the GBRMP. The coastal passage to the deep-water channel from Port Curtis can be executed in all weather and visibility.

- *Great Barrier Reef Marine Park Regulations 1983*. The regulations made under the Great Barrier Reef Marine Park Act declare Port Curtis and its adjacent waters as part of the Port of Gladstone-Rodds Bay Zone B dugong protection area. The dugong protection areas under the regulations and the Great Barrier Reef Marine Park Zoning Plan 2003 extend from the Narrows to the coastline of Curtis Island and through to Rodds Peninsula.
- Draft Policy Statement 2007: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999. This draft policy outlines the Commonwealth Government's position on provisions in the EPBC Act for environmental offsets. This policy will be used when offset strategies are formulated.
- Recovery Plan for Marine Turtles in Australia 2003. The objective of this plan is to "to reduce detrimental impacts on Australian populations of marine turtles and hence promote their recovery in the wild". This plan will be considered when mitigation methods are developed to reduce project impacts on marine turtles.

5. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

This section describes the potentially impacted MNES for the Arrow LNG Plant feed gas pipeline:

- World Heritage properties.
- National Heritage places.
- Listed threatened species and communities.
- Listed migratory species.

The EPBC Protected Matters search undertaken in July 2009 to support the referrals for the project identified 31 threatened species, 34 migratory species and 3 ecological communities as being potentially present in or within 5 km of the project area (identified in this chapter as 'the investigation area'), as well as one World Heritage Property and one National Heritage Place. No Wetlands of International Importance (declared Ramsar wetlands) were identified within the investigation area.

Additional EPBC Protected Matters searches, desktop studies and field surveys undertaken for the project identified additional threatened flora and fauna species, migratory species and an ecological community not documented within the original EPBC Protected Matters search tool.

The additional species and community are included within the description of potentially impacted MNES detailed below, and within the assessment of project impacts upon MNES.

Other matters protected by the EPBC Act summarised within the Protected Matters searches, include Commonwealth Lands, Places on the Register of National Estate and additional listed marine species. These other matters are not defined as MNES, and as such are not included within this attachment. Impacts relating to these other matters are assessed within the EIS.

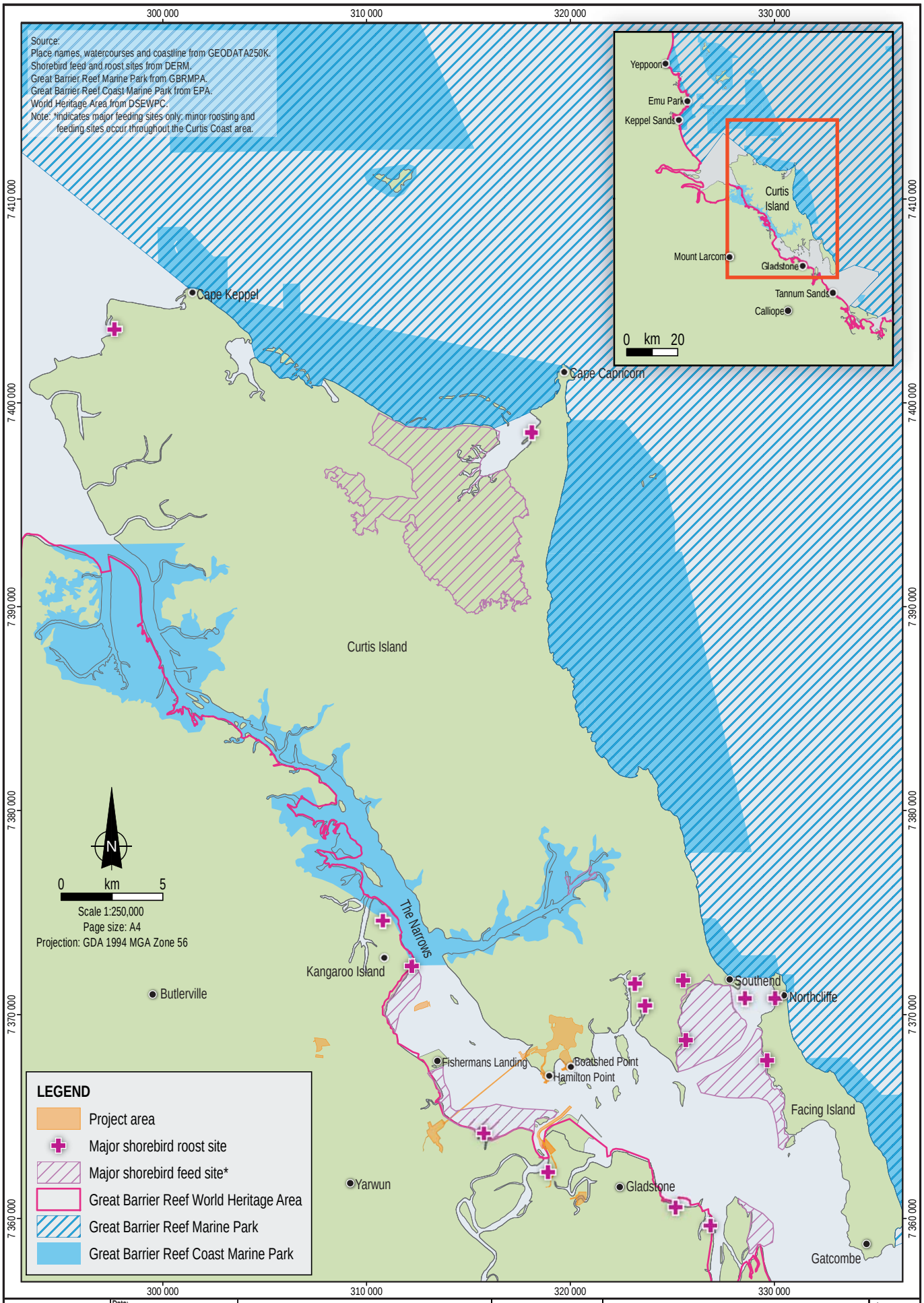
The project area is defined as the potential area of disturbance which encompasses the actual footprint of the project and a buffer required to accommodate construction and operations activities. The study area encompasses the project area and adjacent areas. The project area and nominal study area are shown in Figure 1. While technical studies focussed on the study area, the study area for each environmental aspect was informed by the environmental values and the spatial context required to identify and assess potential impacts. In some instances, desktop studies were carried out over an even wider area to provide an understanding of the relationship of local occurrences to the wider distribution of species and communities. Full details of the field survey and desktop study areas for each technical discipline are given in the technical studies listed in Table 1.1 of this report.

5.1 World Heritage Properties

The sole World Heritage property within the study area is the Great Barrier Reef World Heritage Area (GBRWHA), shown in Figure 3. The GBRWHA is both a World Heritage property and a National Heritage place. Natural Heritage places are discussed in Section 5.2.

5.1.1 Great Barrier Reef World Heritage Area

The GBRWHA was proclaimed as a World Heritage Area in 1981 and is renowned for its extensive coral reef framework and rich biodiversity. As a whole, the reef supports broad scale distribution of seagrass, mangrove, benthic and coral reef habitats.



coffey environments	Date: 09.01.2012 MXT: 7033CA_07_ATT4_GIS001_v1_1 File Name: 7033_07_ATT4_F003_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Great Barrier Reef World Heritage Area, marine parks and shorebird sites	Figure No: 3

The Great Barrier Reef is the world's largest World Heritage Area extending for 2,000 km and covering an area of 35 million hectares on the northeast continental shelf of Australia. The Great Barrier Reef's great biodiversity reflects the maturity of the ecosystem, which has evolved over hundreds of thousands of years. The reef is the world's most extensive coral reef system and is one of the world's richest areas in terms of faunal diversity. The GBRWHA also has extensive areas of seagrass, mangrove, sandy and muddy seabed communities and island communities.

The GBRWHA commences at the low water mark of the mainland side of The Narrows, and encompasses Curtis Island. The GBRWHA is an MNES on the basis of providing habitat for listed threatened species and communities, and migratory birds. Figure 3 depicts the boundaries for the GBRWHA, the GBRMP and the GBRMCP in relation to the Arrow LNG Plant project area.

The Australian Government and Queensland Government have a cooperative and integrated approach to management of the GBRWHA. The Great Barrier Reef Marine Park Authority (GBRMPA) is the Australian Government agency responsible for overall management, and the Queensland Government, particularly the Queensland Parks and Wildlife Service, provides day-to-day management of the area for the Authority.

The World Heritage criteria against which the Great Barrier Reef was listed are as follows:

- To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance (Criterion vii).
- To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features (Criterion viii).
- To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals (Criterion ix).
- To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation (Criterion x).

The World Heritage values of the Great Barrier Reef, as set out by the Australian Government (DSEWPC, 2011a) are restated below. Some values have been summarised.

Criterion vii – an outstanding example of superlative natural phenomena

The Great Barrier Reef provides some of the most spectacular scenery on earth and is of exceptional natural beauty. The World Heritage values include:

- The vast extent of the reef and island systems which produce an unparalleled aerial vista.
- Islands ranging from towering forested continental islands complete with freshwater streams, to small coral cays with rainforest and un-vegetated sand cays.
- Coastal and adjacent islands with mangrove systems of exceptional beauty.
- The rich variety of landscapes and seascapes including rugged mountains with dense and diverse vegetation and adjacent fringing reefs.
- The abundance and diversity of shape, size and colour of marine fauna and flora in the coral reefs.

- Spectacular breeding colonies of seabirds and great aggregations of over-wintering butterflies.
- Migrating whales, dolphins, dugong, whale sharks, sea turtles, seabirds and concentrations of large fish.

Criterion viii – an outstanding example of major stages of earth's evolutionary history

The Great Barrier Reef is by far the largest single collection of coral reefs in the world. The World Heritage values of the property include:

- 2,904 coral reefs covering approximately 20,055 km^2.
- 300 coral cays and 600 continental islands.
- Reef morphologies reflecting historical and on-going geomorphic and oceanographic processes.
- Processes of geological evolution linking islands, cays, reefs and changing sea levels, together with sand barriers, deltaic and associated sand dunes.
- Record of sea level changes and the complete history of the reef's evolution are recorded in the reef structure.
- Record of climate history, environmental conditions and processes extending back over several hundred years within old massive corals.
- Formations such as serpentine rocks of South Percy island, intact and active dune systems, undisturbed tidal sediments and "blue holes".
- Record of sea level changes reflected in distribution of continental island flora and fauna.

Criterion ix – an outstanding example of ongoing ecological and biological processes

Biologically the Great Barrier Reef supports the most diverse ecosystem known to man and its enormous diversity is thought to reflect the maturity of an ecosystem which has evolved over millions of years on the northeast continental shelf of Australia. The World Heritage values include:

- The heterogeneity and interconnectivity of the reef assemblage.
- Size and morphological diversity (elevation ranging from the sea bed to 1,142 m at Mt. Bowen and a large cross-shelf extent encompass the fullest possible representation of marine environmental processes).
- Ongoing processes of accretion and erosion of coral reefs, sand banks and coral cays, erosion and deposition processes along the coastline, river deltas and estuaries and continental islands.
- Extensive *Halimeda* beds representing active calcification and sediment accretion for over 10,000 years.
- Evidence of the dispersion and evolution of hard corals and associated flora and fauna from the "Indo-West Pacific centre of diversity" along the north-south extent of the reef.
- Inter-connections with the Wet Tropics via the coastal interface and Lord Howe Island via the East Australia current.
- Indigenous temperate species derived from tropical species.

- Living coral colonies (including some of the world's oldest).
- Inshore coral communities of southern reefs.
- Five floristic regions identified for continental islands and two for coral cays.
- The diversity of flora and fauna, including:
  - Macroalgae (estimated 400 to 500 species).
  - Porifera (estimated 1,500 species, some endemic, mostly undescribed).
  - Cnidaria: Corals - part of the global centre of coral diversity and including hexacorals (70 genera and 350 species, including 10 endemic species) and octocorals (80 genera, number of species not yet estimated).
  - Tunicata: Ascidians (at least 330 species).
  - Bryozoa (an estimated 300 to 500 species, many undescribed).
  - Crustacea (at least 1,330 species from three subclasses).
  - Worms including Polychaetes (estimated 500 species) and Platyhelminthes (include free-living Tubelleria (number of species not yet estimated), polyclad Tubelleria (up to 300 species) and parasitic helminthes (thousands of estimated species, most undescribed)).
  - Phytoplankton (a diverse group existing in two broad communities).
  - Mollusca (between 5,000 and 8,000 species).
  - Echinodermata (estimated 800 extant species, including many rare taxa and type specimens).
  - Fishes (between 1,200 and 2,000 species from 130 families, with high species diversity and heterogeneity; includes the whale shark (*Rhynchodon typus*)).
  - Seabirds (between 1.4 and 1.7 million seabirds breeding on islands).
  - Marine reptiles (including six sea turtle species, 17 sea snake species, and one species of crocodile).
  - Marine mammals (including one species of dugong (*Dugong dugon*), and 26 species of whales and dolphins).
  - Terrestrial fauna, including invertebrates (pseudoscorpions, mites, ticks, spiders, centipedes, isopods, phalangids, millipedes, collembolans and 109 families of insects from 20 orders, and large over-wintering aggregations of butterflies) and vertebrates (including seabirds, reptiles: crocodiles and turtles, nine snakes and 31 lizards, mammals).
- The integrity of the inter-connections between reef and island networks in terms of dispersion, recruitment, and the subsequent gene flow of many taxa.
- Processes of dispersal, colonisation and establishment of plant communities within the context of island biogeography (e.g., dispersal of seeds by air, sea and vectors such as birds are examples of dispersion, colonisation and succession).
- The isolation of certain island populations (e.g., recent speciation evident in two subspecies of the butterfly (*Tirumala hamata*) and the evolution of distinct races of the bird *Zosterops* spp).

- Remnant vegetation types (hoop pines) and relic species (sponges) on islands.
- Evidence of morphological and genetic changes in mangrove and seagrass flora across regional scales.
- Feeding and or breeding grounds for international migratory seabirds, cetaceans and sea turtles.

Criterion x - important habitats for conservation of biological diversity

The Great Barrier Reef contains many outstanding examples of important and significant natural habitats for in situ conservation of species of conservation significance, particularly resulting from the latitudinal and cross-shelf completeness of the region. The World Heritage values include:

- Habitats for species of conservation significance within the 77 broadscale bioregional associations that have been identified for the property and which include:
  - Over 2,900 coral reefs (covering 20,055 km^2) which are structurally and ecologically complex.
  - Large numbers of islands, including 600 continental islands supporting 2,195 plant species in 5 distinct floristic regions; 300 coral cays and sand cays; seabird and sea turtle rookeries, including breeding populations of green sea turtles and hawksbill turtles; coral cays with 300 to 350 plant species in two distinct floristic regions.
  - Seagrass beds (over 5,000 km^2) comprising 15 species, two endemic.
  - Mangroves (over 2,070 km^2) including 37 species.
  - *Halimeda* banks in the northern region and the unique deep water bed in the central region.
  - Large areas of ecologically complex inter-reefal and lagoonal benthos.
- Species of plants and animals of conservation significance.

Potential impacts to the GBRWHA will be discussed in Section 6.1 along with the management, mitigation and monitoring measures proposed to address these impacts.

5.1.2 World Heritage Values of Port Curtis and Curtis Island

Port Curtis and Curtis Island are both located within the GBRWHA, which extends from the low water mark of the mainland.

Important features of world heritage value for Port Curtis and Curtis Island are described below. Potential impacts to the GBRWHA within Port Curtis will be discussed in Section 6.1 along with management, mitigation and monitoring measures.

Landscape of Port Curtis

Port Curtis is a shallow coastal basin, situated directly offshore from the city of Gladstone. Port Curtis is separated from the Coral Sea by Facing and Curtis islands, which protect the port from ocean swells.

Connections to the Coral Sea exist via South Channel to the south of Facing Island, North Channel between Facing and Curtis islands, and The Narrows, which extends some 40 km to the northwest and separates Curtis Island from the mainland.

The Calliope River flows into Port Curtis and is one of the few remaining waterways in Queensland where major water-retaining infrastructure does not interrupt environmental flows to the coast. Boyne River, Auckland and South Trees inlets also discharge into Port Curtis and to the south, the connected waterways of Colosseum Inlet, Seven Mile Creek and Rodds Harbour. Northward, Grahams Creek and a number of smaller tributaries discharge to The Narrows.

The Curtis Coast Regional Coastal Management Plan (CCRCMP) is the key document designating coastal landscapes and features of scenic value within the study area. It sets out desired environmental outcomes and measures to protect the designated Scenic Coastal Landscapes of state significance which are:

> "areas of outstanding and distinctive scenic quality and are high priority areas for scenic landscape management within Queensland".

The CCRCMP identifies the following elements of the Curtis Coast landscape as contributing to the scenic coastal landscape values of the region (areas of state significance):

> "…islands and offshore features (including large and small coastal islands); coastal wetlands; coastal headlands; estuaries and inlets; riverine corridors and creeks; shorelines; sand dunes; coastal mountain ranges; and coral cays and reefs".

The State Coastal Management Plan includes a policy on Coastal Landscapes. Policy 2.7.1 of the CCRCMP provides the regional direction for implementing the Coastal Landscapes policy in the Curtis Coast Region. It sets out two relevant coastal management principles:

> "7A The values of coastal landscapes are conserved and recognised for their importance to the quality of life of both residents and visitors, as well as to the economic development and growth of Queensland."

> "7B The dominance of the natural character of the coast (excluding developed urban areas) is retained, including elements of landscape and vegetation."

The regional context discussion within policy 2.7.1 recognises the importance of landscape values in the Curtis Coast Region. It states:

> "Incompatible development within these areas can adversely impact on their scenic landscape values, particularly in relation to the coastal islands, Mt Larcom and the coastal ranges and remote natural areas such as The Narrows."

It goes on to further state that:

> "The Gladstone Region is identified to be of 'High Scenic Management Priority' with Curtis Island and the Capricorn Group being of Level 1 Scenic Quality."

The Areas of State Significance (Scenic Coastal Landscapes) described in Policy 2.7.1 relevant to the Arrow LNG Plant are detailed in Table 5.1.

Infrastructure associated with the project falls within designated scenic coastal landscapes, and the EIS study area straddles a number of Key Coastal Sites (KCS) specified in the policy. The LNG plant is located in KCS 1 (Curtis Island). Launch Site 1 is located in KCS 7 (Calliope River/Flying Fox Creek). TWAF8 lies within and adjacent to KCS 5: Targinie Remnant Vegetation. TWAF 7 lies within 'Gladstone City' and is not considered to be a KCS.

Table 5.1 Areas of State Significance (Scenic Coastal Landscapes) relevant to Arrow LNG Plant

Landscape	Sites	Description	Desired Coastal Outcomes	Measures
Islands and offshore features	Curtis Island	Large identifiable coastal islands close to shore and visually prominent from the mainland and harbour. These islands provide a strong structural element to the landscape and define the seaward edge of the coastal viewshed. They provide a high degree of contrast and visual diversity between intertidal and upland areas.	The landscape values of the islands and their contribution to the landscape values of the Curtis Coast region are protected and maintained. Views from the mainland and viewpoints to the island are maintained and enhanced.	Ensure the development remains unobtrusive and compatible with landscape values. For example, buildings should not be higher than mature tree height and not on the shorelines or ridgelines or visible from viewpoints. Screen access points and other development from viewpoints.
Coastal wetlands	Port Curtis, The Narrows	Coastal wetlands in the Curtis Coast region comprise a range of mainly tidal wetlands such as mangroves, salt marsh and claypan, with some freshwater wetlands. Coastal wetlands contribute significantly to scenic quality in terms of vegetation, wildlife and naturalness. The landscape qualities of the tidal wetlands are generally appreciated from boats, access points such as boat ramps and elevated lookouts.	The landscape values and ecological integrity of coastal wetlands are maintained. The edges of mangrove vegetation in areas of high scenic quality are managed to maintain or restore their visual continuity. Degraded wetland areas are rehabilitated.	Minimise visual breaks in areas of continuous mangrove vegetation. Maintain existing vegetation along waterways to a maximum extent to form natural landscape edge and screen. Wetlands should be managed to maintain their natural ecological processes, retain their natural drainage and tidal patterns, control exotic plants and animals, prevent weed invasion and maintain buffer zones.
Estuaries and inlets	Port Curtis, The Narrows	The landscape qualities of estuaries and waterways are generally appreciated from boats and access points such as jetties and boat ramps, the shoreline and elevated lookouts. Estuarine and freshwater systems are dominant in the lower reaches by mangroves, claypans and salt marsh. Many areas have a high degree of naturalness and offer a “remote” experience.	The landscape values and ecological integrity of mangroves, inlets and waterways are maintained. The edges of mangrove vegetation in areas of high scenic quality are managed to maintain or restore their visual continuity.	Minimise visual breaks in areas of continuous vegetation. Maintain existing vegetation along waterways to a maximum extent to form a natural landscape edge and screen. Ensure infrastructure in areas of high visual quality does not obscure views to water or intrude on waterways.

Table 5.1 Areas of State Significance (Scenic Coastal Landscapes) relevant to Arrow LNG Plant (cont'd)

Landscape	Sites	Description	Desired Coastal Outcomes	Measures
Riverine corridors and creeks	Calliope River	The landscape qualities of riverine creeks and corridors are generally appreciated from boats, access points such as jetties, boat ramps and elevated lookouts. River and creek systems and riparian vegetation cross the coastal plain and provide a visual contrast in an otherwise largely modified rural landscape. These areas often form the visual edge and link to local views.	The landscape values of remnant riverine vegetation and other natural features are protected. Views of riverine corridors from significant viewpoints are maintained. Fragmented corridors in significant landscapes are linked and rehabilitated.	Maintain creek corridors and riverine vegetation within developments and rural lands, forming a linear open space corridor. Rehabilitate degraded or fragmented corridor vegetation forming part of visual edges to form a continuous band of vegetation.
Shorelines	The coastline	The water's edge of beaches, bays, rivers, creeks and estuaries. Shorelines are highly valued areas that interface between land and water and are the focus of most coastal recreational activity. Scenic quality is most influenced by the character of water and shoreline forms.	The landscape values of shorelines are maintained. Views of shorelines from significant viewpoints are protected. The dominance of natural character and elements of landform and vegetation that frame or are visible from the shoreline or offshore are maintained.	Maintain a foreshore reserve or buffer along shorelines and other dunal areas with significant landscape values. Along shorelines with significant landscape value: • Ensure new development and extractive industries do not degrade the values of beaches and dunes. • Screen existing development and infrastructure. • Ensure building heights adjacent to shorelines are below the mature tree line.

Source: Curtis Coast Regional Coastal Management Plan (Queensland Government, 2003)

Habitat within Port Curtis

Extensive intertidal flats appear at low tide and large intertidal mangrove and saltpan areas are inundated during high tides. Water depths have been modified by the development of shipping channels, land reclamation and coastal armouring.

Port Curtis, as part of the GBRWHA, provides suitable areas of habitat for populations of rare and endangered EPBC Act listed species. Additionally, this area is an interface between a growing industrial zone and an area of unique and natural beauty, thereby providing significant emphasis on environmental management and mitigation measures related to developments in this area.

Although Port Curtis is not listed as a Ramsar wetland, it is a nationally important wetland under the Directory of Important Wetlands of Australia (Environment Australia, 2001) as it supports a versatile set of habitat types. An array of intertidal and coastal zones exist within Port Curtis and include salt marshes, mudflats, mangroves and water bodies.

Areas in and around Port Curtis provide important habitats used by a range of species, including the EPBC listed dugong, the potentially endemic Australian snubfin dolphin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphin (*Sousa chinensis*), six of the world's seven species of protected marine turtles, sea snakes, the saltwater crocodile, fish species (including seahorses and pipefish), pelagic and benthic invertebrates and plankton. The project is not situated in any declared fish habitat areas (FHA). The closest FHAs to the study area are Colosseum Inlet situated 20 km south of Gladstone and the Fitzroy River located near the northern end of Curtis Island.

These habitat areas contribute to an ecosystem that sustains fisheries and supports the health of the environment and residing organisms. Physical habitat areas include:

- Intertidal mudflats – Intertidal mudflats support a high biodiversity of benthic species, they support fisheries productivity and provide a feeding ground for migratory birds. Soft mudflats composed of fine sediment are exposed during low tide for approximately 300 m at North China Bay, Kangaroo Island and Friend Point.
- Benthic zone - The benthic zone supports an array of small and microscopic organisms which form an important part of the food chain within the GBRWHA and Port Curtis, and assist in sediment and nutrient recycling.
- Reef and rock substrate - Reef and rock substrate habitat are not a major feature of Port Curtis, but contribute to the community assemblage and overall population and diversity within the GBRWHA and Port Curtis. Rubble reef areas and coral bommies cover approximately 15% of the study area substrate within Port Curtis, and support a broad range of organisms including bivalves, ascidians, bryozoans and hard corals. Rock substrate is widespread throughout Port Curtis and is typically composed of oyster-encrusted boulders and rubble in the coastal margins. The rock provides a solid substrate for attachment of organisms such as algal flora, barnacles, oysters and tubeworms. The precise distribution of rock substrate within the study area has not been mapped.

Flora within Port Curtis

Nationally important marine flora habitat communities listed under the Directory of Important Wetlands include:

- Seagrass beds - Seagrass areas occur within the GBRWHA and Port Curtis. Seagrass beds provide several important ecological functions. They help stabilise sediments, trap and recycle nutrients, and provide habitat for juvenile fish and crustaceans. They also provide feeding

areas for EPBC Act listed species such as the dugong and several species of turtles. The importance of seagrasses as feeding areas for dugongs has been recognised, with the establishment of a number of dugong protection areas (DPAs). The Rodds Bay DPA extends into Port Curtis from Rodds Bay in the southeast to the beginning of the Narrows south of Graham Creek (Figure 4). Large areas (as much as 4,000,000 ha) of seagrass are protected or monitored within the GBRWHA and the GBRMP. Seagrass beds are scattered throughout Port Curtis. The main areas are in the west, close to Gladstone and Fishermans Landing. The combined area of all intertidal seagrass beds in Port Curtis is approximately 4,500 ha.

- Mangroves - Mangroves provide ecological benefits through their functions of high productivity, protection against erosion, nutrient filtering and recycling. They also play an important role in providing nursery areas for young fish and crustacean species (including commercially and recreationally important species), as well as terrestrial habitat for the EPBC Act protected water mouse and migratory bird species. Extensive areas of mangroves occur around Port Curtis and Curtis Island; the largest areas occur within Targinie Creek and Graham Creek, and in the southwest, between Fishermans Landing and the Calliope River.
- Saltmarsh - Saltmarsh areas play an important role as feeding habitat for fish during high tides and provide a good source of organic material to coastal waters. As such they play an important role in maintaining the health and ecological functioning of the GBRWHA and Port Curtis surrounding waters. Saltmarsh environments typically occur landward of mangroves in the extreme high tide areas and are inundated only at the highest spring tides. Saltmarsh areas also provide nesting and feeding areas for EPBC Act protected migratory birds. The most extensive areas of saltmarsh in Port Curtis are around Targinie Creek and in the inner embayments of North China Bay and Boatshed Point. Saltmarsh areas also occur to the west of Kangaroo Island, in the southwest of Port Curtis and at the southeast of Curtis Island. The combined area of saltmarsh and salt-tolerant species in the Port Curtis region is approximately 4,573 ha.

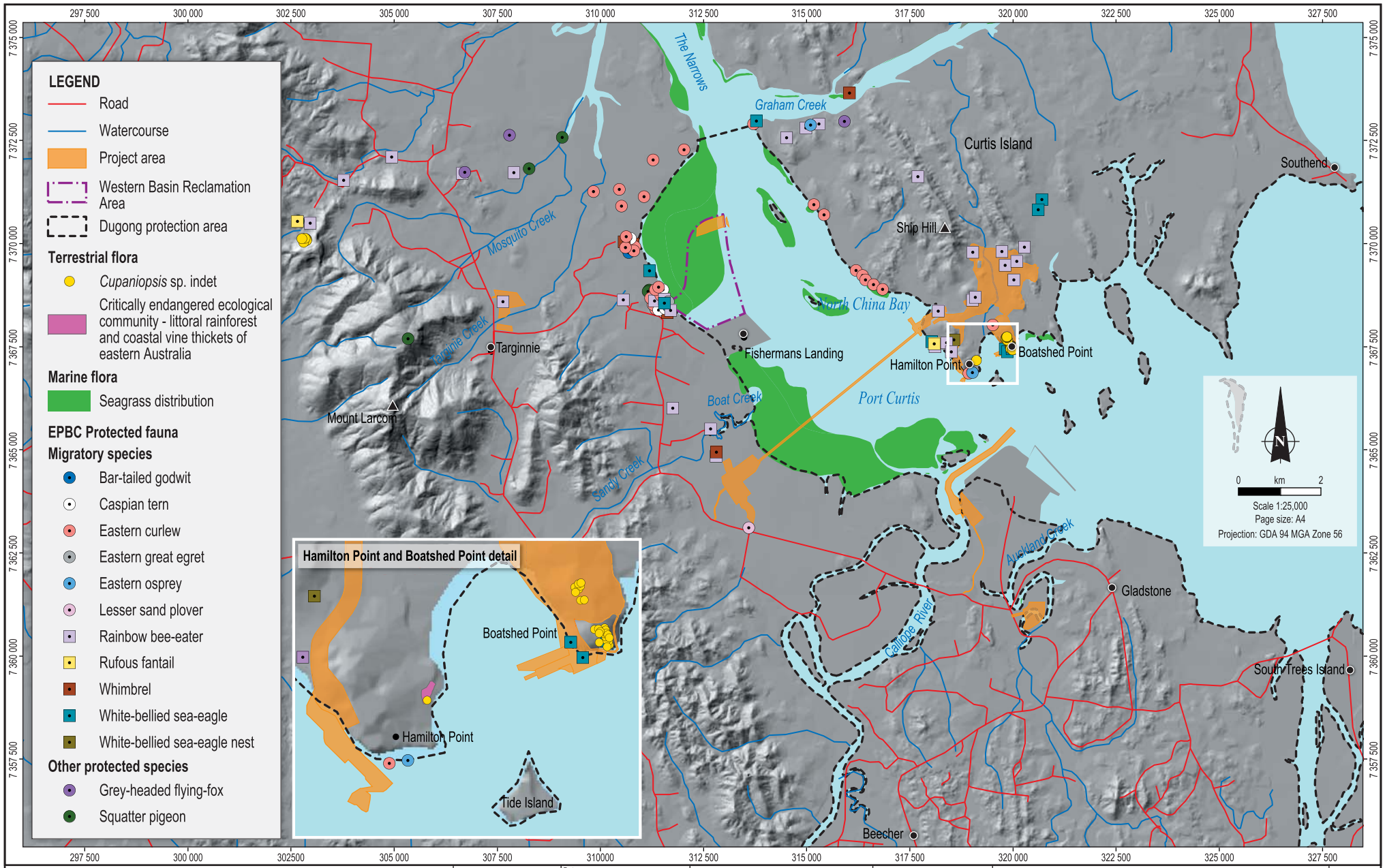
Fauna within Port Curtis

Port Curtis and its surrounding waters are rich in biodiversity and support a large marine fauna population, including several species listed under either the EPBC Act or on the IUCN Red List. Dugongs, marine turtles, cetaceans, fish, sea snakes, seahorses and pipefish all occur within Port Curtis and this area represents the southern limit of habitat for saltwater crocodiles.

Dugong is listed as a protected migratory species under the EPBC Act and the Nature Conservation Act. Large populations (estimated at 14,000 individuals) have been observed within the GBRMP, and their presence has attributed to the area being listed as World Heritage Area and the designation of the Zone B dugong protection area. The entire marine study area falls within the dugong protection area.

Dugong populations are known to feed on the seagrass beds within Port Curtis during their migration along the Queensland coast. They can feed in large herds of approximately 140 individuals, grazing in a single location for four weeks or longer. The long lifespan and low reproduction rate of the dugong means the species population recovery is potentially slow, and the animals are vulnerable to both natural and anthropological factors, including boat strike, underwater noise, Indigenous hunting, commercial fishing or trawling and destruction or fragmentation of habitat.

Six of the seven species of marine turtles worldwide occur within Queensland waters. All six species are listed as vulnerable or endangered by the EPBC Act and Nature Conservation Act.



Source:
Place names and roads from DME.
Flora, fauna and critically endangered ecological community from Ecosure (field validated and literature review locations).
Seagrass from DEEDI (November 2002).
Dugong protection area from Fisheries Queensland (DEEDI).
Project area and digital elevation model from Coffey Environments.

coffey environments

Date: 22.02.2011
MXD: 7033CA_07_ATT4_GIS002_v1_1
File Name: 7033_07_ATT4_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Terrestrial and marine MNES species and communities

Figure No: 4

The flatback, green and loggerhead turtles all nest and forage within the GBRMP and GBRWHA. Some individuals nest within Port Curtis (with the closest nesting area at Southend, 8 km from the proposed LNG plant site and marine facilities). The remaining three species either have wider worldwide distributions or are less likely to nest near Port Curtis.

The marine turtle species found within Port Curtis display a long lifespan, low reproductive rate and high site fidelity. These features restrict the rate of population recovery and, as such, could render the populations more vulnerable to anthropogenic impacts such as loss of foraging habitat, boat strike, and project lighting (light glare can lead to disorientation in both nesting adults and emerging hatchlings).

Thirteen species of cetaceans (i.e., whales, dolphins and porpoises) have known ranges that include the waters of Port Curtis.

Cetaceans most likely to be found regularly within Port Curtis are the Australian snubfin dolphin and the Indo-Pacific humpback dolphin. Both species are listed under the EPBC Act as migratory species. The blue whale (*Balaenoptera musculus*) is listed as endangered under the EPBC Act, although it is only likely to occur offshore around the continental shelf and not in Port Curtis. While other cetacean species have the potential to migrate through Port Curtis, the three species described above have a higher conservation status and have previously been sighted in the Port Curtis region.

The main habitat of the Australian snubfin dolphin and the Indo-Pacific humpback dolphin is shallow coastal waters in or adjacent to modified environments such as dredged channels, breakwaters and river mouths (Parra, 2006). These habitats exist along the majority of the Queensland coastline (including Port Curtis) and support foraging and mating activities. Generally, adult female cetaceans have a low reproductive rate and calve only every few years.

Anthropogenic activities and coastal developments along the Queensland coast that can have an impact on cetacean species survival include gill netting activities, pollution, vessel traffic (and associated noise), boat strike and overfishing.

Many fish and shellfish species occur within the marine and estuarine waters around Port Curtis. The habitats within the study area provide spawning, nursery and feeding areas for recreationally and commercially important fishing species. No species of conservation importance were recorded within the targeted field studies, although species present are of recreational fishing importance.

Port Curtis and surrounding waters also provide key commercial fishing grounds. All common species identified extend in range beyond the Port Curtis region to areas around northern Australia and, for some species, to southern Australia as well.

Australia has 33 of the world's 54 described species of sea snake. The Species Profile and Threats database (SPRAT), a subordinate of the EPBC Act, identifies 12 sea snakes listed as protected species with an indicative range extending into the study area and the surrounding regions. However, no individuals were recorded in the study area.

The saltwater crocodile is protected under the EPBC Act and is recognised as vulnerable under the Nature Conservation (Wildlife) Regulation. Crocodiles are known to inhabit reef, coastal and inland watercourses typically north of the tropics, and their habitat extends to the Gladstone region. The southeast Queensland region is thought to support a moderate density of saltwater crocodiles despite the low quality in nesting and living habitat (Taplin, 1987). Surveys conducted within the region during 1994 and 2000 recorded 434 non-hatchling crocodiles, approximately

10% of the Queensland crocodile population. No saltwater crocodiles were observed during the field surveys.

Selected species of syngnathid fish (seahorses and pipefish) have been recognised to hold significant environmental value and are listed under the EPBC Act. The Species Profile and Threats database lists syngnathid fishes as protected species.

Limited published information exists on the habitat preferences of syngnathid fishes although they have an indicative range extending into Port Curtis and the surrounding regions. As no video recording or diving was performed during the field studies, no individuals were recorded in the area.

Cultural Heritage within Port Curtis

The World Heritage and National Heritage listings pertaining to the Great Barrier Reef acknowledge the presence, generally, of Indigenous cultural heritage values within these areas.

Queensland cultural heritage registers and databases indicate the study area contains a number of stone artefact sites, some scarred trees and a shell midden. Further sites may be uncovered when a comprehensive examination is undertaken with the Aboriginal parties of the areas to be disturbed by the project.

Beyond the known and potential further sites within the study area, the following places in the Gladstone region are generally considered to contain Indigenous cultural heritage values:

- The marine ‘spiritscape’ within and around Port Curtis.
- The Great Barrier Reef marine area including The Narrows.

Two geotechnical investigations were carried out within the project area and determined that sites currently identified within the study area, when measured against registered sites and those recorded in other literature, are neither unrepresented elsewhere, nor of such order to be described as outstanding examples of site-types of which the loss would be scientifically unacceptable. No non-Indigenous sites of ‘national significance’ have been identified within the study area.

5.2 National Heritage Places

The National Heritage List records natural, historic and Indigenous places of outstanding national heritage value to the Australian nation. The EPBC Act includes provisions to identify and enhance the protection, conservation and presentation of Natural Heritage places. The Australian Heritage Council deemed the Great Barrier Reef met five National Heritage List criteria and entered the Great Barrier Reef on the list on 21 May 2007. Both World Heritage and National Heritage listings extend over the same geographic area.

The criteria, and the basis on which the Australian Heritage Council deemed that the place meets the criteria, is as follows:

- Criterion A: Events, Processes. The place has outstanding heritage value to the nation because of the place’s importance in the course, or pattern, of Australia’s natural or cultural history. The determination by the World Heritage Committee that the place meets World Heritage criteria (vii), (viii), (ix) and (x) satisfied this criterion.
- Criterion B: Rarity. The place has outstanding heritage value to the nation because of the place’s possession of uncommon, rare or endangered aspects of Australia’s natural or cultural

history. The determination by the World Heritage Committee that the place meets World Heritage criterion (x) satisfied this criterion.

- Criterion C: Research. The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history. The determination by the World Heritage Committee that the place meets World Heritage criteria (viii), (ix) and (x) satisfied this criterion.
- Criterion D: Principal Characteristics of a Class of Places. The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of:
  - A class of Australia's natural or cultural places; or
  - A class of Australia's natural or cultural environments.

  The determination by the World Heritage Committee that the place meets World Heritage criteria (viii), (ix) and (x) satisfied this criterion.
- Criterion E: Aesthetic Characteristics. The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group. The determination by the World Heritage Committee that the place meets World Heritage criterion (vii) satisfied this criterion.

The official values of the Great Barrier Reef recognised on the Natural Heritage List have been derived from the World Heritage listing. Potential significant impacts on world heritage values are discussed in Section 5.1 and equally apply to National Heritage values.

5.3 Threatened Ecological Communities

Threatened Ecological Communities are listed under the EPBC Act in conservation categories detailed below:

- Critically endangered.
- Endangered.

The EPBC Protected Matters Searches, literature review and field surveys identified four threatened ecological communities as being present or potentially present in and adjacent to the project area, based on their likelihood of occurrence according to distribution. Specific to project infrastructure relating to EPBC referral 2009/5008, the critically endangered ecological community littoral rainforest and coastal vine thickets of eastern Australia was located on the eastern side of Hamilton Point but over 1 km away from project infrastructure associated with this referral.

The ecological community of semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions ('endangered') was deemed likely to occur adjacent to the study area by the literature review. Field surveys failed to locate it within the study area, but communities of semi-evergreen vine thicket of the Brigalow Belt were observed on the foothills and lower slopes of Mount Larcom (approximately 25 km away).

The remaining two communities are unlikely to occur within the project area as identified during the literature review.

Table 5.2 summarises the listed ecological communities along with their likelihood of occurrence within the project area.

Table 5.2 Threatened ecological communities, their likelihood of occurrence, structure and location within the project area

Threatened Ecological Community	EPBC Status	Likelihood of Occurrence	Location and Structure of Community
Littoral rainforest and coastal vine thickets of eastern Australia	Critically endangered	Present	Located on the eastern side of Hamilton Point but well away from project infrastructure associated with referral 2009/5008.
Semi evergreen vine thickets of the Brigalow Belt (north and South) and Nandewar Bioregions	Endangered	Unlikely	Field surveys failed to locate it within the study area, but communities of semi-evergreen vine thicket of the Brigalow Belt were observed on the foothills and lower slopes of Mount Larcom (approximately 25 km away).
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	Unlikely	N/A – unlikely to occur in study area.
Weeping myall woodlands	Endangered	Unlikely	N/A – unlikely to occur in study area.

5.4 Protected Species

Protected species are listed under the EPBC Act in conservation categories detailed below:

- Extinct in the wild.
- Critically endangered.
- Endangered.
- Vulnerable.

Conservation listed species identified during database searches as potentially occurring within the study area are included in this assessment along with those species identified within the Protected Matters search to support the referrals for the project.

These species occur within the study area with varying regularity. Some are highly restricted in extent and habitat (e.g., Mount Larcom silkpod (*Parsonia larcomensis*), while others are widely distributed (e.g., squatter pigeon (*Geophaps scripta scripta*)) and others are nomadic and probably vagrant (e.g., Australian painted snipe (*Rostratula australis*)). Others were assessed within the literature review as being unlikely to occur within the study area, despite being identified within database searches.

Terrestrial Fauna Species

Twenty two terrestrial fauna species listed under the EPBC Act were identified as potentially occurring in the study area, through a combination of the EPBC Protected Matters search and database searches for technical studies undertaken for the Arrow LNG Plant. These species are outlined in Table 5.3, and include ten bird, six mammal and six reptile species.

None of the EPBC Act listed species identified in the database searches were recorded in field surveys undertaken for the project. Three species were identified as having a high likelihood of occurrence within the study area in the course of the literature review for the technical studies.

Squatter pigeon (*Geophaps scripta scripta*) was recorded at a number of locations on the mainland, during the project surveys, within 5 km of the study area. Areas of similar habitat present within the study area, including in the vicinity of the pipeline route on the mainland, makes the presence of the species likely. Other surveys (URS, 2009; QGC Pty Ltd, 2009; GAWB, 2008) have confirmed this to be the case, locating the species within or adjacent to the study area.

Grey-headed flying-fox is highly likely to be present within the study area, in areas of woodland such as inland of the mainland tunnel launch site, along the pipeline corridor. Water mouse (*Xeromys myoides*) is highly likely to be present in fringing mangroves adjacent to the mainland tunnel launch site and tunnel spoil disposal area, and its presence within Port Curtis on the Australia Pacific LNG Plant site has been confirmed (URS, 2009).

Marine Fauna Species

Ten marine fauna species listed under the EPBC Act were identified as potentially occurring in the study area, through a combination of the EPBC Protected Matters search and database searches for technical studies undertaken for the Arrow LNG Plant. These species are outlined in Table 5.3, and include six turtle, two whale and two shark species.

Loggerhead turtle (*Caretta caretta*), flatback turtle (*Natator depressus*) and green turtle (*Chelonia mydas*) all nest and forage within Port Curtis and there is a high likelihood of their presence within the study area, although nesting habitat in the project area is unsuitable for the species. The remaining three turtle species have a moderate likelihood of being present in the study area although Port Curtis is not in the main range of the species. The remaining species of marine fauna are unlikely to occur within Port Curtis and the study area.

Terrestrial Flora Species

Nine terrestrial flora species listed under the EPBC Act were identified as potentially occurring in the study area and are outlined in Table 5.3. All species identified were assessed as having a likelihood of occurrence within the study area of low to moderate and below.

Specimens of an unidentified species of *Cupaniopsis*, thought to be closely related to the threatened flora species, wedge-leaf tuckeroo (*Cupaniopsis shirleyana*), were identified within the study area during early field surveys on Boatshed Point, although away from infrastructure associated with referral 2009/5008. Wedge-leaf tuckeroo is assessed in the MNES assessment for referral 2009/5007.

Table 5.3 summarises the threatened flora and fauna species along with their likelihood of occurrence within the study area and the preferred habitat.

Figure 4 shows previously recorded locations and recently recorded locations of the threatened flora and fauna species which are potentially present within the study area.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds				
Australian painted snipe	*Rostratula australis*	Vulnerable	Low to moderate	Scattered distribution throughout Australia, usually found on shallow inland wetlands. Patches of suitable low-lying grassland habitat (conducive to water ponding) occur in the mainland section of the study area, in particular areas north of Fishermans Landing.
Herald petrel[1]	*Pterodroma heraldia*	Critically endangered	Low	Marine pelagic species occurring in tropical and subtropical waters of Pacific Ocean. Unsuitable habitat and outside of species range.
Kermadec petrel (western subsp.)	*Pterodroma neglecta neglecta*	Vulnerable	Low	Marine pelagic species occurring in southern Pacific Ocean. Unsuitable habitat and outside of species range.
Squatter pigeon (southern)	*Geophaps scripta scripta*	Vulnerable	High	Inhabits grassy understorey of open woodland. This species was observed frequently in disturbed pasture grassland and woodland within several kilometres of the mainland section of the study area. These habitat types occur throughout the study area.
Black-breasted button-quail	*Turnix melanogaster*	Vulnerable	Low to moderate	This species is restricted to coastal and near-coastal regions of south-eastern Queensland and north-eastern New South Wales. The main populations occur within south-east Queensland. Preferred habitat includes drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest.
Red goshawk	*Erythrotriorchis radiatus*	Vulnerable	Low to moderate	This species is very sparsely dispersed across coastal and sub-coastal Australia, from western Kimberley Division to northeastern NSW, and occasionally on continental islands. Habitat includes coastal and sub-coastal areas in wooded and forested lands of tropical and warm-temperate Australia. Small patches of suitable open forest/woodland habitat occurring throughout the study area.
Star finch (eastern), Star finch (southern)	*Neochmia ruficauda ruficauda*	Endangered	Very low	A recent expert review of the status has led to the subspecies being assumed extinct
Southern giant-petrel	*Macronectes giganteus*	Endangered	Low	Breeds on subantarctic islands in Australian territory. Unsuitable habitat and outside of species range.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Black-throated finch (southern subspecies) [1]	*Poephila cincta cincta*	Endangered	Low	Occupies grassy woodland dominated by eucalypts, paperbarks or acacias. The species appears to be out of range despite its inclusion in the Wildlife Online database. Patches of suitable woodland habitat exist adjacent to water sources throughout the study area.
Yellow chat (Capricorn subspecies) [1]	*Epthianura crocea macgregor*i	Critically endangered	Moderate	Inhabits wetlands and associated grasslands on seasonally inundated plains under marine influence. Degraded intertidal habitat along the eastern section of the mainland and southern parts of Curtis Island are unlikely to support this species. A known population exists to the north on Curtis Island.
Mammals				
Northern quoll	*Dasyurus hallucatus*	Endangered	Moderate	Inhabits a range of open woodland and open forest types. Patches of suitable vine thicket and open-forest/woodland habitat on rocky slopes occur along the range in the western portion of the mainland section, and suitable open-forest/woodland habitat within the Curtis Island section, may support this species.
Water mouse	*Xeromys myoides*	Vulnerable	High	Occurs in fringing mangroves in the high intertidal zone. Suitable intertidal habitat occurring along the mainland coastline and the north of Hamilton Point was found. Water mouse has been observed in surveys at the Australia Pacific LNG project site (Worley Parsons, 2011).
Large-eared pied bat, large pied bat	*Chalinolobus dwyeri*	Vulnerable	Low	The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, through to the vicinity of Ulladulla, NSW in the south. Habitat includes sandstone cliffs, fertile woodland valleys, rainforest and moist eucalypt forest at high elevation. Unsuitable roosting habitat and outside of known range.
Grey-headed flying fox	*Pteropus poliocephalus*	Vulnerable	High	Favours variety of woodland types in eastern Australia. Observed in numerous areas within several kilometres of the mainland section of the study area and in an area just south of Graham Creek on Curtis Island. Suitable foraging habitat occurs throughout the study area.
Semon's leaf-nosed bat[1]	*Hipposideros semoni*	Endangered	Low	Occurs from Cape York to Cooktown, but unconfirmed records as far south to Maryborough. Inhabits rocky escarpments and caves. Unsuitable habitat and outside of normal range.
Eastern long-eared bat[1]	*Nyctophilus timoriensis*	Vulnerable	Low	Confined to western slopes of Great Dividing Range in southeast Australia in variety of habitat types. Outside of normal range.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Reptiles				
Brigalow scaly-foot	*Paradelma orientalis*	Vulnerable	Moderate	Largely restricted to the Brigalow Belt bioregion, it extends from approximately 200 km southwest of Charters Towers, south to Bendidee National Park and Eena State Forest. More prevalent in habitats that have few weeds and that consist of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Patches of suitable vine thicket and open-forest/woodland habitat occurring throughout the study area may support this species. It has been recorded on Boyne Island in similar woodland habitat, approximately 12 km to the southeast (DSEWPC, 2011b).
Dunmall's snake[1]	*Furina dunmalli*	Vulnerable	Low	Most records occur in remnant vegetation including Brigalow, open woodland and even tall forests. Confined almost entirely to southern Brigalow Belt region. They may occur in any woodland or forest vegetation types, but are probably absent from disturbed vegetation. Outside of normal range.
Collared delma[1]	*Delma torquata*	Vulnerable	Moderate	This species ranges from Rockhampton in the north, south to Kenmore and inland to the Bunya Mountains. Preferred habitat includes rocky areas associated with dry open eucalypt forests, although the species has also been recorded from semi-evergreen vine thickets. Patches of suitable open-forest and woodland habitat occurring on slopes throughout the study area.
Ornamental snake[1]	*Denisonia maculata*	Vulnerable	Low	Favours brigalow woodland on clay and sandy soils. Unsuitable woodland and open-forest habitat growing on alluvial soils. Recorded approximately 15 km north on the mainland (GAWB, 2008).
Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle[1]	*Rheodytes leukops*	Vulnerable	Low	Favours fast flowing and clear water in Fitzroy River and Brigalow Belt. Unsuitable habitat and outside known distribution.
Yakka skink	*Egernia rugosa*	Vulnerable	Moderate	The yakka skink has a disjunct distribution, with isolated populations occurring from St George, north to Coen on Cape York Peninsula. Habitat includes dry forests and woodlands including poplar box alluvial soils, low ridges, cypress on sands, belah, mulga and *Eucalyptus intertexta*. Suitable dry open forest and woodland habitat occurring throughout the study area.
Marine fauna				
Loggerhead turtle	*Caretta caretta*	Endangered	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna (cont'd)				
Leatherback turtle	*Dermochelys coriacea*	Endangered	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Olive Ridley turtle	*Lepidochelys olivacea*	Endangered	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Flatback turtle	*Natator depressus*	Vulnerable	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Green turtle	*Chelonia mydas*	Vulnerable	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable	Moderate	Unsuitable nesting habitat and south of range. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Green sawfish	*Pristis zijsron*	Vulnerable	Low	Species occurs within Queensland waters, but predominantly north of Cairns and has not been recorded in eastern Australia south of Cairns for many years. Frequently observed in inshore muddy or sandy bottom habitats including estuaries.
Whale shark	*Rhincodon typus*	Vulnerable	Low	Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis. Inhabits both deepwater and shallow coastal waters.
Blue whale	*Balaenoptera musculus*	Endangered	Low	The species migrates past Australian coasts to feeding and breeding grounds in the northern hemisphere. Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Humpback whale	*Megaptera novaeangliae*	Vulnerable	Low	The Great Barrier Reef is a breeding ground for the species but it is unlikely the species will be found within Port Curtis.
Plants				
Yarwun whitewood	*Atalaya collina*	Endangered	Low	Small spreading tree in dry rainforest. Small population known only from Yarwun near Gladstone and Ubobo near Miriam Vale. Suitable habitat present but species restricted to small range outside study area.
Heart-leaved bosistoa/Three-leaved bosistoa	*Bosistoa selwyni/ B.transversa*	Vulnerable	Low	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. Marginally suitable habitat present in study area but no records from immediate region.

Table 5.3 Likelihood of EPBC Act listed species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Plants (cont'd)				
Miniature moss orchid	*Bulbophyllum globuliforme*	Vulnerable	Very low	Epiphytic orchid favouring (almost exclusively) the underside of upper branches of older *Araucaria cunninghamii* in primarily notophyll vine forests and Araucarian microphyll vine forests between 500-800 m altitude. Suitable habitat not present in study area.
Wedge-leaf tuckeroo	*Cupaniopsis shirleyana*	Vulnerable	Low to moderate	Shrub or small tree to 10 m in height from Maryborough district north to Mt. Larcom. Occurs in dry rainforest and scrubby open forest on steep slopes, screeslope gullies and rocky stream channels at elevations between 60-550 m. Suitable habitat present, and has been recorded within the region. An unidentified taxon sharing similar characteristics with this species recorded in infrastructure associated with referral 2009/5007, although status to be confirmed by Queensland Herbarium.
(a) Cycad	*Cycas megacarpa*	Endangered	Low to moderate	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. Suitable habitat present in study area and records within region.
Small-leaved denhamia	*Denhamia parvifolia*	Vulnerable	Low	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. Marginally suitable habitat present but not recorded in vicinity of study area.
Mount Larcom silkpod	*Parsonia larcomensis*	Vulnerable	Low to moderate	Creeping to ascendant climber to 5 m long in subtropical and dry rainforest and adjacent shrublands on cliffs or rocky outcrops. Suitable habitat present, and although the study area does not have the underlying geological requirements, the species is propagated readily by windblown fruit, so isolated specimens may become established.
Quassia	*Quassia bidwillii*	Vulnerable	Low to moderate	Shrub, often suckering from roots, in dry rainforest, vine thickets and lowland rainforests in disjunct populations north from Gympie district. Occasionally open forests adjacent to vine thicket communities, woodlands and fringing mangrove communities on a variety of geological substrates. Suitable habitat present, it has been recorded in similar habitat close to the study area.
Ribbon root orchid	*Taeniophyllum muelleri*	Vulnerable	Low	Common in shrubs and trees in rainforest, sheltered areas in open forest, humid gullies and streamside vegetation. Suitable habitat present, but no records in wider region.

Note1 – EPBC Status: Vulnerable (V), Endangered (E), Critically Endangered (CE).

Note2 – All species sourced from EPBC protected matters search tool unless stated (1 = other database searches in technical studies for project).

5.5 Protected Migratory Species

Sixty terrestrial species classed as migratory under the EPBC Act were identified in the database searches as possibly occurring within the study area (refer to Table 5.4). Forty five were bird species, seven reptile species and eight migratory marine species. Ten of these species were identified within or adjacent to the study area by other studies, and surveys for the Arrow LNG Plant located an additional ten EPBC Act listed migratory species during targeted surveys.

The majority of these species related to wetland bird species (terns, egrets and waders) which were found in various intertidal areas around Port Curtis, including the mudflats adjacent to the proposed mainland tunnel entry shaft and tunnel spoil disposal area. Other species included white-bellied sea-eagle (*Haliaeetus leucogaster*) which was recorded in several locations, including a likely nest on the western side of Hamilton Point, and rainbow bee-eater (*Merops ornatus*) which was recorded in a variety of habitat settings.

The likelihood of the presence of turtle species is discussed in Section 5.4. There are patches of suitable estuarine habitat for saltwater crocodile along the mainland coastline and southern section of Curtis Island. Most migratory marine species are unlikely to occur within the study area, with the exception of dugong. Large populations (estimated at 14,000 individuals) have been observed within the GBRMP, and their presence has attributed to the area being listed as World Heritage Area and the designation of the Zone B dugong protection area. The entire marine study area falls within the dugong protection area.

Other marine species listed are predominantly pelagic in nature, and found well offshore, hence are unlikely to occur within Port Curtis.

Table 5.4 summarises the migratory species along with their likelihood of occurrence within the study area and the preferred habitat.

Figure 4 shows locations of migratory species within the study area.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds				
Australian painted snipe	*Rostratula australis*	Migratory	Low to moderate	Scattered distribution throughout Australia, usually found on shallow inland wetlands. Patches of suitable low-lying grassland habitat (conducive to water ponding) occur in the mainland section of the study area, in particular areas north of Fishermans Landing.
Barn swallow	*Hirundo rustica*	Migratory	Moderate	Scarce visitor to northern Queensland. Favours open country and agricultural land, particularly those areas associated with water. Patches of suitable disturbed grassland habitat occur within the mainland section of the study area.
Bar-tailed godwit	*Limosa lapponica*	Migratory	Recorded (QGC, 2009)	A common migratory wader occurring across most of the Australian coastline. Found on coastal mudflats, sandbars, shores of estuaries and salt marsh. The species was observed on tidal mudflat less than 1 km from the northern boundary of the mainland section. Suitable intertidal habitat occurs along the mainland coastline and coast of Curtis Island.
Black-faced monarch	*Monarcha melanopsis*	Migratory	Moderate	Summer breeding migrant to southeast Australia preferring eucalypt woodlands, rainforests and coastal scrubs. Patches of suitable eucalypt woodland and vine thicket habitat occur throughout the study area.
Black-tailed godwit	*Limosa limosa*	Migratory	Moderate	Regular summer migrant to Australia. Found on tidal mudflats, estuaries, sand spits as well as shallow river margins. Patches of suitable intertidal habitat occur along the mainland coastline and coast of Curtis Island.
Broad-billed sandpiper	*Limicola falcinellus*	Migratory	Moderate	Uncommon summer migrant mostly to coastal Australia. Inhabits tidal mudflats, freshwater wetlands and saltmarsh. Patches of suitable intertidal habitat occur along the mainland coastline and coast of Curtis Island.
Caspian tern	*Hydroprogne caspia*	Migratory	Recorded (Arrow Energy)	Part-migratory, found over most of Australia. Occurs in coastal and offshore waters, mudflats, beaches and estuaries. The species was observed on tidal mudflat in the northern part of the mainland section. Suitable habitat occurs along the mainland coastline and the southern section of Curtis Island.
Cattle egret	*Ardea ibis*	Migratory	High	Usually associated with grazing cattle where it is found in stock paddocks, pastures, wetlands and tidal mudflats. Patches of suitable disturbed grassland habitat occur throughout the mainland section and suitable intertidal habitat occurs along the mainland coastline and coast of Curtis Island.
Common greenshank	*Tringa nebularia*	Migratory	Recorded (QGC, 2009)	Widespread migrant. Occurs across a range of inland and coastal habitats from billabongs, swamps and floodplains to mudflats and mangrove communities. This species was recorded on Curtis Island in another study, and is likely to occur around Port Curtis.
Common sandpiper	*Actitis hypoleucos*	Migratory	Moderate	Scarce summer migrant to eastern Australia inhabiting a variety of substrates on the edges of rivers and streams from coastal areas to far inland. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Cotton pygmy-goose	*Nettapus coromandelianus*	Migratory	Moderate	Considered a vagrant outside Queensland. Found on freshwater lakes, swamps and large water bodies. 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).
Curlew sandpiper	*Calidris ferruginea*	Migratory	Moderate	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. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Double-banded plover	*Charadrius bicinctus*	Migratory	Moderate	Annual winter migrant, mainly to southern Australia. Favours wide beaches, tidal mudflats, shallow saline and freshwater wetlands as well as paddocks with sparse vegetation. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Eastern curlew	*Numenius madagascariensis*	Migratory	Recorded (Arrow Energy)	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. The species was observed on tidal mudflats along the mainland coastline and on an exposed sandbar at Hamilton Point. Suitable intertidal habitat occurs throughout the study area along the mainland coastline, and southern section of Curtis Island.
Eastern osprey	*Pandion haliaetus*	Migratory	Recorded (Arrow Energy)	Large, fishing raptor distributed along most of the Australian coastline. Preferred habitat includes islands, coasts, bays and estuaries. The species was observed in the bay adjacent to the Southend barge landing and the southern tip of Hamilton Point. Suitable coastal habitat occurs along mainland coastline and the southern section of Curtis Island.
Eastern reef egret	*Egretta sacra*	Migratory	High	Distributed across much of the Australian coastline. Usually frequents rocky shores, islands, beaches, tidal rivers and mangroves. This species was observed on tidal mudflats approximately 7.5 km east of study area, south of the Southend township, Curtis Island. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Fork-tailed swift	*Apus pacificus*	Migratory	Recorded (QGC, 2009)	Aerial summer migrant. Occurs in airspace over a diverse range of habitats including rainforest and semi-arid desert. This species was recorded on Curtis Island in another study and is likely to occur anywhere within the study area.
Great egret	*Ardea alba*	Migratory	Recorded (Arrow Energy)	Widespread throughout Queensland. Occurs in wetlands, flooded pastures, dams and tidal mudflats. This species was observed on tidal mudflats in the northern part of the mainland within the study area. Patches of suitable low-lying disturbed grassland occurs throughout the mainland. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Great knot	*Calidris tenuirostris*	Migratory	Recorded (QGC, 2009)	Abundant across northern Australia. Prefers sheltered coastal mudflats of estuaries and inlets. Occasionally present on salt lakes, lagoons and saltworks ponds. This species was recorded on Curtis Island in another study and is likely to occur around Port Curtis.
Greater sand plover	*Charadrius leschenaultii*	Migratory	Moderate	Regular summer migrant. Favours a variety of habitats including tidal mudflats, mangroves, and saltmarsh. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Grey plover	*Pluvialis squatarola*	Migratory	Moderate	Regular summer migrant to coastal Australia and islands where it inhabits tidal mudflats, saltmarsh and estuaries. Patches of suitable intertidal habitat occurring along the mainland coastline and southern section of Curtis Island.
Grey-tailed tattler	*Heteroscelus brevipes*	Migratory	Recorded (QGC, 2009)	Common summer migrant. Prefers coastal areas, in particular mudflats and sand beaches. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Latham's snipe	*Gallinago hardwickii*	Migratory	Moderate	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. Patches of suitable disturbed grassland habitat occur throughout the mainland section of the study area.
Lesser sand plover	*Charadrius mongolus*	Migratory	Recorded (Arrow Energy)	Non-breeding migrant. Widespread along Queensland coastal areas. Inhabits tidal sandflats and mudflats. This species was observed on tidal mudflats along the southern boundary of the mainland section. Suitable intertidal habitat occurs along the mainland coastline and southern section of Curtis Island.
Little curlew	*Numenius minutus*	Migratory	Moderate	Summer migrant favouring floodplains, tidal mudflats and dry grasslands. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Little tern	*Sterna albifrons*	Migratory	Moderate to high	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. Suitable estuarine habitat occurs south of Fishermans Landing along the mainland coastline, and the southern section of Curtis Island.
Marsh sandpiper	*Tringa stagnatilis*	Migratory	Moderate	Common summer migrant to mainly coastal areas of Australia preferring wetlands, tidal mudflats and mangroves. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Oriental plover	*Charadrius veredus*	Migratory	Moderate	Regular summer migrant. Found in tidal mudflats and bare claypans, as well as margins of coastal marshes. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Oriental pratincole	*Glareola maldivarum*	Migratory	Moderate	Rare, nomadic wader. Found on plains, shallow edges of open wetlands, tidal mudflats and beaches. Patches of suitable habitat occur along the mainland coastline and southern section of Curtis Island.
Pacific golden plover	*Pluvialis fulva*	Migratory	Recorded (QGC, 2009)	Common migrant, disperses mainly to coastal areas such as tidal mudflats, beaches. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Rainbow bee-eater	*Merops ornatus*	Migratory	Recorded (Arrow Energy)	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. This species was observed in numerous habitats both within, and in close proximity to the study area. Suitable habitat occurs throughout the study area.
Red knot	*Calidris canutus*	Migratory	Moderate	Regular, widespread summer migrant. Occurs in tidal mudflats, sandflats, beaches, saltmarshes, as well as flooded pastures and ploughed lands. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Red-necked stint	*Calidris ruficollis*	Migratory	Recorded (QGC, 2009)	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. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Ruddy turnstone	*Arenaria interpres*	Migratory	Moderate	Regular summer migrant to coastal Australia preferring tidal reefs and pools, as well as mudflats. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Rufous fantail	*Rhipidura rufifrons*	Migratory	Recorded (Arrow Energy)	Breeding migrant to southeast Australia. Favours undergrowth of rainforests and wetter eucalypt forests, monsoon forests, paperbarks, coastal scrubs and mangroves. This species was observed in vine thicket habitat on Boatshed Point, Curtis Island. It was also observed several kilometres to the northeast of the mainland section of the study area in similar vine thicket habitat. Suitable habitats were found to occur throughout the study area.
Sanderling	*Calidris alba*	Migratory	Moderate	Regular summer migrant found on broad ocean beaches of firm sand, also inhabits tidal mudflats and coastal lagoons. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Birds (cont'd)				
Satin flycatcher	*Myiagra cyanoleuca*	Migratory	Recorded (URS, 2009)	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. This species was recorded on Curtis Island and similar habitat exists throughout the study area.
Sharp-tailed sandpiper	*Calidris acuminata*	Migratory	Recorded (QGC, 2009)	Abundant wader in southeast Australia. Inhabits mainly fresh or salt water wetlands. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Southern giant-petrel	*Macronectes giganteus*	Migratory	Low	Breeds on subantarctic islands in Australian territory. Unsuitable habitat and outside of species range.
Spectacled monarch	*Monarcha trivirgatus*	Migratory	High	Occurs along coastal northeast and eastern Australia. Prefers understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation. This species was observed in vine thicket habitat, several kilometres to the northeast 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*	Migratory	Recorded (QGC, 2009)	Common summer migrant found on coastal mudflats as well as sandbars, reefs and coastal swamps. This species was recorded on Curtis Island in another study and patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.
Whimbrel	*Numenius phaeopus*	Migratory	Recorded (Arrow)	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. This species was observed on tidal mudflat in several locations along the mainland coastline. Suitable intertidal habitat was also found along the southern section of Curtis Island.
White-bellied sea-eagle	*Haliaeetus leucogaster*	Migratory	Recorded (Arrow Energy)	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. This species was observed in numerous habitats both within, and in close proximity to the study area. Suitable habitat was found to occur throughout the study area.
White-throated needletail	*Hirundapus caudacutus*	Migratory	Recorded (QGC, 2009)	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. This species was recorded on Curtis Island in another study and may occur anywhere in the study area.
Wood sandpiper	*Tringa glareola*	Migratory	Moderate	Common summer migrant. Occurs in a variety of habitats including mangroves and the margins of mudflats subject to tidal inundation. Patches of suitable intertidal habitat occur along the mainland coastline and southern section of Curtis Island.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna				
Loggerhead turtle	*Caretta caretta*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Leatherback turtle	*Dermochelys coriacea*	Migratory	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Olive Ridley turtle	*Lepidochelys olivacea*	Migratory	Moderate	Unsuitable nesting habitat. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Flatback turtle	*Natator depressus*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Green turtle	*Chelonia mydas*	Migratory	High	Unsuitable nesting habitat. Commonly found within marine waters surrounding the study area. Species nest and forage within the GBRMP and Port Curtis.
Hawksbill turtle	*Eretmochelys imbricata*	Migratory	Moderate	Unsuitable nesting habitat and south of range. Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis.
Saltwater crocodile	*Crocodylus porosus*	Migratory	Moderate	Inhabits coastal swamps, rivers, estuaries and open sea along Queensland coast south to approximate Rockhampton although records in Port Curtis. Patches of suitable estuarine habitat occur along the mainland coastline and southern section of Curtis Island.
Whale shark	*Rhincodon typus*	Migratory	Low	Species occurs within Queensland waters, and has the potential to occur in marine waters surrounding Port Curtis. Inhabits both deepwater and shallow coastal waters.
Blue whale	*Balaenoptera musculus*	Migratory	Low	The species migrates past Australian coasts to feeding and breeding grounds in the northern hemisphere. Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Humpback whale	*Megaptera novaeangliae*	Migratory	Low	The Great Barrier Reef is a breeding ground for the species but it is unlikely the species will be found within Port Curtis.
Bryde's whale	*Balaenoptera edeni*	Migratory	Low	Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Killer whale	*Orcinus orca*	Migratory	Low	Likely to be in deeper offshore waters, and unlikely within Port Curtis.
Australian snubfin dolphin	*Orcaella heinsohni*	Migratory	High	The species favours shallow coastal waters, and may be observed in Port Curtis.

Table 5.4 Likelihood of EPBC Act listed migratory fauna species occurring in the study area (Cont'd)

Species		EPBC Act Status	Likelihood of Occurrence	Preferred Habitat and Location
Common Name	**Scientific Name**			
Marine fauna (cont'd)				
Indo-pacific humpback dolphin	*Sousa chinensis*	Migratory	High	The species favours shallow coastal waters, and may be observed in Port Curtis.
Dugong	*Dugong dugon*	Migratory	High	Known to be present within Port Curtis in dugong protection area.

Note1 – EPBC Status: Vulnerable (V), Endangered (E), Critically Endangered (CE).

Note2 – All species sourced from EPBC protected matters search tool.

6. POTENTIAL IMPACTS AND MITIGATION MEASURES TO AVOID OR REDUCE IMPACTS ON MNES

This chapter describes potential impacts and mitigation measures to avoid or reduce impacts on MNES. Impacts specific to the GBRWHA and Port Curtis National Heritage Place, threatened ecological communities, protected species and protected migratory species are discussed in relation to specific guidance within the policy statement on those subject areas. Further detailed assessment of the impacts is provided in the chapters and technical reports described in the EIS.

The approximately 9 km long feed gas pipeline will supply gas to the LNG plant on Curtis Island 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 section of pipeline crossing that traverses Port Curtis harbour, will be constructed in a tunnel to be bored under the harbour from the launch shaft to a reception shaft on Hamilton Point.

As the pipeline is to be constructed under the bed of Port Curtis, any potential impacts upon marine MNES below the low water mark, from the crossing are eliminated and therefore are not discussed further within this attachment. They are discussed further within the MNES document relating to referral 2009/5007. Potential impacts upon Port Curtis from work above the low water mark adjacent to the harbour, such as accidental spills, will be mitigated by implementing appropriate materials handling procedures and spill prevention and response plans.

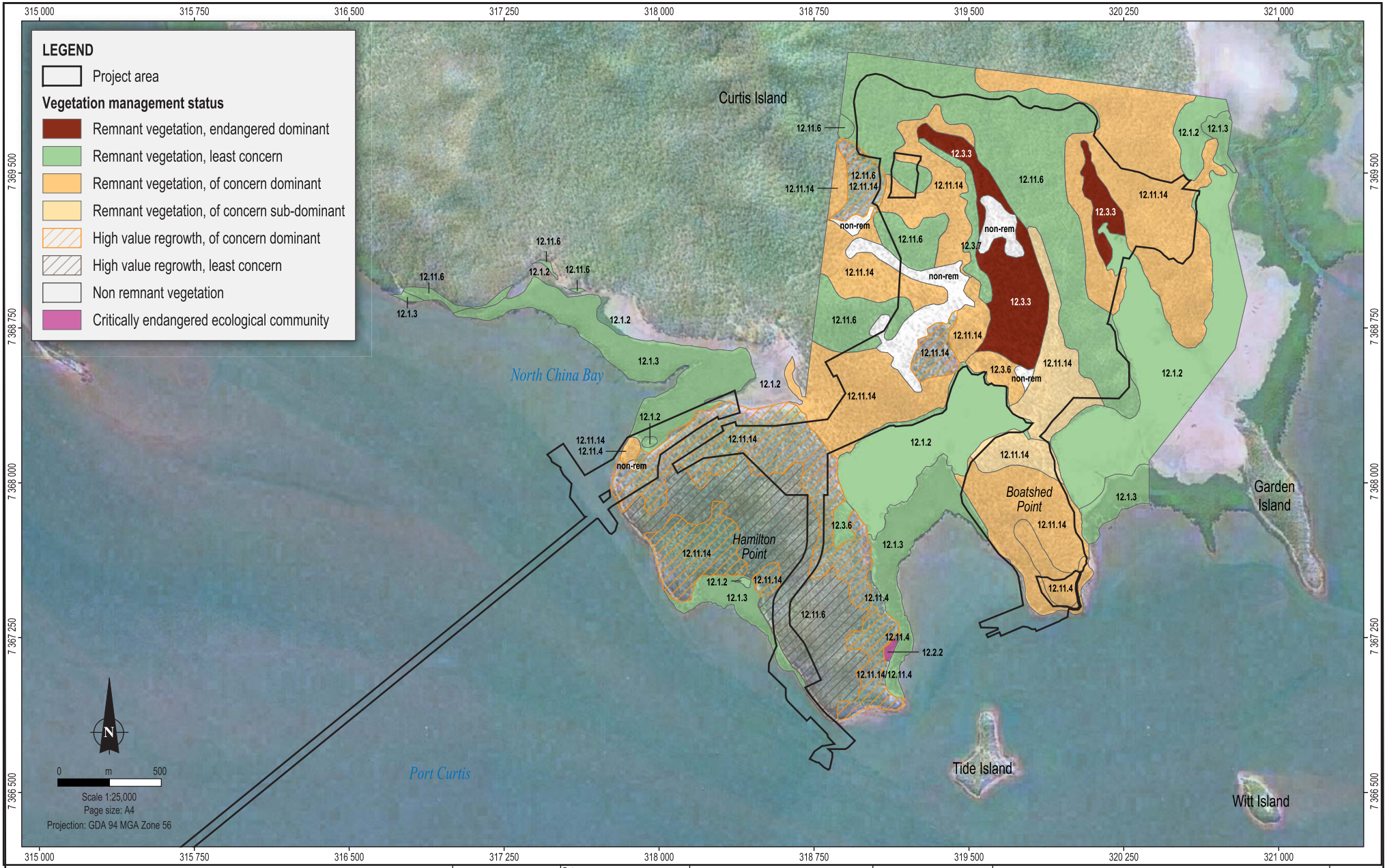
The construction of approximately 2.1 km of pipeline from the reception shaft on Hamilton Point to the LNG plant will require the transport of materials across Port Curtis to Curtis Island. However, the impact of the few vessel transfers required for this materials transport, and the daily vessel movement of the pipeline construction crew will be minimal in comparison to existing and planned vessel movements in Port Curtis, and all project vessels will comply with maritime law and project standards to reduce the impacts of these transfers.

The extent of habitat clearance is presented at the local, bioregion and state level. Habitat for listed species and communities has been identified by reference to regional ecosystems (RE), the system of classifying vegetation communities (and habitat) implemented under the *Vegetation Management Act 1999* (Qld). The distribution of REs in the study area is shown in Figures 5 and 6.

The areas of REs (vegetation communities/habitat) cleared as a result of project activities are expressed in hectares to show the amount of habitat proposed to be cleared by the project which is associated with a particular EPBC Act listed species. The clearance is also discussed cumulatively including in relation to other projects taking place in the Gladstone region, following the framework established in Chapter 32, Cumulative Impacts of the EIS.

In Section 6.3, clearance of REs is expressed as a proportion of the area of each community within the Gladstone Regional Council area, a facsimile for the area encompassed by sub-bioregions. This enables the scale of impacts on local vegetation communities to be clearly ascertained, and Arrow's contribution to these impacts to be established.

The proportion of clearance is also compared to the area of the vegetation communities mapped in Queensland. These figures are very similar to the figures given in Table 6.4 (Section 6.5) which place the clearance in the context of the amount of each RE within the Southeast Queensland bioregion. The figures are similar as the REs present in the project area are predominantly associated with the Southeast Queensland bioregion of Queensland.



Source:
Place names from DME.
Project area from Coffey Environments.
Vegetation management status (field validated) from Ecosure.
Imagery from SPOT (2004-2007).

coffey environments

Date: 25.11.2011
MXD: 7033CA_07_GIS145_v1_7
File Name: 7033_07_ATT4_F005_GIS_GL

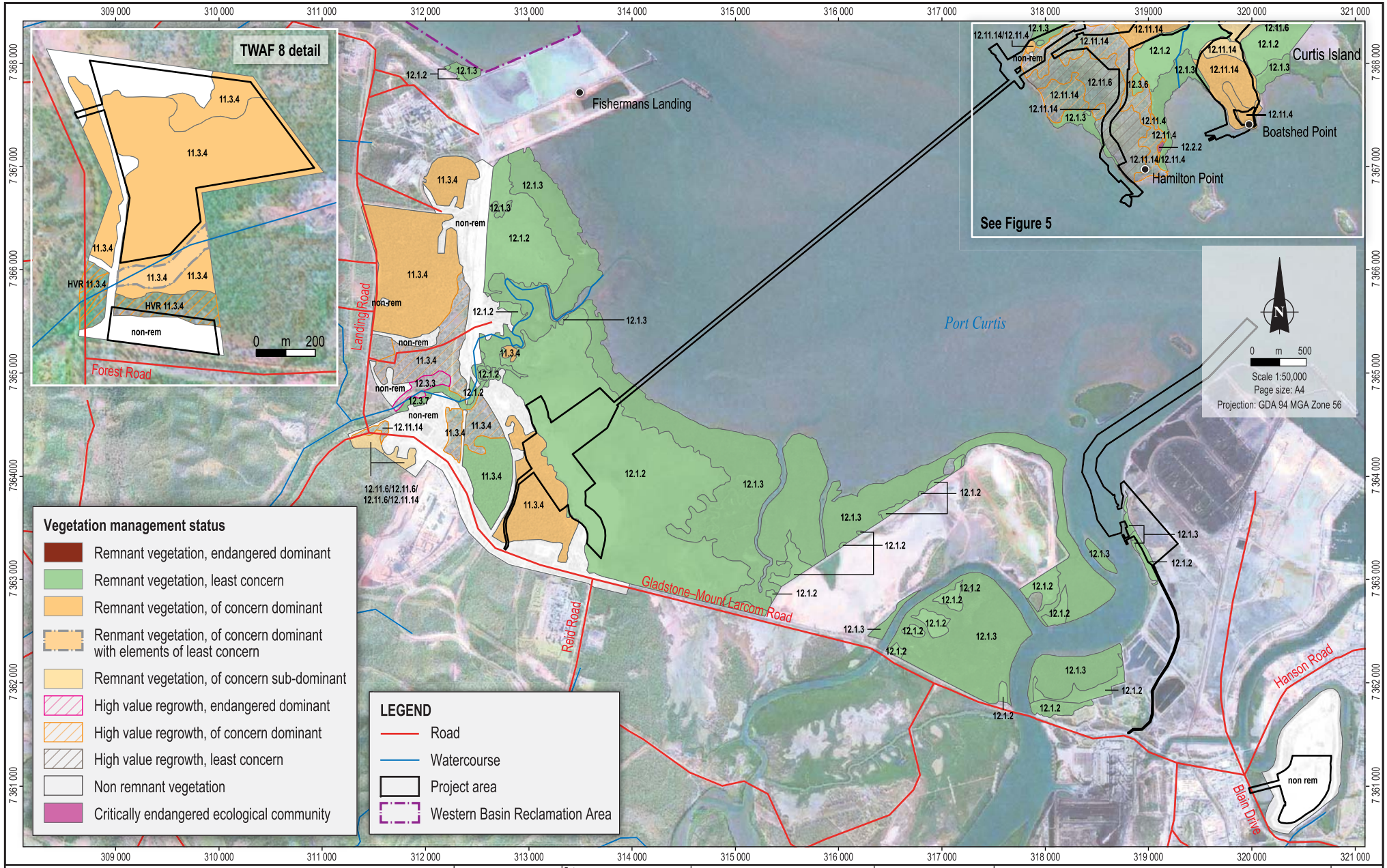
Arrow Energy

Arrow LNG Plant

arrow energy go further

EPBC Act-listed communities and field validated vegetation communities - LNG plant site

Figure No: 5



Source:
Place names, roads and watercourses from DME.
Project area from Coffey Environments.
Vegetation management status (field validated) from Ecosure
Western Basin Reclamation Area from Gladstone Ports Corporation.
Imagery from SPOT (2004-2007).

coffey environments

Date: 25.11.2011
MXD: 7033CA_07_GIS189_v1_6
File Name: 7033_07_ATT4_F006_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

EPBC Act-listed communities and field validated vegetation communities - mainland infrastructure

Figure No: 6

The mitigation measures presented in the EIS and this report are proven techniques for managing the identified impacts. They were proposed by technical specialists and have been reviewed by Arrow Energy and its FEED contractor to ensure they are technically feasible and can be effectively implemented. Mitigation measures that will be applied to the management of impacts on MNES are presented in Appendix 1 to Attachment 4. Specific mitigation measures developed to manage impacts on a particular species are repeated in the relevant section below. The mitigation measures form part of a suite of measures developed for the project. Attachments 6, 7 and 8 to the EIS contain a comprehensive list of all mitigation measures – expressed as commitments – developed for the management of project impacts.

6.1 GBRWHA and Port Curtis National Heritage Place

Approval under the EPBC Act is required for any action occurring within or outside a declared World Heritage property or Natural Heritage place that has, will have, or is likely to have a significant impact on the values of the property or the place.

An action is likely to have a significant impact on the World Heritage values of a declared World Heritage property or Natural Heritage place if there is a real chance or possibility that it will cause:

- One or more of the World Heritage or Natural Heritage values to be lost;
- One or more of the World Heritage or Natural Heritage values to be degraded or damaged; or
- One or more of the World Heritage or Natural Heritage values to be notably altered, modified, obscured or diminished.

As the Great Barrier Reef was placed on the National Heritage List due to its World Heritage listing and associated values, the potential for impact on World Heritage and National Heritage values are assessed together within this section.

The EPBC policy statement, gives examples of how an action is likely to be deemed to have a significant impact on natural heritage values of a World Heritage property or Natural Heritage place.

Table 6.1 summarises the World Heritage values that may be impacted by the project, and gives examples of key actions that may have an impact upon these values, and result in the impact being deemed as significant.

Table 6.1 Examples of Significant Impact on World Heritage or Natural Heritage Values

World Heritage Value	Actions
Geology or landscape values	• Damage, modify, alter or obscure important geological formations in a World Heritage property or Natural Heritage place. • Damage, modify, alter or obscure landforms or landscape features, for example, by excavation or infilling of the land surface in a World Heritage property or Natural Heritage place. • Modify, alter or inhibit landscape processes, by accelerating or increasing susceptibility to erosion, or stabilising mobile landforms, such as sand dunes, in a World Heritage property or Natural Heritage place. • Divert, impound or channelise a river, wetland or other water body in a World Heritage property or Natural Heritage place. • Substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants in a river, wetland or water body in a World Heritage property or Natural Heritage place.

Table 6.1 Examples of Significant Impact on World Heritage or Natural Heritage Values (cont'd)

World Heritage Value	Actions
Biological and ecological values	• Reduce the diversity or modify the composition of plant and animal species in all or part of a World Heritage property or Natural Heritage place. • Fragment, isolate or substantially damage habitat important for the conservation of biological diversity in a World Heritage property or Natural Heritage place. • Cause a long-term reduction in rare, endemic or unique plant or animal populations or species in a World Heritage property or Natural Heritage place. • Fragment, isolate or substantially damage habitat for rare, endemic or unique animal populations or species in a World Heritage property or Natural Heritage place.
Wilderness, natural beauty or rare or unique environment values	• Involve construction of buildings, roads, or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values. • Introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values.
Historic heritage values	• Permanently remove, destroy, damage or substantially alter the fabric of a World Heritage property or Natural Heritage place. • Extend, renovate, refurbish or substantially alter a World Heritage property or Natural Heritage place in a manner which is inconsistent with relevant values. • Permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a World Heritage property or Natural Heritage place. • Involve activities in a World Heritage property or Natural Heritage place with substantial and/or long-term impacts on its values. • Involve construction of buildings or other structures within, adjacent to, or within important sight lines of, a World Heritage property or Natural Heritage place which are inconsistent with relevant values. • Make notable changes to the layout, spaces, form or species composition in a garden, landscape or setting of a World Heritage property or Natural Heritage place which are inconsistent with relevant values.

Source: Matters of National Environmental Significance Significant impact guidelines 1.1 (Australian Government, 2009)

The impacts of the project on the World Heritage property and Natural Heritage place values identified within Section 5.1 are assessed in this section, in terms of the technical discipline areas within the EIS which informs this attachment.

Further detailed assessment of the impacts is provided in the chapters and technical reports described in Table 1.1.

6.1.1 Geology or Landscape Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to geology or landscape values, are described below. The impacts are a summary of those assessed in Chapter 11, Geology, Soils and Landforms and Chapter 23, Landscape and Visual of the EIS.

Geology, Landscape Features and Processes

Native vegetation and topsoil will be removed from the construction ROW to construct the feed gas pipeline. Topsoil will be removed to one or both sides of the construction ROW by a grader and stockpiled separately to the trench spoil to ensure topsoil and subsoils are not mixed. The construction ROW will be levelled to the required gradient using graders, excavators and bulldozers.

General impacts associated with the construction of the feed gas pipeline include erosion, reduction in soil quality and down-system sedimentation. The most significant impact will be the topographic

alteration of the project area. However, the project design avoids most steep slopes both on the mainland section or the Curtis Island section or will remove them through earthworks.

The project has been designed to limit the amount of excavation required on Curtis Island as far as is practicable to reduce the topographic impact. General mitigation measures have been developed in accordance with the industry standard management guidelines (International Erosion Control Association Best Practice Erosion and Sediment Control Manual (IECA, 2008), Australian Pipeline Industry Association Code of Environmental Practice for Onshore Pipelines (APIA, 2009)).

The visual and landscape areas in relation to MNES which are likely to be affected during construction of the feed gas pipeline include the GBRWHA and the areas listed under the Australian Register of the National Estate; which includes The Narrows, Garden Island Conservation Park and Mount Larcom Range. Garden Island Conservation Park is away from the proposed pipeline route, and shielded by the area north of Boatshed Point on which the LNG plant will be located, therefore will not be impacted by infrastructure associated with the feed gas pipeline referral 2009/5008.

Construction impacts on designated landscapes are largely associated with the significant clearance of vegetation, particularly on Curtis Island, and the effect this will have on the perception of Curtis Island as a natural landscape. However, clearance for the pipeline route will be limited to a 40 m construction ROW and associated access, and will be minimal compared to vegetation clearance for the Arrow LNG plant and other proponents clearing to the north on Curtis Island.

Lighting during construction can have a significant impact on landscape and visual receptors. Key light sources on Curtis Island during the construction phase are the perimeter security lights and construction vehicles.

For most visual receptors in Gladstone, the majority of the impact of additional light will be an increase in sky glow, although the contribution of lighting for the feed gas pipeline against that of the Arrow LNG plant and the other three LNG facilities on Curtis Island is minimal. These facilities will provide a lit context against which the lighting associated with the construction activities of the feed gas pipeline will appear less noticeable.

On the mainland, the pipeline alignment from the Arrow Surat pipeline to the mainland tunnel entry shaft and tunnel spoil disposal area is located out with the GBRWHA. However, there is still the potential for the altered landscape to impact upon visual receptors within the GBRWHA. The pipeline route will be on predominantly flat coastal plain, reducing the need for extensive earthworks. Clearance of dry sclerophyll forest and fringing coastal grasses will be required, although from a visual impact perspective, the area is already significantly industrialised with much linear infrastructure including pipelines, roads and railway lines. Construction lighting is largely away from visual receptors in Gladstone, and the majority of the impact of additional light will be a minimal increase in sky glow. Therefore the impact on landscape features from the perspective of the GBRWHA will be minimal.

Mitigation relating to impacts on geology, landscape features and processes will include:

- Limit clearing of vegetated areas to the project area. Areas will be stabilised and progressively rehabilitated to reduce prolonged exposure of soils [C11.05].
- Implement sediment and erosion control measures upslope of watercourses, wetlands and coastal areas or in areas with sodic soils to minimise increases in natural sediment discharge. Measures may include sediment traps, silt fencing, riprap, contour banks, detention dams, sediment ponds and vegetation and diversion berms [C11.11].

- Minimise night-time working and associated lighting impacts for activities (including construction of the LNG plant). Limit construction activities that need to be highly lit to daytime hours (to the greatest extent practical) [C23.20].

Waterbodies

For the construction of the feed gas pipeline on Curtis Island within the GBRWHA, it is not anticipated that any waterway crossings will be required. Therefore the impact upon freshwater waterbodies in the study area is anticipated to be minimal.

Erosion and increases in sediment loads to nearby watercourses will occur during rainfall and runoff events at all project sites as areas are cleared of vegetation and site preparation earthworks are carried out. Runoff from soil stockpiles will also carry sediment into watercourses. Increased erosion and sedimentation will be especially prevalent during heavy rainfall events. Stormwater may become contaminated with hydrocarbon or chemical residues in storage facilities such as bunds.

Runoff may carry oil and grease that has collected on access tracks and hard standing areas into watercourses. Spills of chemicals or fuels are also potential sources of contamination if they enter watercourses at project sites.

All these contaminants have the potential to enter the waterbody of Port Curtis, part of the GBRWHA. The tunnel spoil disposal area immediately adjacent to the GBRWHA will be designed to consider seawater inundation, drainage, management of acid sulfate soils and properties of intertidal mudflat sediments. The pad will be shaped to direct stormwater runoff to retention ponds located adjacent to the southern boundary of the site where, if necessary, runoff will be treated before discharge to the intertidal mudflats. This will ensure adequate separation of discharge points from Boat Creek and its associated estuarine ecosystem.

Mitigation relating to waterbodies will include:

- Train all relevant personnel in spill response and recovery procedures [C13.13].
- Prior to construction commencing, develop a site drainage plan to define how the civil construction will address site drainage, stormwater management, erosion control and stockpile placement. Risks relating to flood events will also be addressed with appropriate mitigation measures to minimise erosion and surface water quality issues [C11.16].
- Store fuels, chemicals and hazardous wastes in appropriately sized bunded storage facilities (in leak proof sealed containers) [C14.04].
- Develop an emergency response plan for the project and include spill contingency or emergency measures. Make material safety data sheets available at the LNG plant and other project sites to aid in the identification of appropriate spill clean-up and disposal methods [C31.47].
- Where works are required in watercourses, they will be confined to reduced width construction right of ways that preserve, to the extent possible, the integrity of the riparian vegetation and any associated wildlife corridors [C13.22].
- Where waterway crossings are necessary, cross ephemeral streams in preference to permanent streams, where practical. Where pipeline waterway crossings are necessary, approach stream crossings perpendicular to the stream where possible to reduce bank erosion risk and minimise the footprint within the bed and riparian zone [C13.16].

6.1.2 Biological or Ecological Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to biological or ecological values, are described below. The impacts are a summary of those assessed in Chapter 17, Terrestrial Ecology and Chapter 19, Marine and Estuarine Ecology of the EIS.

Loss or fragmentation of habitat – marine areas

Marine and estuarine habitat (saltmarsh vegetation) will be disturbed or fragmented by project infrastructure (at the mainland tunnel entry shaft and tunnel spoil disposal site). Adjacent areas have the potential to be affected by sedimentation from construction equipment outside the footprint area, although Arrow will implement mitigation to prevent access to the saltpans and fringing mangroves outside the planned area of disturbance at this site.

The project has sought to reduce the impacts on mangroves by siting the mainland tunnel entry shaft and tunnel spoil disposal site approximately 60 m inland of the mangroves fringing the mudflats at this site. Mitigation to reduce the impacts from loss or fragmentation of marine habitat includes detailing the inspection and monitoring procedures to be applied during construction in relevant management plans for the project (including a construction management plan, marine offsets management strategy, dredge management plan, rehabilitation management plan and shipping activity management plan), including periodic monitoring of any habitat replaced as a part of the offset strategy.

Arrow has also committed to establishing a marine offsets strategy – in accordance with relevant Queensland legislation – for the project to compensate for the loss of marine and estuarine habitat as a result of the project [C19.02].

Loss or fragmentation of habitat – terrestrial areas

Vegetation will be cleared by the construction of project infrastructure. No threatened ecological community listed under the EPBC Act, or endangered regional ecosystems under the *Vegetation Management Act 1999* (Qld) will be cleared for the pipeline infrastructure elements of the project.

Vegetation clearance on Curtis Island, will include an area of the 'Of Concern' RE 12.11.14. The areas of RE 12.11.14 that were identified on the northern and eastern slopes of the Hamilton Point headland along the pipeline alignment, 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.

Potential impacts from the clearance of vegetation include possible loss of individuals of flora and fauna species of conservation significance, the loss of scattered remnant trees, including hollow-bearing trees utilised by terrestrial fauna species for roosting and nesting and loss of foraging areas, breeding sites and shelter.

Site access and construction activities will clear vegetation possibly used by wildlife as corridors resulting in a loss of connectivity between habitats. Linear infrastructure, such as the feed gas pipeline has the potential to create smaller disconnected patches of vegetation, and possible isolation of flora and fauna populations leading to increased vulnerability to local extinction due to stochastic events (such as fire) and decreased genetic diversity in the long term. Vegetation integrity may be lost particularly along the margins of remaining areas of vegetation as a result of increased light penetration, and possible additional impacts of disease occurrence, altered water flows and weed invasion.

Vegetation on Curtis Island has already been subject to cattle grazing and continued grazing by feral horses and pigs and this pressure has resulted in degraded ecosystems with limited habitat value.

Mitigation to reduce the impacts from loss and fragmentation of terrestrial habitat include:

- Conduct pre-clearance surveys across project areas to be cleared of vegetation. The surveys will aim to determine whether any threatened species are present at each site. Appropriate mitigation measures will be implemented if threatened species are confirmed within the area [C17.25].
- Reduce vegetation clearing where practical and only after all other options such as selective clearing and trimming of vegetation have been considered [C17.27].
- Locate construction equipment, lay-down areas, turn-around areas, stockpiles and working areas within areas of existing disturbance where practical [C17.15].
- Develop fauna relocation protocols as part of fauna management measures including procedures if fauna is found during clearing activities, including in hollows of trees to be felled [C17.07].
- Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present [C17.22].
- Clearly mark no go zones, where required, including the *Cupaniopsis* fenced area and the 'Critically Endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected) [C17.23].

Reduction or loss of terrestrial species or populations

Construction of the feed gas pipeline for the Arrow LNG Plant has the potential to impact upon terrestrial flora and fauna values through direct loss of habitat or disturbance to individual species or populations. This may be as a result of hydrological impacts or pollution, stringing and laying of pipelines with trenches acting as a barrier to fauna movement or entrapping species or disturbance from lighting and noise.

Lighting and noise can have direct and indirect impacts on fauna species, and result in ongoing disturbance to local fauna populations. Increased vehicle movements may cause direct mortality or injury. Impacts include:

- Roadkill or injury to native fauna due to increased traffic around construction sites.
- Disturbance of fauna species in areas immediately adjacent to construction sites, through noise and vibration, personnel and vehicle movements, dust and artificial lighting.
- Attraction to insects which in turn encourage insectivorous species such as frogs and reptiles, microbats and some birds such as frogmouths (*Podargus* sp.) and bush stone curlew (*Burhinus grallarius*) to feed on increased prey concentrations. However, species assemblages may change in an area with less adaptable species being out competed by more adaptable ones.
- Alteration of bird and frog species mating and nesting behaviours through increased lighting. Increased activity by these species depletes energy resources and lighting often disorientates bird species, including nocturnal migratory species.
- Displacement of migratory birds from mudflat areas adjacent to construction sites through increased noise. Birds may be deterred from foraging in areas immediately adjacent to worksites, thus impacting on the fuel reserves of these migratory species.

Mitigation to reduce the impacts to terrestrial species includes:

- Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:

  - Shield/direct the light source onto work areas where practical [C17.16].
  - Use long-wavelength lights, where practical, including use of red, orange or yellow lights [C17.17].
  - Lower the height of the light sources as far as practical [C17.18].

- Consider use of solar powered LED studs, or similar, in roadways and paths of travel as an alternative to permanent lighting, where practical [C23.22].

- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].

- Design construction lighting on the causeway at the mainland tunnel entry shaft and tunnel spoil disposal area to minimise impacts on roosting shorebirds, where practical. The lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas, where practical [C17.21].

6.1.3 Wilderness, Natural Beauty or Rare or Unique Environment Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to wilderness, natural beauty or rare and unique environment values, are described below. The impacts are a summary of those assessed in Chapter 16, Marine Water and Sediment, Chapter 21, Air Quality and Chapter 22, Noise and Vibration.

Noise

Construction of the feed gas pipeline on Curtis Island within the GBRWHA has the potential to create noise sources which will lead to substantial, long-term or permanent impacts on relevant values within the GBRWHA. Project construction and operation activities will comply with project noise criteria assuming implementation of the identified mitigation measures and acoustic treatments.

Mitigation relating to noise includes:

- Ensure that project related noise generated during operations complies with the project noise criteria at all assessment locations [C22.07].

- Where practical, locate noise making equipment to maximise the distance between noise sources (e.g., diesel generators) and sensitive receptors. The use of structures or natural topography to create barriers to noise may be used to lessen the noise impacts on sensitive receptors [C22.02].

- Regularly maintain all machinery and equipment and check for excessive noise generation [C22.04].

- Where noise from a construction activity would exceed the project night time noise criteria of 45 dB(A) at a sensitive receptor, schedule, where practical construction activities to occur between 7:00 a.m. and 10:00 p.m [C22.05].

Air Quality

Emissions to the atmosphere during the construction period will consist of fugitive dust generated during earthworks (due to vegetation and soil removal, and wind erosion of exposed surfaces, soil stockpiles and spoil), together with exhaust emissions (from construction vehicles and earthmoving equipment, operation of a concrete batching plant and minor emissions from welding fumes). These sources will temporarily increase the local concentrations of airborne particulate matter and combustion gases.

The design will comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas.

Mitigation relating to air quality includes:

- Design the LNG plant to comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas [C21.01].
- Maintain construction vehicles and equipment regularly to reduce exhaust emissions [C21.08].

6.1.4 Historic Heritage Values

A summary of the impacts and mitigation measures relevant to the GBRWHA, pertaining to historic heritage values, are described below. The impacts are a summary of those assessed in Chapter 24, Indigenous Cultural Heritage and Chapter 25, Non Indigenous Cultural Heritage of the EIS.

Indigenous Cultural Heritage

The World Heritage and National Heritage listings pertaining to the Great Barrier Reef acknowledge the presence of Indigenous cultural heritage values within these areas.

Search results from the DERM Indigenous Cultural Heritage Register and Database found Indigenous places are concentrated in the coastal development strip to the north of Gladstone and, given the extent of industrial development in the study area, are relatively low in number.

A number of Indigenous cultural heritage places and objects are situated within, or in close proximity to the project area. While no sites of 'national significance' have been identified within the study area, places or objects may hold significance to local Aboriginal parties.

When viewed exclusively from a scientific perspective, the impact of the Arrow LNG Plant on Indigenous cultural heritage is low. Many of the archaeological sites identified in the disturbance footprint can be found elsewhere in the region, and include numerous, directly comparable examples with scientifically low-order sites, many of which offer far more opportunity for detailed investigation and analysis than those currently known to exist within the study area.

Avoidance of Indigenous cultural heritage places and objects is the preferred management measure. The ability to relocate specific elements of the project is limited and some impacts will be unavoidable. If avoidance is not possible, the loss of sites in the study area would be offset by a suitable program of mitigation, which will include:

- Develop an approved CHMP or a native title agreement that addresses Aboriginal cultural heritage in consultation with the endorsed Aboriginal parties for the project [C24.01].
- Comply with the approved CHMP or native title agreement that addresses Aboriginal cultural heritage [C24.02].
- Consider the cultural heritage management principles set out in Section 7.2.3 of the Indigenous Cultural Heritage Impact Assessment completed for the project (Appendix 18 of the EIS) when developing a CHMP or native title agreement that addresses Aboriginal cultural heritage. Agree final principles with the relevant Aboriginal parties/native title parties [C24.03].

Non-Indigenous Cultural Heritage

Non-Indigenous cultural heritage impacts associated with the pipeline infrastructure element of the project generally relate to the clearing of land and earthworks for the construction of the feed gas pipeline. A small number of non-Indigenous heritage sites are located in the project area, particularly on the south western corner of Curtis Island. None of the sites are listed in any national, state or local council heritage register or heritage list, but may have local significance.

The standard heritage practice measures for managing impacts on non-Indigenous cultural heritage sites encompass avoidance, relocation, salvage, archival recording and interpretation. Other mitigation will include:

- Prepare a heritage management plan prior to construction which specifies how known and unknown heritage sites are to be managed during construction [C25.01].
- Include in the heritage management plan prepared prior to construction, requirements for accidental discovery, and management of cultural heritage items or human remains. Conflict resolution and other contingencies will also be addressed in the plan [C25.06].

6.1.5 Summary of Potential Impact

Impacts on geological values of the GBRWHA from the project are likely to be insignificant, as geological formations will not be affected by the project. The landscape of Curtis Island will be altered as a result of earthworks for the construction of the feed gas pipeline. Mitigation to control erosion and sedimentation will be implemented, and the pipeline route avoids steeper contours wherever possible. The impact on landscape processes will be localised and largely confined within the industry precinct designated for the LNG plants on Curtis Island.

Impacts from pollutants or contaminants entering waterbodies within the GBRWHA will be insignificant. Stormwater will be managed across all project sites during construction and operation and will assist in controlling the runoff of sediment and other pollutants.

Construction of the feed gas pipeline for the Arrow LNG Plant will remove regulated vegetation and habitat from the GBRWHA, although the proportions when compared to available habitat within the Gladstone area and bioregion are very small. It is not anticipated that the removal of vegetation will reduce the diversity or fragment, isolate or substantially damage remaining habitat for flora and fauna. Arrow Energy will produce an Offsets Plan which will be developed prior to construction, in consultation with DERM and the Department of Sustainability, Environment, Water, Population and Communities where impacts on ecological assets cannot be avoided or adequately mitigated.

Construction, operations and decommissioning of the feed gas pipeline will produce noise and air emissions. Emissions will meet relevant air quality and noise criteria and will not have a significant impact on the values of the GBRWHA.

Historic heritage values within the project area are generally low, with the few Indigenous cultural heritage sites on the registers being of low scientific value, although places or objects may hold significance to local Aboriginal parties. No non-Indigenous sites are listed in any national, state or local council heritage register or heritage list, but sites within the project area may have local significance.

The construction, operation and decommissioning of the Arrow LNG Plant will not lead to any values of the GBRWHA being lost. The project will have minor impacts to values of the GBRWHA on Curtis Island, such as clearance of vegetation and alteration of the landscape.

The GBRWHA has been considered in the assessment of impacts of the project and the development of mitigation measures and the environmental management plan for the project. Potential impacts on the values of the GBRWHA will be further considered in the further development of the design of the project.

6.2 Threatened Ecological Communities

The EPBC Protected Matters Searches, literature review and field surveys identified four threatened ecological communities as being present or potentially present in and adjacent to the project area, based on their likelihood of occurrence according to distribution.

Field surveys confirmed the presence of one threatened ecological community listed under the EPBC Act within the study area. This was the 'critically endangered' littoral rainforest and coastal vine thickets of eastern Australia. As discussed earlier, within the study area this community was represented by small pockets of low microphyll-notophyll vine forest, including a small pocket of vine forest situated on a small Holocene sand dune on the eastern side of Hamilton Point.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or;
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.
- Interfere with the recovery of an ecological community.

The community is located on the eastern margin of Hamilton Point, and is not within the project area. Therefore, the extent of the community will not be affected, cleared or fragmented as a result of the project. Habitat and abiotic factors within the community will not be altered by the project, and no burning or harvesting will take place.

Although roads and other infrastructure avoid the area on Hamilton Point, the asset could be vulnerable to weed infestation, trampling from increased personnel movement and potentially increased fire frequency. The presence of the critically endangered community was considered in project design, and haul route options at Hamilton Point were routed away from the eastern margin of

the headland to avoid the 'critically endangered' RE 12.2.2 ('Microphyll/notophyll vine forest on beach ridges') [C17.05].

In addition, the following mitigation will be implemented:

- Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present [C17.22].
- Clearly mark no go zones, where required, including the semi evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the 'critically endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected) [C17.23].
- Develop weed management measures prior to initiation of construction activities in accordance with local and regional management guidelines and best practice advice prescribed in DERM's pest control factsheet series [C17.09].
- Route the haul road for the Hamilton Point MOF option away from the eastern margin of the headland to avoid the 'critically endangered' RE 12.2.2 (Microphyll/notophyll vine forest) on beach ridges [C17.05].

6.2.1 Summary of Potential Impact

The project is not expected to have a significant impact on threatened ecological communities. Project infrastructure will avoid the area around the community on Hamilton Point, access will be prevented to the area and mitigation measures implemented to prevent weed invasion.

6.3 Protected Species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species.
- Reduce the area of occupancy of an important population.
- Fragment an existing important population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of an important population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere substantially with the recovery of the species.

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal.
- Populations that are necessary for maintaining genetic diversity.
- Populations that are near the limit of the species range.

As discussed in Section 3.2, the likelihood of a species being present within the study area was assessed within the technical studies. All species with a rating of low to moderate and above (therefore considered possible to occur within the project area) are assessed in the sections below against the relevant significant impact criteria from the EPBC guidance note, and using information from the Species Profile and Threats Database maintained by the Commonwealth Government to provide information about species and ecological communities listed under the EPBC Act. All other species were considered not possible within the project area as a result of a lack of suitable habitat, or being outside of the species normal range, and therefore are not assessed further. The precautionary approach ensures that species that could potentially occur, despite marginal habitat or being known only from the wider region, are considered below.

No terrestrial flora or fauna species listed as critically endangered, endangered or vulnerable under the EPBC Act were identified through field surveys within the study area for the project. However, the following species, based on habitat preference and distribution, may occur within the project area.

Potential impacts from the project on terrestrial flora and fauna are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

6.3.1 Terrestrial Fauna

A total of 11 terrestrial fauna species identified in database searches were, after further desktop review and field survey, thought to possibly occur within the project area. None of these species were identified in the project area through the course of field surveys for the project.

Australian Painted Snipe

The Australian painted snipe has a 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. Its habitat includes small islands where it prefers to build nests and although more common in southeast Australia and ephemeral wetlands in inland areas, there are records from across Queensland. It can be a permanent resident but is more likely to be nomadic, temporarily occupying suitable habitat areas. It can be found in loose colonies, although it is more likely to be found in small polyandrous groups or as breeding pairs.

There are no ephemeral wetlands on or adjacent to the feed gas pipeline alignment. Ephemeral wetlands occur inland of the coast and north of Fisherman's Landing in low-lying grassland areas.

The Species Profile and Threats database (DSEWPaC, 2011b) lists key threats for the Australian painted snipe as loss and degradation of wetland habitat (including decline in water quality and

invasion by noxious weeds) and predation from feral fauna species such as red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) as the species nests on the ground.

The feed gas pipeline alignment for the Arrow LNG Plant does not pass through suitable wetland habitat for this species, as no freshwater wetlands are impacted by the project. Therefore the loss of wetland habitat will not be an impact of the Arrow LNG Plant. The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement the measures outlined in the pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora on this and other species.

There is no recovery plan for Australian painted snipe.

Significant Impact Criteria – Australian Painted Snipe

1) Lead to a long-term decrease in the size of an important population of a species.

   While low lying grassland on the mainland and Curtis Island provides habitat for the species, the habitat in the study area is patchy and the species was not observed in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) notes that it has been mainly recorded in the Murray-Darling region, Southeast Queensland and in the southeastern states.

   The likelihood of Australian painted snipe being present in the study area is low, as suitable freshwater wetland habitat is not present. Although patchy marginal habitat is present within the study area, the species is likely to only be present in such areas on a transitory basis on very rare occasions.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   The Australian painted snipe was not observed in the study area which contains patchy habitat. The feed gas pipeline alignment does not traverse suitable habitat for the species. For these reasons, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   The species was not observed in the study area which contains patchy habitat for the species. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The study area contains patchy habitat for the Australian painted snipe which was not observed in surveys carried out for the project. The feed gas pipeline alignment does not traverse suitable habitat. Project activities will not adversely affect habitat critical to the survival of the species because there is a lack of suitable habitat.

5) Disrupt the breeding cycle of an important population.

   As suitable habitat is patchy and will be avoided by construction and operation activities for the feed gas pipeline, and no birds were observed in the field surveys, project activities will not disrupt the breeding cycle of an important population of the Australian painted snipe.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The Australian painted snipe favours shallow inland wetland habitats, which are either permanently or temporarily filled. Ephemeral wetlands occur inland and north of the mainland tunnel launch site, in cleared and partially cleared farmland. The wetlands are patchy and the quality of the habitat is dependent on land use which varies from grazing to horticulture to hobby farms. No ephemeral wetlands will be affected by construction and operation of the feed gas pipeline. Consequently, project activities will not cause the species to decline as a result of modification or loss of quality habitat.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive species (both flora and fauna) have been identified as a key threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to Australian painted snipe. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No habitat suitable for the species will be lost as a result of project activities. Therefore, project activities will not interfere with the recovery of the species.

It is unlikely that any impacts from the project upon Australian painted snipe are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of habitat, and measures will be implemented to reduce the impacts of pest flora and fauna species as a result of the project.

No Australian painted snipe have been identified in the study area for the Arrow LNG Plant. The species is nomadic and typically found on ephemeral wetlands in inland areas, rarely visiting coastal areas. As such, the species is likely to be a very infrequent visitor to the Gladstone region, and should it occur, it will be found in suitable freshwater wetland areas away from the project area. No areas were identified as habitat critical to the survival of the species.

No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this, and other, species. In conclusion, impacts on the Australian painted snipe from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no birds were observed and no suitable freshwater wetland habitat will be removed by the project.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or

individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Black-breasted Button-Quail

The black-breasted button-quail populations are small and isolated and in Queensland are confined to restricted habitat in the southeast Queensland Bioregion. Up to 14 groups have been identified with the most significant populations found in the Jimna-Conondale Range, Yarraman-Nanango and Great Sandy regions of Queensland (DSEWPaC, 2011b). It is found to favour 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.

The species' distribution and range is limited by vegetation clearing for forestry and agricultural developments. Other threats include fragmentation of remaining habitat by grazing by cattle, horses and feral pigs, loss of shrubby understorey from frequent fire events and predation by cats, foxes and pigs.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline is unlikely to result in reduced habitat within the range of the black-breasted button-quail, as dry rainforest and vine thicket habitat will not be cleared along the feed gas pipeline alignment. Patches of vine thicket are located west of the mainland tunnel launch site, on Hamilton Point north of the feed gas pipeline alignment and on the southern sections of Hamilton Point and Boatshed Point, which are avoided by the feed gas pipeline.

The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Black-breasted Button-Quail

1) Lead to a long-term decrease in the size of an important population of a species.

   While the small patches of vine thicket found on the mainland in the western half of the study area provide suitable habitat for the species, no birds were observed in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any populations in the Gladstone region, as being of importance for the species. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were observed in the study area and no habitat (vine thicket) that has been identified as having a moderate or higher likelihood of this species occurring will be cleared for project infrastructure. Consequently, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by individuals not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

The black-breasted button-quail was not observed in the study area. Suitable habitat exists only as small isolated patches with no connectivity to large tracts of habitat. As no areas of vine thicket or dry rainforest habitat suitable for the species will be removed for the project infrastructure associated with the feed gas pipeline, project activities will not adversely affect habitat critical to the survival of the black-breasted button-quail.

5) Disrupt the breeding cycle of an important population.

   Important populations occur in the Jimna-Conondale Range, Yarraman-Nanango and Great Sandy regions of Queensland (DSEWPaC, 2011b). No individuals were identified in the study area which is remote from areas occupied by the 14 main groups in Queensland. Potential suitable habitat occurs as patches not connected to larger tract of similar vegetation. Therefore, project activities will not adversely affect habitat critical to the survival of the species.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The black-breasted button-quail favours vine thicket habitat. Within the study area, the species has been identified as having a low to moderate likelihood of occurrence within RE 12.11.4. The location of this RE within the study area is shown in figures 5 and 6. This vegetation community will not be cleared for construction and operation of the feed gas pipeline. Project activities will not modify or remove quality habitat to the extent that it would cause the species to decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   The Species Profile and Threats database (DSEWPaC, 2011b) identifies invasive species (both flora and fauna) as a key threat to the species.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to black-breasted button-quail. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   The project will not result exacerbate threatening processes identified in the recovery plan for the species in areas of its range. The Arrow LNG Plant will not contribute towards the loss and fragmentation of habit and the impact from pest flora and fauna will be negligible, as the species is unlikely to be present in the study area.

The species was not identified in the study area in the course of surveys for Arrow Energy or any of the other LNG projects on Curtis Island. Desktop searches indicate that the species is not present in the region having undergone a significant range contraction, although if it does occur, it is likely to be found within vine thicket habitat such as RE 12.11.4.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts upon this species, should it occur in the project area. No offsets are required for this species, as the project area is outside its known range and suitable habitat (RE 12.11.4) is avoided by the feed gas pipeline alignment. RE 12.11.4 has been

identified as a likely area requiring to be offset as a result of vegetation clearance associated with the LNG facility component of the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for this RE will have benefits for this and other species potentially found within this RE, such as the black-breasted button-quail.

In conclusion, impacts on black-breasted button-quail from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no critical habitat has been identified and no suitable vine thicket or dry rainforest habitat will be removed by the feed gas pipeline.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Red Goshawk

The red goshawk is found in northern Australia and eastern Queensland where it requires a very substantial home range covering between 50 and 220 km^2. It is very sparsely dispersed across approximately 15% of coastal and sub-coastal Australia, from western Kimberley to northeastern NSW. The largest densities of the species have been reported from the Northern Territory and the Kimberley region of Western Australia. It utilises a variety of habitat types including tall open forest, woodland, savannah with scattered trees and the edge of rainforest, favouring areas near rivers and a mosaic of forest types.

Open forest and woodlands of the study area provide suitable habitat for the red goshawk. It is possible the species could be found in the patches of open forest and woodland.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss (deforestation of lowland and riverine forests), illegal egg collecting and potential threats such as changes in land management, persecution, disease and application of pesticides which may result in shell thinning.

Potential impacts from the Arrow LNG Plant feed gas pipeline may include loss of foraging habitat through the clearance of eucalypt woodland. However, the loss of the foraging habitat is small in comparison to similar habitat available in adjacent areas, and the habitat on and adjacent to the pipeline alignment is sub-optimal for the species. Further, construction of a haul road for the GLNG Project adjacent to the pipeline alignment on Curtis Island will reduce the potential food resource of this area.

There is no recovery plan for the red goshawk.

Significant Impact Criteria – Red Goshawk

1) Lead to a long-term decrease in the size of an important population of a species.

   Ecological surveys for the Arrow LNG Plant and other LNG projects did not identify the red goshawk in or adjacent to the study area, and there are no records of sightings in the Gladstone region. Consequently, project activities will not lead to a long-term decrease in the size of an important population of the red goshawk.

2) Reduce the area of occupancy of an important population.

   No birds or nests have been recorded or found in surveys carried out for the Arrow LNG Project and other LNG projects. As similar, more intact foraging habitat is available in adjacent areas,

particularly the Curtis Island Environmental Management Precinct, Targinie State Forest and conservation reserves on Curtis Island, project activities will not reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   Habitat to be cleared for the Arrow LNG Plant feed gas pipeline is sub-optimal foraging habitat for the red goshawk. This is reinforced by the lack of evidence of visitation in the study area (mainland and Curtis Island) and adjacent areas on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   Suitable habitat for the red goshawk on the mainland and Curtis Island is sub-optimal which is supported by the lack of sightings of the species in and adjacent to the study area. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any critical habitat or important populations of the species, and there are no records on Curtis Island or the adjacent mainland (Garnett *et al*, 2011). The area of sub-optimal habitat lost as a result of project activities is small in comparison to the area of suitable habitat in adjacent areas including conservation reserves. Consequently, project activities will not adversely affect habitat critical to the survival of the red goshawk.

   The species favours a range of woodland habitats, with a mosaic of vegetation types, large prey populations (birds), and permanent water. No large areas of habitat suitable for the species will be removed for the project infrastructure. The loss of eucalypt woodland habitat on Curtis Island is small in comparison to similar habitat in the surrounding area.

   Although unlikely, should the species be present on Curtis Island it is likely to be in the more extensive habitat of varying quality, in undisturbed areas in the north of the island in the vicinity of wooded watercourses.

5) Disrupt the breeding cycle of an important population.

   No nests were identified in surveys for the Arrow LNG Plant and other LNG projects. Consequently, project activities will not disrupt the breeding cycle of an important population of the red goshawk.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Construction and operation activities for the Arrow LNG Plant will result in the loss of suitable habitat for the red goshawk. However, the habitat has been assessed as sub-optimal. Further, construction of a haul road for the GLNG Project adjacent to the feed gas pipeline alignment on Curtis Island has potentially reduced food resources in that area. Clearance of vegetation (and habitat) for the Arrow LNG Plant will not lead to a decline in the red goshawk because the lack of historic records and sightings indicates it is not known in the area, or a very infrequent visitor.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   No invasive flora or fauna has been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has been identified as a key threat to the red goshawk, as has the application of pesticides, the effects of which result in thinning of egg shells. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and sub-optimal habitat will be lost to the project, proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for such species as the red goshawk.

It is unlikely that any impacts from the project upon red goshawk are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of critical habitat, and the potential impact from disease will be unlikely due to the implementation of pest and quarantine management plans for the project.

There are no historic records of the species in the Gladstone area and the species was not identified in the study area in the course of surveys for Arrow Energy or any of the other LNG projects. Although it is a secretive species, it is highly unlikely to be present based on the available sub-optimal habitat and adjacent GLNG Project construction activities. The loss of sub-optimal habitat is small in comparison to suitable habitat in adjacent areas including the Curtis Island Environmental Precinct and Targinie State Forest on the mainland. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

In conclusion, impacts on the red goshawk from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as there are no historic records of the species in the area and no individuals were observed in recent surveys. Further, the sub-optimal habitat to be cleared for the project is small in comparison to the potential foraging habitat available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Squatter Pigeon

The squatter pigeon inhabits the grassy understorey of open woodland and is largely found on inland slopes of the Great Dividing Range. The species is nomadic in response to food and water resources.

This species was observed frequently in disturbed pasture grassland and woodland within several kilometres of the mainland section of the study area in surveys for the project. These habitat types occur throughout the study area, and as such it is likely to occur in the study area, including the woodland inland from the mainland tunnel launch site and tunnel spoil disposal area, through which the feed gas pipeline will run. The species could potentially be impacted by habitat loss, fragmentation and edge effects and direct disturbance from increased personnel and vehicle presence.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include the loss of habitat due to clearing for agricultural or industrial purposes, degradation of habitat

by grazing herbivores and excessive predation, particularly from pest fauna such as the red fox and feral cat.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline is unlikely to result in reduced habitat within the range of the squatter pigeon. Construction of the pipeline will necessitate clearance of eucalypt woodland on Curtis Island, and eucalypt woodland and coastal grassland on the mainland. However, this loss of habitat is small in comparison to the large extent of similar habitat in the surrounding Gladstone area. Eucalypt woodland vegetation communities to be cleared for the project comprise less than 1% of each of the regional ecosystems locally and in the bioregion, with two exceptions RE 11.3.4 (8.09% and 0.26% respectively) and RE 12.11.14 (5.72% and 0.66% respectively). The mainland tunnel launch site is partly located in RE 11.3.4. The feed gas pipeline alignment traverses RE 12.11.14 on Curtis Island, part of which has been cleared for the construction of the haul road for the GLNG Project.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for squatter pigeon.

Significant Impact Criteria – Squatter Pigeon

1) Lead to a long-term decrease in the size of an important population of a species.

   While eucalypt woodland and coastal grassland habitat on the mainland behind the mainland tunnel launch site and tunnel spoil disposal area is suitable habitat for this species, no individuals were identified in the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any local populations as being especially important to the long-term survival or recovery of the squatter pigeon.

   Due to the extent of similar habitat in adjacent areas, and the mobile nature of the species, it is unlikely that the project will result in a long term decrease in the size of the population, even if the local population were an important population.

2) Reduce the area of occupancy of an important population.

   No individuals were observed in the study area. Individuals were observed at sites within several kilometres of the study area. As no individuals were identified, project activities are highly unlikely to reduce the area of occupancy for an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by the squatter pigeon not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No areas of critical habitat have been identified on the Species Profile and Threats database (DSEWPaC, 2011b). While individuals were observed adjacent to the study area, none were observed in the study area. Vegetation communities within the study area include the wide range of habitats utilised by the squatter pigeon and it is highly likely the species might utilise the area periodically for foraging. However, as substantial tracts of similar habitat exist in the Curtis Island

Environmental Management Precinct, on Curtis Island generally and on the mainland, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population.

   There is no indication that the population in the Gladstone region is an important population. No individuals were discovered in the study area during surveys for the Arrow LNG Plant and other LNG projects. As no individuals were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the squatter pigeon.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The squatter pigeon favours a variety of woodland and grassland habitats, which are widespread within and adjacent to the study area. The species was identified as having a moderate or higher likelihood of occurrence in woodland inland from the mainland tunnel launch site in RE 11.3.4, but may also be present in other habitats. The location of this RE within the project area is shown on Figures 5 and 6.

   The proportion of RE 11.3.4 proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region is 8.09% of the local resource and 0.26% of the resource in the bioregion. Table 6.4 (Section 6.5) provides a detailed list of vegetation (habitat) clearance for the project which is also assessed in Chapter 32, Cumulative Impacts.

   The extent and quality of habitat lost as a consequence of project activities is small in comparison to the available habitat in the vicinity of the project area, particularly in the Curtis Island Environmental Management Precinct and Targinie State Forest. The lack of evidence of usage of the available habitat means it is highly unlikely the loss of habitat will result in a decline in the species in the region.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive species (fauna) have been identified as a key threat to the species (DSEWPaC, 2011b), particularly foxes and feral cats.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to squatter pigeon. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, adjacent areas including the Curtis Island Environmental Management Precinct and

Targinie State Forest contain similar habitat. Proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for such species as the squatter pigeon.

It is unlikely that any impacts upon squatter pigeon are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant will not contribute towards the loss and fragmentation of critical habitat, with areas of suitable habitat cleared for the pipeline similar to large areas of retained habitat in adjacent areas. The potential impact from pest fauna will be unlikely due to the implementation of a pest management plan (Appendix 10 to the EIS) for the project.

The species is likely to be sparsely distributed in the study area associated with the feed gas pipeline. The species is highly mobile, and likely to move in and out of the study area utilising a wide variety of habitats in response to food resources. Although the cumulative loss of RE 11.3.4 within the Gladstone area and Queensland is 8.09% and 0.26% respectively, the species is expected to be associated with similar grassland and woodland habitats within and adjacent to the study area.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this, and other species. No offsets are required under the EPBC Act for this species.RE 11.3.4 has been identified as a likely area requiring to be offset under the *Vegetation Management Act 1999* (Qld) as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the Vegetation Management Act for this RE will have benefits for species potentially found within this RE, such as the squatter pigeon.

In conclusion, the impacts on squatter pigeon from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no critical habitat has been identified and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Yellow Chat

The Capricorn race of yellow chat is endemic to the central Queensland Coast. It is known only on Curtis Island and the adjacent mainland coast, where its range is estimated to be 25 km^2. It 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.

An assessment of the habitat types present within the study area reveals that any areas of wet grassland and/or saltmarsh, are generally small and heavily degraded. The stronghold of this species in the region is further north around northern Curtis Island, near the Fitzroy River delta and Torilla Plain (Garnett, 2011), remote from the study area. Numbers at Curtis Island Marine Plain suggest that this location is no longer used by the species (Garnett, 2011).

No individual species, breeding sites or nesting sites were observed in the study area.

A recovery plan for yellow chat (Houston and Melzer, 2008) has been produced. It identifies threats to the species from modification to hydrological regimes through flow reductions into catchments and construction of barriers within tidal areas where the subspecies occurs. The Arrow LNG Plant feed

gas pipeline is unlikely to result in reduced habitat within the range of the yellow chat, as habitat present within the study area is marginal and degraded.

Impacts on the hydrological regime of the project area will not affect potential habitat of the yellow chat, as they are confined to stream diversions of the ephemeral watercourses that drain the LNG plant site. The ephemeral watercourses drain to intertidal mudflats with negligible suitable habitat. The stream diversions will maintain flows to the intertidal mudflats.

Significant Impact Criteria – Yellow Chat

1) Lead to a long-term decrease in the size of a population.

   While the intertidal habitat on the mainland and Curtis Island provides suitable habitat for the species, no birds or nests were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. While the Species Profile and Threats database (DSEWPaC, 2011b) identifies that populations of the Capricorn subspecies of the yellow chat is located on the Torilla Plain and the Fitzroy River delta, and a third breeding population could persist on northern Curtis Island, these known populations are remote from the study area for the Arrow LNG Plant.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of the species.

2) Reduce the area of occupancy of the species.

   No individuals, breeding sites or nesting sites were identified in the study area. The degraded intertidal habitat along the eastern section of the mainland and southern parts of Curtis Island and recent research suggesting that the Curtis Island Marine Plain is no longer used by the species (Garnett, 2011) also indicates that construction and operation activities of the proposed project will not lead to a long-term decrease in the size of a population of species.

3) Fragment an existing population into two or more populations.

   No population has been identified in the study area, as evidenced by breeding sites, individual species and nesting sites not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Given this, project activities will not fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individual species, breeding sites or nesting sites have been identified in the study area. Vegetation in the study area includes intertidal habitat along the eastern section of the mainland and southern parts of Curtis Island, being suitable habitat for this species. However this is degraded and recent research suggests that the Curtis Island Marine Plain is no longer used by the species (Garnett, 2011). This indicates that project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population.

   Breeding and nesting sites were not discovered during surveys for the Arrow LNG Plant and other LNG projects. Given this, project activities will not disrupt the breeding cycle of a population of the yellow chat.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The yellow chat inhabits marine plain wetlands that experience extensive seasonal inundation and fresh and saltwater influences (Garnett, 2011). 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. The intertidal habitat for the species along the eastern section of the mainland and southern parts of Curtis Island is degraded and not known to support populations of this species. Project activities will not lead to a decline of the species through modification or loss of suitable habitat.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.

   Exotic pasture grasses which displace native flora species in habitat occupied by the yellow chat have been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to the yellow chat. The pest management plan (Appendix 10 the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species.

   A recovery plan for yellow chat (Houston and Melzer, 2008) has been produced. It identifies threats to the species from modification to hydrological regimes through flow reductions into catchments and construction of barriers within tidal areas where the subspecies occurs.

   The project will not result in the threatening processes identified in the recovery plan for the species. Industrial expansion as a result of the project is into areas of habitat not suitable for the species.

It is unlikely that any impacts upon yellow chat are unknown, unpredictable or irreversible. Of the main threats identified to the yellow chat (DSEWPaC, 2011b; Houston and Melzer, 2008), the Arrow LNG Plant will not contribute towards the loss and fragmentation of habitat suitable for the species, and known populations are not present within the study area. The species is not known from within the study area for the Arrow LNG Plant, and is unlikely to be present other than on a transitory basis. The range for the species is to the north of Curtis Island and the adjacent mainland coast, away from proposed works and as such the project will not impact upon the species.

In conclusion, impacts on yellow chat from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no optimal habitat has been identified and populations are not known within the study area.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Northern Quoll

The northern quoll inhabits a range of open woodland and open forest types. Northern quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated

habitats used for foraging and dispersal. It is distributed across the eastern half of Queensland in fragmented populations with the highest densities occurring in the Mackay-Whitsunday area. Recent surveys throughout Queensland have suggested northern quolls are more likely to be present in high relief areas that have shallower soils, greater cover of boulders, less fire impact and are closer to permanent water (DSEWPaC, 2011b).

Patches of suitable vine thicket and open-forest/woodland habitat (RE 11.3.4) on rocky slopes occur along the Mount Larcom Range which is located to the west of the study area. Eucalypt open-forest/woodland habitat occurs on Curtis Island, although it has low relief in comparison to Mount Larcom Range, and there are limited rocky areas, particularly those containing boulders. The study area is subject to periodic fuel reduction burns and has cane toad infestations. Feral horses and pigs use the study area on Curtis Island.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and in the recovery plan for the species (Hill and Ward, 2010) include habitat loss, weed invasion, inappropriate fire regimes and predation by feral predators, as well as death by ingestion of the toxic cane toad.

The northern quoll was not recorded in field surveys for the project or other LNG projects on Curtis Island. The species is likely to be uncommon in the area based on the lack of records in the area, and if present, it would range widely over a large territory. If present, vegetation clearing, fuel reduction burning and actions that cause an increase in cane toad populations could potentially affect the northern quoll.

RE 11.3.4 is found in the vicinity of the mainland tunnel launch site between the Cement Australia railway siding and the intertidal mudflats (see Figure 6). RE 11.3.4 is not represented in eucalypt open forest and woodland on Curtis Island.

Vegetation to be cleared for the Arrow LNG Plant feed gas pipeline on Curtis Island will occur adjacent to the haul road and materials offloading facility constructed for the GLNG Project. On the mainland, it will occur between the intertidal mudflats and existing pipeline access tracks in an area of coastal woodland that is periodically subject to fuel reduction burns.

The patch of RE 11.3.4 lost for construction and operation of the mainland tunnel launch site is small in comparison to patches adjacent to that site in and adjacent to the study area. Eucalypt woodland adjacent to the feed gas pipeline alignment on Curtis Island has been cleared for construction of the haul road for the GLNG Project.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Northern Quoll

1) Lead to a long-term decrease in the size of a population.

   The northern quoll was not identified in surveys – described in Section 3 of Appendix 9 to the EIS – for the Arrow LNG Plant. Suitable habitat along the feed gas pipeline alignment is limited and subject to edge effects from construction of the GLNG Project on Curtis Island. The loss of potentially suitable habitat is small in comparison to available habitat in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Project activities will not lead to a long-term decrease in the size of a population.

2) Reduce the area of occupancy of the species.

Northern quoll is a mobile species with large territories. It makes local movements within its territory in relation to food and water supply. The species was not found in the study area and potentially suitable habitat is subject to periodic fuel reduction burns, is used by feral horses and pigs (on Curtis Island) and is exposed to edge effects from construction activities on Curtis Island associated with the GLNG Project. Construction of the feed gas pipeline is highly unlikely to reduce the area of occupancy of the species.

The species is not associated with any particular RE type within the project area for the feed gas pipeline and favours a variety of woodland and forest habitats, particularly around rocky slopes. The species was not identified as having a moderate or higher likelihood of occurrence in the area of the pipeline alignment on Curtis Island.

The Curtis Island Industry Precinct (including the Arrow LNG Plant and three other LNG plant sites on Curtis Island) covers less than 3% of the overall area of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to be in less disturbed areas in the north of Curtis Island.

3) Fragment an existing population into two or more populations.

   The species was not identified in the study area in surveys for the Arrow LNG Plant. Potentially suitable habitat is sub-optimal and adjacent to larger tracts of more intact habitat, particularly in areas of the Curtis Island Environmental Management Precinct and Targinie State Forest. Project activities are highly unlikely to fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The area of potentially suitable habitat to be cleared for the Arrow LNG Plant feed gas pipeline is sub-optimal for the species, and is small in relation to uncleared areas within the adjacent Curtis Island Environmental Management Precinct and Targinie State Forest. No individuals were found in surveys for the Arrow LNG Project. Consequently, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population.

   As suitable habitat on the mainland and Curtis Island is sub-optimal and subject to threatening processes and no individuals were found, it is highly unlikely that the breeding cycle of a population of northern quoll would be disrupted.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Potentially suitable habitat for the northern quoll in the study area is sub-optimal and subject to threatening processes including periodic fuel reduction burns, cane toad infestations and edge effects from construction activities associated with the GLNG Project. Clearing of part of the remnant patches of woodland will not decrease the availability or quality of habitat to the extent the species is likely to decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive species (both flora and fauna) have been identified as a key threat to the species (DSEWPaC, 2011b; Hill and Ward, 2010).

Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

Cane toads were widespread and common throughout the study area during field surveys for the project. The species is already widely established in the area. The pest management plan (Appendix 10 of the EIS) includes measures to locally control cane toads although their distribution and reproductive potential limits the effectiveness of any control.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to northern quoll. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere with the recovery of the species.

   The project will not result in threatening processes identified in the recovery plan for the species. Pest and quarantine management plans and control of invasive weeds on Curtis Island will support measures to reduce the decline in the species.

It is unlikely that any impacts upon northern quoll are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b; Hill and Ward, 2010), the Arrow LNG Plant feed gas pipeline will not contribute towards the loss and fragmentation of habitat suitable for the species, and the impact from pest flora and fauna will be negligible as the species is unlikely to be present in the project area. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

The species is likely to be uncommon within the project area for the feed gas pipeline, as the habitat is not optimal. If present, it would range widely over a large territory. None of the surveys undertaken for the Arrow LNG Plant or other LNG projects on Curtis Island located this species.

If the species does occur on Curtis Island, it is likely to be largely within the suitable habitat to the north of the industry precinct, the remaining 97% of the island not covered by the industrial designation.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

In conclusion, impacts on the northern quoll from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no optimal habitat has been identified in the project area and large areas of more suitable habitat are present to the north in the Curtis Island Environmental Precinct.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Water Mouse

The water mouse occurs in three discrete populations on the eastern and northern Australian coastline. In central Queensland, it is known to occur in fringing mangroves in the high intertidal zone dominated by *Ceriops tagal* and/or *Bruguiera* spp.

Suitable intertidal habitat occurring along the mainland coastline and the southern section of Curtis Island was found. No individuals were recorded in surveys for the Arrow LNG Plant, although water mouse has been detected in surveys at the Australia Pacific LNG Project site. Consequently, the species was assessed as having a high likelihood of being present in the study area.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) and in the recovery plan for water mouse (DERM, 2010) include habitat loss and degradation, fragmentation, predation from introduced species and herbicides, acid sulfate soils exposure, pesticides and oil pollution.

Water mouse is likely to be present in mangrove habitat across the study area. Loss of areas of mangrove ecosystems with abundant fallen woody debris and hollow logs, is likely to result in loss of habitat for the water mouse.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline alignment does not require removal of any mangrove habitat therefore the project will not fragment or remove any suitable habitat. Impacts on the hydrological regime in the project area will be reduced by the implementation of a stormwater management plan by Arrow Energy, and a spill prevention and response plan. Arrow Energy has committed to implementing an acid sulfate soils management plan.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

Significant Impact Criteria – Water Mouse

1) Lead to a long-term decrease in the size of an important population of a species.

   While fringing mangroves along the mainland coastline and the southern section of Curtis Island provide suitable habitat for the species, no nest mounds were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant (see Section 3 of Appendix 9, Terrestrial Ecology Impact Assessment) and other LNG projects. Information provided in the Species Profile and Threats database (DSWEPaC, 2011b) does not identify any nesting sites in the Gladstone region. No mangrove habitat will be removed for infrastructure associated with Referral No. EPBC 2009/5008. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals or nest mounds were identified in the study area. Individuals were detected at a site adjacent to the study area. As no nest mounds were identified, and no mangrove habitat will be removed for infrastructure associated with Referral No. EPBC 2009/5008, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by nest mounds not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on

Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   Vegetation clearance associated with Referral No. EPBC 2009/5008 does not involve the removal of mangrove habitat, hence no areas support nesting or foraging sites for the water mouse will be affected. While evidence of water mouse was detected adjacent to the study area on the Australian Pacific LNG Project site, none were observed or detected in the study area. Vegetation communities within the study area include the range of habitats utilised by the water mouse and it is highly likely the species might utilise mangrove habitat in the study area periodically for foraging. However, as similar tracts of habitat exist around Port Curtis, project activities will not adversely affect habitat critical to the survival of species.

5) Disrupt the breeding cycle of an important population.

   Nesting sites and mounds were not discovered during surveys for the Arrow LNG Plant and other LNG projects. As no nest mounds were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the water mouse.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The water mouse favours fringing mangroves in the high intertidal zone dominated by *Ceriops tagal* and/or *Bruguiera* spp. No mangrove habitat will be removed for the infrastructure associated with referral No. EPBC 2009/5008. Arrow Energy will implement controls on weed and pest management, and to prevent spills, to reduce the risks of impacts to adjacent habitat for water mouse.

   The species was assessed as having a moderate or higher likelihood of occurrence in RE 12.1.3. The location of this RE within the project area is shown on Figures 5 and 6. This RE will not be cleared as a result of infrastructure associated with Referral No. EPBC 2009/5008.

   The proportion of RE 12.1.3, proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects in the Gladstone region is described in Section 6.5 (Table 6.4) of this attachment and Chapter 32, Cumulative Impacts.

   The amount of the RE to be cleared by all projects as a proportion of the extent of the RE in the Gladstone Regional Council area and Queensland is 0.12% and 0.04% respectively.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b; DERM, 2010). Degradation of habitat by feral pigs and horses has also been identified as a threat to the species.

   Arrow Energy has committed to a pest management plan (Appendix 10 of the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of adjacent areas of habitat to the project inhabited by water mouse, becoming degraded by weed invasion.

A quarantine management plan will be developed for the project and its implementation will control pest fauna that may threaten the species, being introduced accidentally to areas of mangrove adjacent to the project.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to water mouse. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No habitat suitable for the water mouse (RE 12.1.3) will be cleared for infrastructure associated with Referral No. EPBC 2009/5008.

It is unlikely that any impacts upon water mouse are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the feed gas pipeline will not contribute towards the loss and fragmentation of habitat, as no mangrove habitat will be cleared.

No individuals, or nest mounds were identified in the study area, although individuals were detected in surveys on the Australia Pacific LNG Project site. The lack of evidence of visitation in the study area indicates it is highly unlikely the species is reliant on the area. It is likely to be uncommon in fringing mangroves around Port Curtis, and although the exact distribution and abundance of the species is unknown, a trapping program is proposed for the Arrow LNG Plant to establish the presence or absence of the species in the project area (see Section 17.7.2 of EIS).

The cumulative loss of RE 12.1.3 within the Gladstone area and Queensland is small, and if present the species is expected to be associated with and find refuge in, adjacent areas of mangrove habitat.

The general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species. In addition, the following mitigation measure will be implemented:

- Prohibit access to the saltpans and fringing mangroves (RE 12.1.2 and 12.1.3) outside the planned area of disturbance of the mainland tunnel launch site and tunnel spoil disposal area.

In conclusion, impacts on water mouse from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no mangrove habitat will be cleared for the pipeline infrastructure.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Grey-headed Flying Fox

The grey-headed flying fox is distributed along eastern coastal Australia, extending from Rockhampton to Melbourne. Curtis Island and Gladstone are located at the northern limit of its distribution. It is found to favour rainforests, open forests, closed and open woodlands, as well as melaleuca swamps and banksia woodlands. It is also found throughout urban and agricultural areas where food trees exist.

Vegetation communities (regional ecosystems) of the study area provide a wide range of suitable foraging habitat for the grey-headed flying fox. Consequently, the species was assessed as having a high likelihood of being present in the study area.

The grey-headed flying fox was observed at numerous sites adjacent to the study area on the mainland and in the area just south of Graham Creek on Curtis Island. No individuals or colonies were recorded in the project area, nor were any roosts discovered in that area indicating the habitat available in the project area is not an important foraging resource.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include biological factors (restricted breeding season and one birth per year in context of modern day increase in flying fox mortality), habitat loss and fragmentation, shooting to reduce destruction of fruit at commercial orchards, competition with the black flying fox (*Pteropus alecto*) as this species' range extends further south, pollutants and electrocution on powerlines.

Vegetation clearance and the consequential reduction in foraging habitat may affect the grey-headed flying fox, as the project area is within its range. However, the loss of foraging habitat is small in comparison to the habitat available in adjacent areas, and the lack of sightings and roost sites indicates it is not important foraging or breeding habitat.

There is no recovery plan for the species.

Significant Impact Criteria – Grey-headed Flying Fox

1) Lead to a long-term decrease in the size of an important population of a species.

   While eucalypt woodland on the mainland and Curtis Island provides suitable habitat for the species, no breeding camps or roosts were identified in and adjacent to the project area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any colonies or breeding camps in the Gladstone region. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals, roosts or breeding camps were identified in the project area. Individuals were observed at sites adjacent to the study area. As no colonies or breeding camps were identified, project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by breeding camps and colonies not being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   The study area and project area currently do not support colonies, breeding camps or roosts for the grey-headed flying fox. While individuals were observed adjacent to the study area, none were observed in the project area. Vegetation communities within the study area include the wide range of habitats utilised by the grey-headed flying fox and it is highly likely the species might utilise the area periodically for foraging. However, as substantial tracts of similar habitat exist in

the Curtis Island Environmental Management Precinct, on Curtis Island generally and on the mainland, project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population.

Breeding camps and roosts were not discovered during surveys for the Arrow LNG Plant and other LNG projects. As no colonies were identified in surveys of the study area, project activities will not disrupt the breeding cycle of an important population of the grey-headed flying fox.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The grey-headed flying fox favours a variety of woodland habitats, and more open areas where suitable food trees are present. Spring foraging resources have been identified as critical to the survival of the species.

Within the project area, the species has been identified as having a moderate or higher likelihood of occurrence within REs 11.3.4, 12.3.3, 12.3.6, 12.3.7, 12.11.4, 12.11.6 and 12.11.14.The locations of REs within the project area are shown on Figures 5 and 6 of the EIS.

The extents of the identified REs proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region are detailed in Table 6.2 which is an extract of the information provided in Section 6.5 (Table 6.4) of this attachment and Chapter 32 Cumulative Impacts.

The amount of each RE to be cleared by all projects as a proportion of the extent of the RE within the Gladstone Regional Council area is less than 1% in all cases, with the exception of RE 11.3.4 and RE 12.11.14, which are 8.09% and 5.72% of the extent of the RE type in the Gladstone Regional Council area respectively. Within Queensland, the proportions of these two REs to be cleared are 0.26% and 0.66% respectively.

The extent and quality of habitat lost as a consequence of project activities is small in comparison to the available habitat in the vicinity of the project area, particularly in the Curtis Island Environmental Management Precinct and Targinie State Forest. The lack of evidence of breeding camps, roosts and colonies means it is highly unlikely the loss of habitat will result a decline in the species in the region.

Table 6.2 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Grey-headed Flying Fox

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5008	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	16.74	486.90	9.50	8.09	0.26	0.26
RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	15.93	199.90	61.70	5.72	0.67	0.66
RE 12.11.6 (LC, -) *Corymbia citriodora, Eucalyptus creba* open forest on metamorphics ± interbedded volcanics.	1.92	483.40	14.80	0.52	0.21	0.20
RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics.	0	3.90	100.00	0.13	0.13	0.10
RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains.	0	202.60	16.00	0.98	0.47	0.47
RE 12.3.6 (LC, -) *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland on coastal alluvial plains.	0	3.60	100.00	0.09	0.03	0.01

Table 6.2 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Grey-headed Flying Fox (cont'd)

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5008	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 12.3.7 (LC, -) *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest.	0	7.10	59.20	0.08	0.01	0.01

Notes: Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e., 12.11.14/12.11.4 and 12.11.6/12.11.14), the dominant RE area was chosen (in this case, 12.11.14 and 12.11.6 respectively).

[1] Regional Ecosystem status: CE = critically endangered, E = endangered, OC = of concern, LC = least concern (Vegetation Management Act, EPBC Act).

[2] Projects included APLNG Project, WBDD 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 Island Community Project, Boyne Island Aluminium Smelter Extension of Reduction Lines Project, GLNG Project, QCLNG Project, Yarwun Alumina Refinery Expansion Project.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   No invasive flora or fauna has been identified as a threat to the species (DSEWPaC, 2011b). Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to grey-headed flying fox. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, proposed management measures for the Curtis Island Environmental Management Precinct are aimed at enhancing the vegetation communities that provide suitable habitat for the grey-headed flying fox.

It is unlikely that any impacts upon grey-headed flying fox are unknown, unpredictable or irreversible. Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline may contribute towards the loss and fragmentation of habitat, however the area that will be lost is small in comparison to the available habitat in adjacent areas.

No grey-headed flying fox roosts have been identified within the project area for the Arrow LNG Plant. The species is highly mobile, and likely to travel large distances in response to food resource. Vegetation communities to be cleared by project activities include the wide range of suitable foraging habitats for the grey-headed flying fox. However, the area of foraging habitat lost is small in relation to areas of woodland within the study area and the Gladstone region.

No individuals, breeding camps or roosts were identified in the project area, although individuals were observed in areas adjacent to the study area. The lack of evidence of visitation indicates it is highly unlikely the species is reliant on the area. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

RE 11.3.4 and RE 12.11.14 have been identified as likely areas requiring to be offset under the *Vegetation Management Act 1999* (Qld), as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for these REs will have benefits for the species utilising these REs, including the grey-headed flying fox.

In conclusion, impacts on the grey-headed flying fox from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no colonies, breeding camps or roosts were identified and potential foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat of that species or potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Brigalow Scaly-Foot

The Brigalow scaly-foot is largely restricted to the Brigalow Belt bioregion although it has been recorded on Boyne Island approximately 12 km to the southeast of the study area. The species is found in a wide variety of remnant and non-remnant open forest to woodland habitats. The species is more prevalent in habitats that have few weeds and that consist of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Most records occur in remnant habitats, but the species can also occur in young regrowth (two to three years old) and in modified habitats.

Vegetation communities of the study area provide suitable habitat for Brigalow scaly-foot with similar habitat to that found on Boyne Island, and in areas of Curtis Island. Patches of vine thicket and open-forest/woodland habitat containing leaf litter, hollow logs, crevices in rocks and fallen timber are known to occur throughout the study area and may support this species. There are no records from Curtis Island or the adjacent mainland; consequently, the species was assessed as having a moderate likelihood of being present in the study area.

Key threats listed to the Brigalow scaly-foot on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing and thinning, road widening and maintenance activities and predation by feral animals such as feral cats.

If present within the project area Brigalow scaly-foot is likely to be impacted through unearthing during construction activities, trench fall, loss of habitat including hollow logs, rocks and leaf litter, and edge effects such as weed invasion, changed hydrological regimes and increase in pest fauna species such as cane toads.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline may result in reduced potential habitat for Brigalow scaly-foot. The pipeline will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. However, this loss of habitat is small in comparison to similar habitat in the surrounding area. Further, the habitat loss on Curtis Island will occur adjacent to vegetation clearance for the GLNG Project, where a haul road has been constructed adjacent to the proposed feed gas pipeline alignment.

The project has the potential to facilitate the spread of pest fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for the species.

Significant Impact Criteria – Brigalow Scaly-Foot

1) Lead to a long-term decrease in the size of an important population of a species.

   Important Brigalow scaly-foot populations occur in large contiguous areas of remnant vegetation that are suitable for the species, such as the Central Queensland sandstone rises, the Blackwater/Blackdown Tablelands region and the Moura/Theodore region. An important population has been identified at Boyne Island 12 km to the southeast of the study area.

   It is unlikely that the project will result in a long term decrease in size of the population, even if the local population were considered as an important population, due to the large areas of suitable habitat adjacent to the project area. This species, if present will be displaced to areas of similar habitat adjacent to the project area.

   While eucalypt woodland on the mainland and Curtis Island provides suitable habitat for the species, no individuals were identified in and adjacent to the study area in surveys conducted for

the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any populations in the Gladstone region, other than the population on Boyne Island.

Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in the size of an important population of the species.

2) Reduce the area of occupancy of an important population.

No individuals were identified in the study area. Removal of vegetation and habitat for the project may reduce the extent of habitat available for the species, however the extent of habitat lost as a proportion of habitat available within the region is small.

Project activities are highly unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

No important population has been identified in the study area. The area of habitat to be lost is small in relation to uncleared areas of eucalypt woodland within the study area and the Gladstone region, and the effect of this loss will be minimal. The vegetation clearance for the pipeline alignment will occur on Hamilton Point at the southwestern tip of the island, not preventing movement of the species to other areas of the island, including the Curtis Island Environmental Management Precinct, if present. Regular trench inspection and measures to prevent fauna entrapment within the trench will be undertaken to reduce potential impacts upon the species.

4) Adversely affect habitat critical to the survival of a species.

The Brigalow scaly-foot's core habitat occurs mostly in the Brigalow Belt South bioregion. The species is found in a wide variety of remnant and non-remnant open forest to woodland habitats, under sandstone slabs, surface debris or in grass hummocks. No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. Large areas of suitable habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Therefore project activities will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population.

No populations in the study area are considered to be an important population, although an important population is present on Boyne Island 12 km to the southeast of the project area. Surveys did not discover this species. Habitat is marginal and the species is largely restricted to the Brigalow Belt bioregion.

No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no Brigalow scaly-foot were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Areas of eucalypt woodland suitable for the species will be cleared for the project (less than 20 ha on both the mainland and Curtis Island). Large areas of similar habitat exist in adjacent areas. Therefore, project activities will not disrupt the breeding cycle of an important population of the Brigalow scaly-foot.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The species favours a variety of dry woodland habitats favouring leaf litter, hollow logs, crevices in rocks and fallen timber. Within the project area for the feed gas pipeline, the species has been identified as having a moderate likelihood of occurrence within RE 11.3.4 and RE 12.11.14. The locations of REs within the project area are shown on Figures 5 and 6.

Clearance of these REs for the feed gas pipeline infrastructure comprises of 16.74 ha and 15.93 ha respectively, which is a small proportion of cumulative clearance in the region for all projects.

The extents of the identified REs proposed to be cleared by the Arrow LNG Plant (LNG plant and pipeline infrastructure) and other projects within the Gladstone region are detailed in Table 6.3 which is an extract of the information provided in Section 6.5 (Table 6.4) of this attachment and Chapter 32 Cumulative Impacts.

Table 6.3 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state – relevant to Brigalow Scaly-Foot

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5008	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	16.74	486.90	9.50	8.09	0.26	0.26
RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	15.93	199.90	61.70	5.72	0.67	0.66

The areas of each RE to be cleared by all projects as a proportion of the extent of the RE within the Gladstone Regional Council area is 8.09% and 5.72% of the extent of the RE in the Gladstone Regional Council area respectively. Within Queensland, the proportions of these two REs to be cleared are 0.26% and 0.66% respectively.

Most records of the Brigalow scaly-foot occur in remnant habitats of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses, but the species can also occur in young regrowth (two to three years old) and in modified habitats containing dry woodland habitats favouring leaf litter, hollow logs, crevices in rocks and fallen timber.

The habitat lost for the feed gas pipeline, is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Habitats that have few weeds are more likely to contain this species, while invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b).

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to Brigalow scaly-foot. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon Brigalow scaly-foot are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of suitable habitat, although there are no records from Curtis Island or the adjacent mainland, and the loss of habitat is small in comparison to available habitat in adjacent areas.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect. Available habitat is not considered to be critical habitat for the species, and the nearest record to the project area is over 12 km away. If present, the species is probably present in small numbers.

If present, they are likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increases in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts on this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].

- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

No offsets under the EPBC Act are required for this species. RE 11.3.4 and RE 12.11.14 have been identified as likely areas requiring to be offset under the *Vegetation Management Act 1999* (Qld), as a result of vegetation clearance associated with the project (see Section 7.2 of this report). Any offsets under the *Vegetation Management Act 1999* (Qld) for these REs will have benefits for the species utilising these REs, including the Brigalow scaly-foot.

In conclusion, impacts on Brigalow scaly-foot from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no individuals were identified and potential foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Collared Delma

The collared delma is endemic to southeast Queensland and distributed around central Queensland at Ulam Range (60 km south of Rockhampton) and Expedition National Park (70 km west of Taroom). It 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.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, however rocky and grassy areas in eucalypt woodland within the mainland section of the study area and at the LNG plant site along the feed gas pipeline alignment is suitable habitat for the species. Consequently, the species was assessed as having a moderate likelihood of being present.

Key threats listed for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing, habitat degradation and loss of features such as rocks, predation by feral animals such as feral cats and red foxes and weed invasion.

If present within the project area, collared delma is likely to be impacted through unearthing during construction activities, trench fall, loss of habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and an increase in pest fauna species such as cane toads.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline may result in reduced potential habitat for collared delma. The pipeline will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. However, this loss of habitat is small in comparison to similar habitat in the surrounding area.

The project has the potential to facilitate the spread of pest flora and fauna species, a key threat for the species. Arrow Energy will implement measures in a pest management plan (Appendix 10 to the EIS) to reduce the impacts of pest fauna and flora as a result of the project.

There is no recovery plan for the species.

Significant Impact Criteria – Collared Delma

1) Lead to a long-term decrease in the size of an important population of a species.

   While rocky and grassy areas in eucalypt woodland on the mainland and Curtis Island provide suitable habitat for the species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. The habitat within the project area is not likely to be habitat critical to the survival of the species. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations for the species in the Gladstone region or the vicinity of the study area. Significant populations are located around the Brisbane and Toowoomba areas in southeast Queensland.

   Implementation of mitigation measures to reduce fauna entrapment in trenches developed for the project, and development of trench inspection procedures will reduce the risk of entrapment of the species impacting on the population size in the region. It is unlikely that the project will result in a long term decrease in size of the population, even if the local population were an important population, due to the large areas of suitable habitat adjacent to the project area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Removal of vegetation and habitat for the project may reduce the extent of habitat available for the species, however the extent of habitat lost as a proportion of habitat available within the region is small. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, the area of habitat lost for the construction of the feed gas pipeline is small in relation to uncleared areas of eucalypt woodland in the study area and the Gladstone region, and the effect of this loss will be minimal. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. The species normally inhabits eucalypt dominated woodlands. The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30–100 mm thick) appears to be an essential characteristic of the collared delma microhabitat and is always present where the species occurs.

   Large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   The species was not recorded in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. It is unlikely that any critical habitat to the breeding cycle of the species

will be cleared. While areas of eucalypt woodland suitable for the species will be cleared for the project (less than 20 ha on both the mainland and Curtis Island), large areas of similar habitat are available in adjacent areas. Therefore, project activities will not disrupt the breeding cycle of an important population of the collared delma.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The species favours a variety of dry woodland habitats, predominantly on rocky slopes, favouring leaf litter, hollow logs, crevices in rocks and fallen timber.

   The habitat lost for the project is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas. The Curtis Island Industry Precinct (including the Arrow LNG Plant and three other LNG projects on Curtis Island) covers less than 3% of Curtis Island, including large areas of the Curtis Island Environmental Management Precinct to the north and east. Although unlikely, should the species be present on Curtis Island it is likely to inhabit less disturbed areas in the north of Curtis Island.

   Eucalypt woodland vegetation communities to be cleared for the project comprise less than 1% of each of the regional ecosystems locally and in the bioregion, with two exceptions RE 11.3.4 (8.09% and 0.26% respectively) and RE 12.11.14 (5.72% and 0.66% respectively). The mainland tunnel launch site is partly located in RE 11.3.4. The feed gas pipeline alignment traverses RE 12.11.14 on Curtis Island, part of which has been cleared for the construction of the haul road for the GLNG Project.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b). Weed invasion may also degrade habitat for the collared delma.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to collared delma. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail the measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon collared delma are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant may contribute towards the loss of suitable habitat, although there are no records of the collared delma from Curtis Island or the adjacent mainland.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect. Available habitat in the study area is not considered to be habitat critical to the survival of the species. If present, the species is probably present in small numbers.

If present, the collared delma is likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increase in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].
- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

In conclusion, impacts on collared delma from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no critical habitat has been identified, no important populations are present and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

Yakka Skink

This endemic skink is found in the Brigalow Belt and northern southeast Queensland where it lives in small colonies, inhabiting burrows it digs in dry open forest and woodland. It can also be found in heaped dead timber and in deep rock crevices.

The dry open forest and woodland habitat that occurs throughout the study area provides suitable habitat for the yakka skink. However, no individuals were observed during the field surveys. The species was assessed as having a moderate likelihood of being present in the study area due to the suitability of the habitat.

Key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include habitat loss due to land clearing and thinning, road widening and maintenance activities and predation by feral animals such as feral cats. The species exhibits high site fidelity and low fecundity, making it susceptible to population crashes.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline may result in reduced potential habitat for yakka skink. The pipeline will necessitate clearance of eucalypt woodland on Curtis Island and on the mainland. However, this loss of habitat is small in comparison to similar habitat in the surrounding area. Open forest and woodland vegetation communities to be cleared for the project comprise less than 1% of each of the regional ecosystems locally and in the bioregion, with two exceptions RE 11.3.4 (8.09% and 0.26% respectively) and RE 12.11.14 (5.72% and 0.66% respectively). The mainland tunnel launch site is partly located in RE 11.3.4. The feed gas pipeline alignment traverses RE 12.11.14 on Curtis Island, part of which has been cleared for the construction of the haul road for the GLNG Project. The core range of this species is in the Mulga Lands and Brigalow Belt South bioregions and as such, the loss of habitat which is outside its preferred range will be insignificant.

There is no recovery plan for the species.

Significant Impact Criteria – Yakka Skink

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry open forest and woodland habitat occurring throughout the study area provides suitable habitat for this species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations (colonies identified or within 5 km of known records of the species) in the Gladstone region or the vicinity of the study area. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area as evidenced by no individuals or colonies being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, the area of habitat lost for the construction of the feed gas pipeline is small in relation to uncleared areas of eucalypt woodland in the study area and the Gladstone region, and the effect of this loss will be minimal. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area. Large areas of eucalypt woodland habitat with ground habitat features such as leaf litter, fallen logs and rocks exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest. Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

No colonies or individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no colonies were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Large areas of similar habitat exist in adjacent areas. Therefore, project activities will not disrupt the breeding cycle of an important population of the yakka skink.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The yakka skink inhabits burrows in dry open forest and woodland and can also be found in heaped dead timber and in deep rock crevices.

   The habitat lost for the project, is unlikely to decrease the availability of habitat to an extent that the species may decline, due to large areas of similar habitat being present in adjacent areas.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive fauna species such as feral cats, feral pigs and red fox have been identified as a key threat to the species (DSEWPaC, 2011b). Weed invasion may also degrade habitat for the yakka skink.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to yakka skink. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region, and large areas of similar habitat exist in adjacent areas including the Curtis Island Environmental Management Precinct and Targinie State Forest.

It is unlikely that any impacts upon yakka skink are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline may contribute towards the loss of suitable habitat, although there are no records from Curtis Island or the adjacent mainland and the loss of habitat is small in comparison to available habitat in adjacent areas.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is cryptic and likely to be hard to detect. Available habitat is not considered to be core habitat for the species. If present, the species is probably present in small numbers.

If present, the species is likely to be impacted by earthworks during construction activities, trench fall, loss of foraging and resting habitat including hollow logs, rocks and leaf litter, and edge effects such as changed hydrological regimes and increase in pests such as cane toads.

Mitigation measures for the project that will reduce the impacts upon this species are:

- Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works [C17.06].
- Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) [C17.35].
- Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench [C17.36].

In conclusion, impacts on yakka skink from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no critical habitat has been identified, no important populations are present and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.3.2 Terrestrial Flora

Four terrestrial flora species identified in database searches were assessed, after further desktop review and field survey, to possibly occur within the project area, and are discussed below. None of these species were identified in the project area through the course of field surveys for the project, although the unidentified species of *Cupaniopsis* recorded on Boatshed Point, shares similar characteristics to wedge-leaf tuckeroo (*Cupaniopsis shirleyana*). This is discussed further in the attachment for Referral No. EPBC 2009/5007.

Wedge-leaf Tuckeroo

The wedge-leaf tuckeroo is a shrub or small tree growing to 10 m in height which occurs from Maryborough district north to Mount Larcom (west of Gladstone), and has a disjunct distribution in the Carina area in Brisbane. It occurs in dry rainforest and scrubby open forest on steep slopes, scree slope gullies and rocky stream channels at elevations between 60 and 550 m.

Suitable habitat is present and records exist in the vicinity of the study area. Marginal habitat for the species, being dry rainforest and scrubby open forest, occurs along the feed gas pipeline alignment. However no individuals of the wedge-leaf tuckeroo were observed in the study area during the assessment (Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS). A potentially related species was recorded on Boatshed Point. This unidentified species of *Cupaniopsis* shares similar characteristics to the wedge-leaf tuckeroo (*Cupaniopsis shirleyana*) and is discussed further in the attachment for Referral No. EPBC 2009/5007.

Key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include clearing and disturbance from activities such as roadworks and other infrastructure works,

including associated drainage works. These activities can impact directly on the species and also promote canopy gaps which are readily colonised by weed species, which form dense thickets.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline will not take place in marginal habitat for this species. No specimens were recorded in the study area in surveys for the Arrow LNG Plant or for other LNG projects on Curtis Island. Impacts on the species from the feed gas pipeline are highly unlikely.

There is no recovery plan for the species.

Significant Impact Criteria – Wedge-leaf Tuckeroo

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry rainforest and scrubby open forest occurring within the study area provides suitable habitat for this species, no individuals were identified within the study area. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations (colonies identified or within 5 km of known records of the species) in the Gladstone region or the vicinity of the study area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, construction of the feed gas pipeline will avoid its preferred habitat which is marginal within the project area. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. No areas of critical habitat for the species have been identified (DSEWPaC, 2011b). Marginally suitable habitat is present adjacent to the feed gas pipeline alignment on Curtis Island, but the species was not located in field surveys and large areas of suitable habitat exist in adjacent areas. Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species found, specific mitigation measures developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   No specimens were discovered in surveys carried out for the LNG Plant and other LNG projects on Curtis Island. There is no habitat critical to the survival of the species in the study area.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The habitat to be cleared for the feed gas pipeline alignment is unlikely to decrease the availability of habitat to an extent that the species may decline, due to areas of similar habitat

being present in adjacent areas. The lack of evidence of any individuals of this species means it is highly unlikely the loss of habitat will result in a decline in the species in the region.

The species favours dry rainforest on moderate to very steep slopes and scree-slope gullies, and is associated with semi-evergreen vine thicket of the Brigalow Belt bioregion. This habitat is not present along the alignment for the feed gas pipeline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b), as areas are cleared and invasive flora colonises the cleared areas.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to wedge-leaf tuckeroo.

   The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. The loss of habitat is not habitat critical to the species presence in the region, and areas of similar habitat in adjacent areas will be retained.

It is unlikely that any impacts on the wedge-leaf tuckeroo are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area in desktop searches or field surveys. The habitat for the species along the feed gas pipeline alignment on Curtis Island is marginal.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. If this species is confirmed by the Queensland Herbarium to be a new taxon and listed under the EPBC Act, an offset will be provided in accordance with the draft Environmental Offsets Policy under the EPBC Act (see Section 7.2 of this report).In conclusion, impacts on wedge-leaf tuckeroo from the feed gas pipeline (Referral No. EPBC 2009/5008) for the Arrow LNG Plant are not significant, as no important habitat has been identified and the species was not identified in field surveys.

Mount Larcom Silk Pod

This species is a creeping to ascendant climber growing up to 5 m long in subtropical and dry rainforest and adjacent shrublands on cliffs or rocky outcrops of acid volcanic rocks or serpentinites. It

is known from Mount Perry, Mount Larcom, Mingga Mountain and Mount Wheeler with disjunct populations on the Byfield Range and at Cape Upstart.

The subtropical, dry rainforest and shrubland habitat that occurs in the study area provides suitable habitat for the Mount Larcom silk pod. However, underlying geology and coarse topographical requirements of cliffs and rocky outcrops are not present.

No individuals were observed during the field surveys, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS. The species was assessed as having a moderate likelihood of being present in the study area, as it has a highly effective wind-blown fruit, resulting in the potential for isolated specimens to become established within the study area.

Key threats identified to the species (DSEWPaC, 2011b) include fire, clearing and disturbance increasing fragmentation and the loss of remnants. The species is thought to be susceptible to fire and incapable of regenerating from underground organs, meaning that the continued existence of the species after fire would depend on regeneration by seed. If fires occurred at a frequency that did not allow the production of sufficient seed for future recruitment, populations would decline.

Vegetation clearance for the feed gas pipeline is unlikely to take place in the habitat for this species, namely open heathland and shrubland at or near the summits of mountain peaks, or outcrops of acid volcanic rocks and serpentinites.

No specimens were recorded in the study area in surveys for the Arrow LNG Plant or for the other LNG projects on Curtis Island. Habitat is marginal, as underlying geology and core topographical requirements are not present. Therefore impacts on the species from the feed gas pipeline alignment are unlikely.

There is no recovery plan for the species.

Significant Impact Criteria – Mount Larcom Silkpod

1) Lead to a long-term decrease in the size of an important population of a species.

   While the dry open forest and woodland habitat occurring throughout the study area provides marginally suitable habitat for isolated individuals germinated from windblown seeds, the underlying geological requirements are not present. No individuals of the species were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) does not identify any important populations in the study area.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   The species favours cliffs and rocky outcrops. There is no clearing of suitable habitat for Mount Larcom silk pod by other LNG projects on Curtis Island, and it is unlikely that the species will be impacted by this project or other projects within the Gladstone region.

   No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on

Curtis Island. The species is highly fragmented around the region being tied to suitable habitat, and it is highly unlikely the project will further fragment populations of this species.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area, although there is the small chance that an isolated specimen may become established as the species has a highly effective wind-blown fruit. The species inhabits heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentinites at 350 to 750 m above sea level.

   Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of an important population.

   No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Suitable habitat including underlying geology is not present within the study area. Therefore, project activities will not disrupt the breeding cycle of an important population of the Mount Larcom silkpod.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   The Mount Larcom silkpod inhabits heathland and shrubland at or near the summits of mountain peaks, in shallow loamy soils on cliffs or among outcrops of acid volcanic rocks and serpentites at 350 to 750 m above sea level.

   The habitat lost for the feed gas pipeline alignment which is at or just above sea level, is not optimal for this species, although there is the small chance that an isolated specimen may become established as the species has a highly effective wind-blown fruit. Project activities are unlikely to decrease the availability of habitat to an extent that the species may decline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b) as areas are cleared and invasive flora takes over.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to Mount Larcom silkpod.

   The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. While vegetation will be cleared for the project, the loss of habitat is not habitat critical to the species foothold in the region. The species is found on open heathland and shrubland at or near the summits of mountain peaks, or outcrops of acid volcanic rocks and serpentinites, habitat that is not present in the study area. Surveys failed to locate the species in the study area.

It is unlikely that any impacts upon Mount Larcom silkpod are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island, and no records have been identified within the study area for the Arrow LNG Plant, and the habitat for the species is marginal. No important population is present within the study area.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

In conclusion, impacts on Mount Larcom silkpod from the feed gas pipeline (Referral No. EPBC 2009/5008) for the Arrow LNG Plant are not significant, as no individuals were identified and habitat proposed to be cleared is not optimal habitat for the species.

Quassia

Quassia is a shrub, often suckering from roots, which can be found in dry rainforest, vine thickets and lowland rainforests in disjunct populations north of the Gympie district and occasionally open forests adjacent to vine thicket communities, woodlands and fringing mangrove communities on a variety of geological substrates.

The lowland rainforest, open woodland and vine thicket habitat that occurs in the study area provides suitable habitat for this species. However, this vegetatively distinct species was not observed in the study area during the field surveys, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment of the EIS.

There are records of this species in similar habitat in close proximity to the study area (<3 km to the northwest on Mount Larcom). The species was therefore assessed as having a low to moderate likelihood of being present in the study area.

The key listed threats for the species on the Species Profile and Threats database (DSEWPaC, 2011b) include clearing and disturbance from activities such as roadworks and other infrastructure works, inappropriate fire regimes and soil erosion. The response of this species to fire is unknown. However, the spread of lantana and exotic grasses may pose a threat to the quassia.

The feed gas pipeline alignment does not affect the vine thicket, or lowland rainforest communities of the project area. It traverses open woodland adjacent to the mainland tunnel launch site and on Curtis Island.

There is no recovery plan for the species.

Significant Impact Criteria – Quassia

1) Lead to a long-term decrease in the size of an important population of a species.

   While the lowland rainforest, open woodland and vine thicket habitat within the study area provide suitable habitat for this species, no individuals were identified in the study area in surveys conducted for the Arrow LNG Plant or other LNG projects. Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of an important population of the species.

2) Reduce the area of occupancy of an important population.

   No individuals were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of an important population.

3) Fragment an existing important population into two or more populations.

   No important population has been identified in the study area, as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. In addition, there will be no loss of its preferred vine thicket and rainforest habitat for the construction of the feed gas pipeline. Consequently, project activities will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found and hence no important populations of the species were identified in the study area. No areas of critical habitat for the species have been identified (DSEWPaC, 2011b). Quassia commonly occurs in lowland rainforest or on rainforest margins but it can also be found in other forest types, such as open forest and woodland. None of its preferred vine thicket and rainforest habitat will be lost for the construction of the feed gas pipeline. No specimens were identified within the study area.

5) Disrupt the breeding cycle of an important population.

   No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Quassia favours dry rainforest, vine thickets and lowland rainforests on a variety of geological substrates. No suitable habitat will be lost for the construction of the feed gas pipeline.

7) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

   Invasive flora has been identified as a threat to the species (DSEWPaC, 2011b), as areas are cleared and invasive flora takes over.

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

Weed management measures will be developed prior to initiation of construction activities, which will reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to quassia.

   The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No population has been identified in the study area, and the species was not found in field surveys within the study area. No suitable habitat will be lost for the construction of the feed gas pipeline.

It is unlikely that any impacts upon quassia are unknown, unpredictable or irreversible.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. Known populations are located outside the study area.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the project area.

Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

In conclusion, the impacts on quassia from the feed gas pipeline (Referral No. EPBC 2009/5008) for the Arrow LNG Plant are not significant, as no important habitat has been identified and the species was not identified in field surveys.

(a) Cycad

Cycas megacarpa is a small to medium-sized cycad with an erect trunk, growing to 3 m in height. It grows on margins of, or occasionally within, dry rainforest and in sclerophyll forest and woodland. It is found north from Kilkivan near Gympie to Moonlight Range, west of Rockhampton.

The dry rainforest and sclerophyll woodland habitat that occurs in the study area provides suitable habitat for *Cycas megacarpa*. However, the species is not known within the study area, and no plants were identified in field surveys. This species is usually associated with sloping country, such as Mount Larcom to the west of the study area, and as such was assessed as having a low (to moderate) likelihood of occurrence within the study area.

The recovery plan for the species (Queensland Herbarium, 2007) has identified land clearance, illegal harvesting and fragmentation of remaining populations as threats to the species.

Vegetation clearance for the Arrow LNG Plant feed gas pipeline is unlikely to take place in habitat for this species. No specimens were recorded in field surveys for the Arrow LNG Plant or for other LNG projects on Curtis Island. Within the region, the species is associated with sloping country of the Mount Larcom Range. Therefore impacts on the species from the feed gas pipeline alignment are unlikely.

Significant Impact Criteria – (a) Cycad

1) Lead to a long-term decrease in the size of a population.

   While the dry open forest and woodland habitat occurring throughout the study area provides suitable habitat for this species, no individuals were identified in and adjacent to the study area in surveys conducted for the Arrow LNG Plant and other LNG projects, which are described in Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment to the EIS. Information provided in the Species Profile and Threats database (DSEWPaC, 2011b) and the Queensland Herbarium (Queensland Herbarium, 2007) identified 46 populations of this species.

   Within the Gladstone region, these populations are not located in the vicinity of the project, as it is associated with sloping country. Populations have been found south of Mount Larcom.

   Consequently, construction and operation activities of the proposed project will not lead to a long-term decrease in size of a population of the species.

2) Reduce the area of occupancy of a species.

   Populations for the species in the Gladstone region are unlikely to be located in the vicinity of the project, being found on the slopes of Mount Larcom to the west. Therefore clearance for the project is unlikely to impact upon this species.

   No individuals or colonies were identified in the study area. Given this, project activities are unlikely to reduce the area of occupancy of a population.

3) Fragment an existing population into two or more populations.

   No population has been identified in the study area as evidenced by no individuals being discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. Consequently, project activities will not fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of a species.

   No individuals were found of this distinctive species, and hence no populations of the species were identified in the study area. There is no habitat critical to the survival of the species in the study area.

   The species is found in woodland, open woodland and open forests, often in conjunction with a grassy understory, often on undulating to hilly terrain at an altitude of 40–680 m. Suitable habitat is available adjacent to the area to be cleared for the project but not in or adjacent to the project area.

   Pre-clearance surveys will be undertaken prior to works taking place, and if any conservation listed species are found, specific mitigation measures will be developed to reduce impacts on the species.

5) Disrupt the breeding cycle of a population.

No individuals were discovered in surveys carried out for the Arrow LNG Plant and other LNG projects on Curtis Island. As no specimens were identified, it is unlikely that any critical habitat to the breeding cycle of the species will be cleared. Suitable habitat is present within the study area although no known populations were found in the study area. Therefore, project activities will not disrupt the breeding cycle of a population of *Cycas megacarpa*.

6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

   Cycas megacarpa inhabits dry rainforest and is found in sclerophyll forest and woodland, often on undulating to hilly terrain at an altitude of 40–680 m.

   Although habitat within the feed gas pipeline alignment on Curtis Island is suitable for the species, it is relatively flat and not within the preferred habitat for the species. Vegetation clearance for the feed gas pipeline is unlikely to decrease the availability of habitat to an extent that the species may decline, as no known populations are present in the study area on Curtis Island.

7) Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.

   Invasive flora was not identified as a threat to the species (DSEWPaC, 2011b).

   Arrow Energy has committed to a pest management plan (Appendix 10 to the EIS) for the project. Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs.

   Weed management measures will be developed prior to initiation of construction activities to reduce the likelihood of noxious and environmental weeds being introduced or spread into adjacent areas of habitat.

8) Introduce disease that may cause the species to decline.

   Disease has not been identified as a main threat to *Cycas megacarpa*. The pest management plan (Appendix 10 to the EIS) and quarantine management plan to be developed for the project will detail measures to prevent the introduction and spread of disease.

9) Interfere substantially with the recovery of the species.

   No recovery plan is in place for the species. No population has been identified in the study area, and the species was not found in field surveys of the study area.

   While vegetation and suitable habitat will be lost to the project, the loss of habitat is not core habitat critical to the species foothold in the region. Known populations of the species within the region are centred around Mount Larcom to the west of the study area.

It is unlikely that any impacts upon *Cycas megacarpa* are unknown, unpredictable or irreversible.

Of the main threats identified to the species (DSEWPaC, 2011b), the Arrow LNG Plant feed gas pipeline is unlikely to contribute towards the loss and fragmentation of habitat, as the species was not located in the study area.

The species was not recorded in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. Known populations are located outside the study area.

No specific mitigation is proposed for this species, as the general mitigation discussed previously in Section 6 will reduce the magnitude of impacts upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of that individual or individuals. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

In conclusion, impacts on *Cycas megacarpa* from the feed gas pipeline (Referral No. EPBC 2009/5008) for the Arrow LNG Plant are not significant, as no important habitat has been identified and the species was not identified in field surveys.

6.3.3 Marine Fauna

Six marine fauna species identified in database searches were assessed, after further desktop review and field survey, as possibly occurring within the project area. All of these species are marine turtles – flatback, loggerhead, green, leatherback, hawksbill and olive ridley turtles.

Potential impacts of the LNG facility on marine fauna are detailed further within Chapter 19, Marine and Estuarine Ecology of the EIS. Impacts from the feed gas pipeline are likely to be negligible, as discussed in Section 6. The pipeline alignment is by tunnel underneath Port Curtis, so turtle habitat will be unaffected. The impact of the vessel transfers required for materials transport, and the daily vessel movement of the pipeline construction crew will be minimal in comparison to existing and planned vessel movements in Port Curtis, and all project vessels will comply with maritime law and project standards to reduce the impacts of these transfers. Therefore, the impact upon marine turtles by the feed gas pipeline is not significant.

6.3.4 Summary of Potential Impact

Terrestrial fauna species are likely to be impacted primarily through vegetation clearance, trench fall, loss of habitat and fragmentation of existing habitat. The occurrence of large areas of similar suitable habitat to that cleared within the Gladstone area is likely to reduce the impacts on these species, as the proportion of regulated vegetation cleared within the region for the pipeline alignment is small, compared with other projects within the region, and clearance for the LNG plant site itself (see Referral No. EPBC 2009/5007).

The pipeline will involve linear clearance along the pipeline easement comprising less than 20 ha of vegetation on both the mainland (RE 11.3.4 and RE 12.11.6) and Curtis Island (RE 12.11.14). Impacts associated with this clearance are likely to be minor, as the habitat in these areas is not habitat critical to the survival of any of the listed species.

The main clearance of RE vegetation is at the mainland tunnel entry shaft and tunnel spoil disposal site, where approximately 53 ha will be removed by the project.

For most fauna species, field surveys and desktop review as part of the EIS and supporting studies have demonstrated that there is not habitat critical to the survival of a species, or any important populations present within the project area for the EPBC Act listed species assessed. Pre-clearance surveys will be undertaken across project areas to be cleared, and appropriate mitigation measures will be implemented if any EPBC listed species are confirmed within the project area.

6.4 Protected Migratory Species

An action will require approval if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species listed below are also listed as threatened

species. Species listed as threatened which are also listed as migratory (such as painted snipe) are addressed in Section 6.3 of this attachment. The criteria below are relevant to migratory species that are not threatened.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

As discussed in Section 6.3, the likelihood of a species being present within the study area was assessed in the technical studies.

All species with a rating of moderate and above likelihood (therefore possible to occur within the project area) are assessed below against the relevant significant impact criteria from the EPBC guidance note. All other species were assessed as not possible within the project area as a result of a lack of suitable habitat, or being outside of the species normal range, and therefore are not considered. The precautionary approach ensures that species that could potentially occur, despite marginal habitat or being known only from the wider region, are assessed below.

Species identified in the EPBC referral and through the course of further database searches and desktop review in the technical study, can be categorised into four groups; migratory shorebirds, other migratory wetland birds, terrestrial migratory birds and migratory marine fauna.

6.4.1 Migratory Shorebirds

Migratory shorebirds breed in the northern hemisphere and migrate to non breeding grounds of Australia along the East Asian-Australasian flyway, from the breeding grounds in Siberia southwards through east Asia to New Zealand and Australia. Migratory shorebirds depart from their breeding grounds in July to October and begin arriving in Australia from late August. Return migration occurs from around March to early June.

Habitat used in Australia varies across the species present. Intertidal habitats including coastal estuaries and mudflats are generally considered to provide the most important sites.

Thirty-six international migratory shorebird species regularly visit Australia each year. These species are listed as migratory under the EPBC Act. Species relevant to the study area are detailed in Section 5.4. Listed migratory species are a ‘matter of national environmental significance’.

The EPBC Act Policy Statement 3.21 ‘Significant Impact Guidelines for 36 Migratory Shorebird Species’ (Australian Government, 2009) provides the framework for the assessment of potential impacts upon migratory shorebird species from the Arrow LNG Plant. The policy statement builds on the information and explanations in EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance.

The policy statement is designed to help determine the impacts of proposed actions on migratory shorebird species, and to provide mitigation strategies to reduce the level or extent of those impacts. The policy aim is to promote ecologically sustainable development that allows for the continued ecological functioning of important habitat for migratory shorebirds.

Using these guidelines, a site is considered to provide important habitat for migratory shorebirds if:

- The site is identified as internationally important.
- The site supports at least 0.1 per cent of the flyway population of a single species.
- The site supports at least 2000 migratory shorebirds.
- The site supports at least 15 shorebird species.

Latham's snipe does not commonly aggregate in large flocks or use similar habitat to many other coastal species. Consequently, habitat important to Latham's snipe is not regularly identified using the process outlined above. A different method for identifying important habitat for Latham's snipe is described below.

Important habitat for Latham's snipe occurs at sites that have previously been identified as internationally important for the species, or sites that:

- Support at least 18 individuals of the species, and
- Are naturally occurring open freshwater wetland with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland).

The migratory shorebird policy statement outlines four principal threats to shorebirds within Australia. These threats form the criteria that should be considered when assessing impacts on migratory shorebirds from a project.

Habitat Loss

The loss or degradation of sites that support large numbers of migratory shorebirds can cause disproportionate declines in shorebird populations, as displaced birds are unable to find suitable replacement habitat. Similarly, the incremental loss of smaller sites affects the broader conservation of habitat. In Australia, the loss of important habitat reduces the availability of foraging and roosting sites, affecting the ability of birds to build up the energy stores necessary for successful migration and breeding. Some sites are also important year-round for juvenile birds, with loss of these habitats affecting the future breeding populations of these species.

Habitat may be lost due to a variety of activities that make the habitat unavailable to shorebirds. These may include direct loss through clearing, inundation, infilling or draining (for example, for buildings or marine services, such as harbours, marinas, ports, oil terminals) or indirect loss through changes to hydrology, water quality or structural changes near some roosting sites (for example, increased cover, encroachment of buildings).

Habitat Degradation

Migratory shorebirds are sensitive to subtle changes to their habitat. In particular, many have specialised feeding techniques making them susceptible to slight changes to prey sources and their foraging environments. Any activity that reduces the ability of shorebirds to use an area for roosting or foraging, or reduces the availability of food, degrades habitat. These activities include (among others):

- Substantial loss of marine or estuarine vegetation, which is likely to alter the dynamic equilibrium of sediment banks and mudflats, as well as providing organic matter to support the invertebrates on which migratory shorebirds feed.
- Invasion of intertidal mudflats by weeds such as cord grass (*Spartina* species).
- Water pollution and changes to the water regime.

- Artificial changes to hydrological regimes that affect the productivity of the feeding environment (for example, changes in water depth).
- Exposure of acid sulphate soils changing the chemical balance of the site.

Disturbance

Disturbance is emerging as a major conservation issue for migratory shorebirds. Certain activities may interrupt migratory shorebirds during their limited foraging periods, such as during low tide, and prevent them from foraging effectively. Disturbance can also affect roosting birds and cause them to waste energy stored for migration.

Disturbance can result from residential and recreational activities such as four-wheel-drive vehicles, jet and water skiing, power boating, fishing, walking, wind surfing, kite surfing, walking dogs, noise and night lighting. While some activities may result in only low levels of disturbance, it is important to consider the combined effects of disturbance with other threats when determining the level of potential impact of an action. Roosting and foraging birds are most sensitive to discrete, unpredictable disturbances such as sudden loud noises (for example, from demolition activities) and from objects that approach them from the water (for example, boats). High and sustained levels of disturbance can prevent shorebirds from using all or parts of the habitat.

Direct Mortality

Direct mortality of birds may occur due to a variety of reasons. Activities that may result in direct mortality may include development of wind farms in migration or movement pathways, bird strike caused by aeroplanes, and chemical or oil spills.

The impact criteria above are applied to migratory shorebirds as a whole, and then separately to Latham's snipe as the policy statement recommends.

Potential impacts from the feed gas pipeline on migratory shorebirds are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

The loss of habitat at the mainland tunnel launch site and tunnel spoil disposal area is small (less than 0.5% of the RE type in the Gladstone region), and the site is one of a network of shorebird sites around Port Curtis. Areas of key shorebird foraging habitat and shorebird roosts within Port Curtis are identified in the Curtis Coast Regional Coastal Management Plan, 2003 (Queensland Government, 2003), and do not include the mainland tunnel launch site and tunnel spoil disposal area.

Ecosure identified that 11 migratory species of shorebird were recorded within Port Curtis either during surveys for the Arrow LNG Plant or surveys for other LNG proponents (Section 5.4 of this attachment, Section 3 of Appendix 9 Terrestrial Ecology Impact Assessment to the EIS). The identified species are:

- Bar-tailed godwit.
- Common greenshank.
- Eastern curlew.
- Great knot.
- Grey-tailed tattler.
- Lesser sand plover.
- Pacific golden plover.
- Red-necked stint.
- Sharp-tailed sandpiper.

- Terek sandpiper.
- Whimbrel.

An additional 17 migratory shorebird species were identified during the course of the EPBC Protected Matters search for Referral No EPBC. 2009/5008, and were found by Ecosure to have potential to occur within the study area based on habitat preferences and distribution. The species identified through the EPBC Protected Matters search are:

- Australian painted snipe.
- Black-tailed godwit.
- Broad-billed sandpiper.
- Common sandpiper.
- Curlew sandpiper.
- Double-banded plover.
- Greater sand plover.
- Grey plover.
- Latham's snipe.
- Little curlew.
- Marsh sandpiper.
- Oriental plover.
- Oriental pratincole.
- Red knot.
- Ruddy turnstone.
- Sanderling.
- Wood sandpiper.

All of the species migrate to Australia during the southern hemisphere summer, having bred in Siberia and high Arctic regions, with the exception of the double-banded plover which is a trans-Tasman migrant and visits Australia during the winter months.

Considering the data reviewed and these guidelines, there is potential for the mudflats at the mainland tunnel launch site and tunnel spoil disposal area to be classified as important habitat for migratory shorebirds. Although significant numbers (over 0.1% of a flyway population or at least 2000 migratory shorebirds) are not likely to use this site, Ecosure identified that the site may support at least 15 migratory species.

Although the area of mudflats at the mainland tunnel launch site and tunnel spoil disposal area is relatively intact, four-wheel driving, kite flying and illegal dumping cause some disturbance to this area. Any shorebirds foraging in this area are already likely to be subjected to low to moderate disturbance.

An area of key shorebird foraging habitat identified in the Curtis Coast Regional Coastal Management Plan (EPA, 2003) is located on the eastern or seaward side of the mangroves adjacent to the mainland tunnel launch site. The mudflats on which the mainland tunnel launch site is located are not designated as part of this site, and greater numbers are likely to be present in the area on the eastern side of the mangroves, rather than the mainland tunnel launch site itself.

The mangroves will act as a visual buffer between the area of key shorebird foraging habitat and construction and operational works at the mainland tunnel launch site. There may be temporary displacement of birds from the area of mudflat closest to the works for less tolerant shorebird species, as a result of construction noise. Areas to the north and southeast of these mudflats will be relatively

undisturbed and will still provide foraging habitat for species disturbed and temporarily displaced from the areas closest to the works.

A shorebird roost site was found approximately 1 km to the southeast, at Flying Fox Creek, as identified in the Curtis Coast Regional Coastal Management Plan. This site is unlikely to be disturbed by project construction and operation activities, as it is located over 1 km to the southeast of the mainland tunnel launch site and tunnel spoil disposal area.

Further shorebird field survey work will be conducted prior to construction. A monitoring program will be undertaken at sites where impacts to migratory shorebird habitat have been identified, such as the mainland tunnel launch site and tunnel spoil disposal area. Requirements for further monitoring will be determined after an initial study to establish usage of the project area by migratory shorebirds and, if required, appropriate management measures formulated.

During construction of the feed gas pipeline, project activities may result in displacement of birds from the immediate area adjacent to the construction site. During operation, shorebird species are likely to return to use the intertidal areas for foraging as habituation takes place. Some birds may be displaced from a small area immediately adjacent to project infrastructure due to personnel and vehicle movements, and construction noise.

Significant Impact Criteria: Migratory Shorebirds

1) Habitat loss

   Approximately 53 ha of RE 12.1.2 (saltpan vegetation on clay plains) will be lost for construction of project infrastructure under referral No EPBC 2009/5008. The greater balance of the area comprises an extensive bare estuarine mudflat. This represents less than 0.5% of the RE within the Gladstone local government area.

   Shorebird habitat on the coastal margins of Curtis Island along the feed gas pipeline alignment consists of mangrove habitat and small areas of saltpan around North China Bay. It is unlikely this habitat is well utilised by shorebirds due to its small size and disturbance from other proponents' activities on Curtis Island. The area is not considered likely to support 0.1% of the flyway population of any species, over 2000 shorebirds or support 15 species of shorebird, and the habitat is not important. As such, the impacts on shorebird habitat on Curtis Island are insignificant.

   The majority of saltpan vegetation on clay plains lost for the project will be on the mainland, at the mainland tunnel launch site. Project infrastructure avoids the areas of mangrove at this site, and the nearest works will be over 60 m away from the mangrove community.

   There is potential for the mudflats at and adjacent to the mainland tunnel launch site and tunnel spoil disposal area to be classified as important habitat for migratory shorebirds. Ecosure identified that the site may support at least 15 migratory species.

   The saltpan is a small proportion of a large network of shorebird feeding and roosting sites around Port Curtis which covers an area of approximately 200 km^2. The area of saltpan to be lost is of low value and a small proportion of that present in the Gladstone area (less than 0.5%).

   Although the area of mudflats at the mainland tunnel launch site and tunnel spoil disposal area is relatively intact, four-wheel driving, kite flying and illegal dumping cause some disturbance to this area. Any shorebirds foraging in this area are already likely to be subjected to low to moderate disturbance. The loss of foraging habitat at this site is not likely to significantly decrease the foraging habitat available for shorebirds within the wider Port Curtis area.

No shorebird roost sites are present within the project footprint, and the area is not identified as key shorebird foraging habitat in the Curtis Coast Regional Coastal Management Plan, 2003 (see Figure 3).

2) Habitat degradation

The project has the potential to impact on areas of shorebird habitat through sediment mobilisation (as a result of exposure of the ground surface) and reduced water quality, leading to loss of habitat condition in adjacent areas and decline in water quality, loss of vegetation integrity as a result of increased or altered water flows and weed invasion, pollution from project use of petroleum based products or poor waste management causing runoff and spills, or release of leachates as a result of acid sulphate soil mobilisation.

Mitigation measures implemented for the project will control these impacts on adjacent areas of intertidal habitat used by shorebirds. These include implementing sediment and erosion control measures upslope of watercourses and implementation of an acid sulfate soils management plan. They also include training all relevant personnel in spill response and recovery procedures, storing fuel, oil and chemicals in appropriate, bunded storage facilities and implementing measures in the pest management plan to control invasive plant species that may colonise the saltpan and degrade remaining habitat.

As such, it is unlikely that the project will significantly degrade areas of shorebird habitat in Port Curtis.

3) Disturbance

Construction activity has the potential to displace birds from adjacent areas of mudflat preventing them from foraging, thus impacting on the fuel reserves of these migratory species. Loud, discontinuous construction noise has been identified as a major disturbance factor in shorebirds adjacent to industrial sites, although birds do become habituated to regular vehicle movements and lower levels of operational background noise, often returning to feed close to disturbed areas, with displacement solely from areas immediately adjacent to infrastructure.

The area around the mainland tunnel launch site has been identified as likely shorebird feeding habitat and part of the State Significant Wetland of Port Curtis. The site is likely to support EPBC Act listed migratory birds, and has the potential to support over 15 species of migratory shorebird, and be identified as important shorebird habitat.

The area is likely to provide habitat for migratory waders between October and April, with a peak in November to March. Smaller numbers may also be present over winter. Displacement of birds is likely from the immediate area adjacent to the construction site. This may disrupt foraging and jeopardise the ability of birds to lay down fat reserves for the northward migration or to refuel after their southern migration.

During operation, shorebird species are likely to return to use the intertidal areas for foraging, as habituation takes place. Some birds may be displaced from a small area immediately adjacent to project infrastructure and fragmentation from other areas of the mudflats may take place.

The area of saltpan is relatively intact although four-wheel driving, kite flying and illegal dumping cause some disturbance to this area. Shorebirds foraging in this area are likely to be subjected to low to moderate disturbance at this site already.

A shorebird roost site is present to the southeast of the mainland tunnel launch site, at Flying Fox Creek, as identified in the Curtis Coast Regional Coastal Management Plan, 2003 (Queensland

Government, 2003). This site is unlikely to be disturbed by construction and operation activities, as it is located over 1 km to the southeast of the mainland tunnel launch site and tunnel spoil disposal area.

An area of key shorebird foraging habitat in the Curtis Coast Regional Coastal Management Plan, 2003 is located on the eastern or seaward side of the mangroves adjacent to the mainland tunnel launch site. The saltpan on which the mainland tunnel launch site is located is not part of the key shorebird foraging habitat.

The mangroves will act as a visual buffer between this area of key shorebird foraging habitat and construction and operational works at the mainland tunnel launch site. There may be temporary displacement of birds from the area of mudflat immediately adjacent to the worksite for less tolerant shorebird species, however, areas to the north and southeast on these mudflats will be relatively undisturbed and still provide foraging habitat for species disturbed from the areas closest to the worksite.

Mitigation at this site will include consideration (in the design process) of techniques such as use of lowest possible luminescent globes, light shielding and sensitive light placement. Access will be prohibited to the saltpans and fringing mangroves outside the footprint of the mainland tunnel launch site and tunnel spoil disposal area to reduce disturbance to adjacent areas.

As such, it is unlikely that the project will significantly disturb areas of shorebird habitat in Port Curtis.

4) Direct mortality

There are few mechanisms that will result in direct mortality of shorebirds as a result of project activities. Bird strike will not be an issue during construction, and it is likely birds will be temporarily displaced from areas immediately adjacent to construction to other areas in Port Curtis.

The potential for spills is covered in significant impact criterion 2 (habitat degradation) above. There is potential for the project to aid the introduction of terrestrial pest species (such as rats, cats and foxes) into the project area, which may predate on shorebird species. Measures to reduce the likelihood of this issue will be detailed in the pest and quarantine management plans.

As such, the project is unlikely to result in the direct mortality of shorebirds in Port Curtis.

It is unlikely that any impacts upon migratory shorebirds are unknown, unpredictable or irreversible. The area of habitat lost for construction of infrastructure associated with Referral No. EPBC 2009/5008 is small, being approximately 53 ha of saltpan vegetation on clay plains. This represents less than 0.5% of the RE within the Gladstone local government area.

The mainland tunnel launch site is not identified as key shorebird foraging habitat in the Curtis Coast Regional Coastal Management Plan 2003, although it is adjacent to key foraging habitat on the seaward side of the mangroves. The inland edge of the mangroves is approximately 60 m from the nearest point of proposed construction activities. The mangroves will act as a visual buffer between the area of key shorebird foraging habitat and construction and operational works at the mainland tunnel launch site.

There may be a temporary displacement of birds from the small area of mudflat on the eastern side of the mangroves adjacent to the construction site, for less tolerant shorebird species, however, areas to the north and southeast on these mudflats will be relatively undisturbed, and still provide foraging habitat for species disturbed from the areas adjacent to the worksite.

The saltpan on which the tunnel site will be constructed, is a small proportion of a large network of shorebird feeding and roosting sites around Port Curtis, which covers an area of approximately 200 km^2. The area of saltpan to be lost is of low value and a small proportion of that present in the Gladstone area (less than 0.5%).

A shorebird roost site is present to the southeast of the mainland tunnel launch site, at Flying Fox Creek, as identified in the Curtis Coast Regional Coastal Management Plan 2003 (Queensland Government, 2003). This site is unlikely to be disturbed by project construction and operation activities, as it is located over 1 km to the southeast of the mainland tunnel launch site and tunnel spoil disposal area.

The cumulative impact contribution of the loss of shorebird habitat for the Arrow LNG Plant and other projects within the region is less than 1% for both mangrove habitat and saltpan vegetation.

Mitigation measures for the project that will reduce the impacts upon migratory shorebirds are:

- Include measures in the pest management plan to control invasive plant species that may colonise the mudflats and degrade remaining habitat [C17.13].
- Design construction lighting on the causeway at the mainland tunnel entry shaft and tunnel spoil disposal area to minimise impacts on roosting shorebirds. The lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas, where practical [C17.21].
- Prohibit access to the saltpans and fringing mangroves (RE 12.1.2 and RE 12.1.3) outside the planned area of disturbance of the mainland tunnel entry shaft and tunnel spoil disposal area [C17.24].

Arrow Energy will also undertake a monitoring program at sites where impacts to migratory shorebird habitat have been identified, which includes the mainland tunnel launch site and tunnel spoil disposal area. Requirements for further monitoring will be determined after an initial study to establish usage of project areas by migratory shorebirds and, if required, appropriate management measures formulated.

Latham's Snipe

Latham's Snipe is a non-breeding visitor to southeastern Australia. The species favours soft wet ground associated with mainly open, freshwater wetlands, as well as flooded paddocks and seepage below dams.

Suitable disturbed grassland habitat in the mainland section of the study area provides suitable foraging habitat for Latham's snipe. Consequently, the species was assessed as having a moderate likelihood of being present in the study area.

No Latham's snipe were identified in field surveys for the Arrow LNG Plant or other LNG projects on Curtis Island. The species is unlikely to be impacted by the feed gas pipeline, as no suitable wetland habitat or wet grassland will be cleared for project infrastructure.

Historically, the greatest threats to Latham's snipe in Australia have been a loss of habitat caused by the drainage and modification of wetlands, and excessive mortality due to hunting. The Arrow LNG Plant will not permit hunting to take place unless for pest control purposes (not applicable to Latham's Snipe) and construction of the feed gas pipeline will not result in the loss of any suitable wetland habitat.

Significant Impact Criteria: Latham's Snipe

1) Habitat loss

No habitat suitable for the species will be lost for construction of the feed gas pipeline infrastructure. The species favours freshwater wetlands and flooded grassland, and this habitat is not present within the project area.

Ephemeral habitat could be created in open areas of the project area, but this is likely to be short-lived and not provide key habitat for the species. Any presence would be short term in nature.

The project will not result in significant habitat loss for the species.

2) Habitat degradation

No habitat suitable for the species will be degraded as a result of the project. The species favours freshwater wetlands and flooded grassland, and this habitat is limited within the study area.

Potential impacts on any freshwater wetlands within the study area from accidental spills will be mitigated by implementing appropriate materials handling procedures and spill prevention and response plans.

The project will not significantly degrade areas of Latham's snipe habitat in the study area.

3) Disturbance

The species is unlikely to be present in or adjacent to the project area in significant numbers. As such, project activities will not significantly disturb areas of Latham's snipe habitat.

4) Direct mortality

The potential for spills is covered in significant impact criterion 2 (habitat degradation) above. There is potential for the project to aid the introduction of terrestrial pest species (such as rats, cats and foxes) into the project area, which may predate on the species. A pest management plan has been developed for the project (Appendix 10 to the EIS) and will detail the measures to prevent the introduction and spread of pest flora and fauna which may impact upon the species.

As such, the project will not result in the direct mortality of Latham's snipe.

It is unlikely that any impacts from the project on Latham's snipe are unknown, unpredictable or irreversible. The species is typically found on freshwater wetlands. There are no suitable freshwater wetlands within the project area. Consequently, the project will not impact upon this species.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species. No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this, and other, species.

In conclusion, impacts on the Latham's snipe from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no areas of habitat likely to hold the species were identified in the project area. Suitable areas of wetland habitat within the study area will not be impacted by the project.

6.4.2 Other Migratory Wetland Birds

In addition to the migratory shorebirds discussed in Section 6.4.1, database searches and field surveys identified eight species of birds listed as migratory under the EPBC Act that are associated with wetlands and marine habitats occurring, or having the potential to occur, in the study area. The identified species are:

- Caspian tern.
- Cattle egret.
- Cotton pygmy-goose.
- Eastern osprey.
- Eastern reef egret.
- Great egret.
- Little tern.
- White-bellied sea-eagle.

Of these species, Caspian tern, eastern osprey, great egret and white-bellied sea eagle were recorded in surveys for the project or for other LNG projects on Curtis Island.

Cotton pygmy goose is typically associated with freshwater lakes and swamps. Both great egret and cattle egret are common and widespread in a variety of wetland habitats. Eastern reef egret favours rocky shorelines, but it is also occasionally found in areas of mudflat. Both osprey and white-bellied sea-eagle occur on coastal and inland waterbodies. Little tern occurs in sheltered coastal areas and on ocean beaches, and Caspian tern occurs in coastal waters but also on large inland waterbodies.

Habitat loss is listed as a threat for many of the species listed above (DSEWPaC, 2011b). Invasive fauna species are also identified as a threat, preying on eggs and young. Habitat loss and degradation from invasion by pest flora species is also identified as a threat to wetland migratory species.

Potential impacts from the project on migratory wetland birds are likely to be primarily associated with clearance and habitat loss, degradation and fragmentation of remaining habitat, direct disturbance of fauna through noise and lighting and construction activities, and the introduction or spread of invasive weeds or pests.

There are no recovery plans in place for any of the listed species.

The significant impact criteria are applied for these species as follows.

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

   No freshwater wetland habitat within the study area suitable for the cotton pygmy goose will be impacted by the feed gas pipeline.

   The remaining species are associated with coastal waters, or partly associated with coastal waters. The study area contains suitable foraging and roosting habitat for these species. The suitable habitat potentially impacted by the feed gas pipeline is small, compared to the extent of similar suitable habitat within the wider Port Curtis area. It is unlikely that the area potentially impacted by the mainland tunnel launch site would be considered important habitat for these species.

   Most species will range widely within a suitable range of habitats in the Port Curtis and Gladstone area. The project will not involve the removal or disturbance of large areas of these habitats. The

feed gas pipeline will be constructed underneath Port Curtis in a tunnel; therefore the impact on coastal waters will be negligible.

The project will not result in significant habitat loss for any of the above species.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

A pest management plan has been developed for the project (Appendix 10 to the EIS) and a quarantine management plan will be developed for the project. Implementation of the plans will reduce the potential for diseases that will threaten the species to be introduced as a result of the project activities. This will include the control of feral fauna species through the pest management plan.

The project will also liaise with Biosecurity Queensland and Gladstone Regional Council on project pest management programs. This will include the control of invasive flora species which may degrade wetland habitats suitable for the above listed species.

The project will not result in invasive species harmful to the identified migratory species, being introduced to the area.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The project will not significantly disrupt the lifestyle of a migratory species within the area. All species listed above are found in a range of habitats present in the study area, and removal of these habitats is small in comparison to available habitat in adjacent areas. Therefore, the breeding, feeding, migration or resting behaviour of any of the listed species is not likely to be affected by the project.

The colonial nester, little tern is vulnerable to disturbance which leads to the colony being abandoned. No nesting sites were identified within the study area and these are more likely on the sandy beaches on the eastern side of Curtis Island.

A likely white-bellied sea eagle nest was identified on Hamilton Point, although away from the project area. The nest will be inspected for activity during the breeding season prior to construction activities commencing. If active, appropriate management measures will be formulated, including avoiding clearing activities in the breeding season, should the Hamilton Point MOF option be pursued.

As such, it is highly unlikely the project will significantly disrupt the lifestyle of migratory species within the area.

It is unlikely that any impacts from the project upon other migratory wetland birds are unknown, unpredictable or irreversible. The species listed are typically found either on freshwater wetlands or in a range of estuarine and coastal habitats. This habitat is represented by the saltpan at the mainland tunnel launch site and tunnel spoil disposal area for Referral No. EPBC 2009/5008, although the species are likely to be found in suitable wetland areas away from the project footprint, as they are wide ranging around Port Curtis. Foraging habitat lost as a result of the project is a small proportion of that available in the wider region.

The mitigation measures for migratory shorebirds, as identified in Section 6.4.1 are applicable to these species.

In conclusion, impacts on wetland migratory species from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no important habitat or populations have been identified and feeding habitat cleared is a small proportion of that available in the wider region around Port Curtis. Freshwater wetlands will not be impacted by the project.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.4.3 Terrestrial Migratory Birds

In addition to the migratory species discussed in Sections 6.4.1 and 6.4.2, database searches and field surveys identified eight species of birds listed as migratory under the EPBC Act that are predominantly associated with terrestrial habitats occurring, or having the potential to occur, in the study area. The identified terrestrial migratory species are:

- Barn swallow.
- Black-faced monarch.
- Fork-tailed swift.
- Rainbow bee-eater.
- Rufous fantail.
- Satin flycatcher.
- Spectacled monarch.
- White-throated needletail.

Of these species, all were recorded in surveys for the project or for other LNG projects bar two species, the monarch and barn swallow.

Monarch, rufous fantail, rainbow bee-eater and satin flycatcher are species primarily associated with a variety of woodland habitats, although they may also occur in mangroves within the study area. All are insectivorous species, and suitable habitat was identified as being present throughout the study area in field surveys for the project.

Barn swallow, fork-tailed swift and white-throated needletail are aerial foraging species, which will potentially forage in air space over the entire study area.

Habitat loss is listed as a threat for many of the species listed above (DSEWPaC, 2011b). The invasive fauna species, the cane toad, has been identified as a threat to the rainbow bee-eater, preying on eggs and competing for nesting holes.

Impacts from the project are likely to primarily relate to loss of habitat and fragmentation of existing habitat, as well as associated edge effects such as increased weed invasion (and habitat degradation) and predation.

There are no recovery plans in place for any of the listed species.

The significant impact criteria are applied for these species as follows.

1) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

Most species will range widely within a range of suitable habitats in the Port Curtis and Gladstone area. Removal or disturbance of large areas of these habitats is not proposed. The habitat within the area to be cleared is small in comparison to the available habitat in adjacent areas (less than 20 ha of woodland habitat on both the mainland and Curtis Island).

The project will not result in significant habitat loss for any of the above species.

2) Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.

Of these species only rainbow bee-eater is likely to be significantly affected by invasive species. Feral fauna such as cane toads, red fox and feral cats may prey on eggs and young, as the species nests in burrows on the ground. A pest management plan has been prepared and is appended to the EIS, as Appendix 10. A quarantine management plan will be developed for the project and its implementation will reduce the potential for diseases to be introduced as a result of project activities.

Arrow Energy will liaise with Biosecurity Queensland and Gladstone Regional Council on project pest management programs. This will include the control of invasive flora species which may degrade woodland and grassland habitats suitable for the above listed species.

The project will not result in invasive species harmful to the identified migratory species, being introduced to the area.

3) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The project will not significantly disrupt the lifestyle of a migratory species within the project area. All species listed above are found in a range of habitats present in the study area, and removal of these habitats is small in comparison to available habitat in adjacent areas. Therefore, the breeding, feeding, migration or resting behaviour of any of the listed species is not likely to be affected by the project.

It is unlikely that any impacts from the project upon terrestrial migratory species are unknown, unpredictable or irreversible. The species listed are found in a range of terrestrial habitats, not specific to one RE type. The cumulative loss of habitats for all projects within the Gladstone region is small, in comparison to the overall habitat available within the region. Available habitat in adjacent areas to the project includes the Curtis Island Environmental Management Precinct on Curtis Island and Targinie State Forest on the mainland.

Construction of the pipeline will involve linear clearance of less than 20 ha of woodland vegetation on both the mainland (RE 11.3.4 and RE 12.11.6) and Curtis Island (RE 12.11.14). Impacts associated with this clearance are likely to be minor as the habitat within this area is small in comparison to the available habitat in adjacent areas.

No specific mitigation is proposed for this species. General mitigation discussed previously in Section 6 will reduce the magnitude of any potential impacts on this and other species.

In conclusion, impacts on terrestrial migratory species from the Arrow LNG Plant feed gas pipeline (Referral No. EPBC 2009/5008) are not significant, as no important habitat or populations have been identified and foraging habitat cleared is a small proportion of that available in the wider region.

Pre-clearance surveys will be undertaken for the project. Any species identified in the pre-clearance surveys will result in an unavoidable loss of habitat for that species and potentially the individual or

individuals if alternative habitat is not available. This assessment has determined that, were losses to occur, they wouldn't be a significant impact. Hence, no offsets are required under the EPBC Act for this species.

6.4.4 Migratory Marine Fauna

In addition to the migratory turtles discussed in Section 5.3, database searches and field surveys identified four species of marine fauna listed as migratory under the EPBC Act as occurring, or having the potential to occur, in the study area. These are the saltwater crocodile, dugong, Australian snubfin dolphin and Indo-Pacific humpback dolphin.

Potential impacts of the LNG facility on marine fauna are detailed in Chapter 19, Marine and Estuarine Ecology of the EIS. Impacts from the feed gas pipeline are likely to be negligible, as discussed in Section 6. The pipeline alignment is by tunnel underneath Port Curtis, so turtle habitat will be unaffected. The impact of the vessel transfers required for the materials transport, and the daily vessel movement of the pipeline construction crew will be minimal in comparison to existing and planned vessel movements in Port Curtis, and all project vessels will comply with maritime law and project standards to reduce the impacts of these transfers. Therefore, the impact upon marine turtles and migratory marine fauna by the feed gas pipeline is not significant.

6.4.5 Summary of Potential Impact

There were no areas of habitat critical to the survival of a species identified for terrestrial migratory species within the project area, or significant areas likely to be disturbed or degraded as a result of the project.

The area of potential shorebird habitat on Curtis Island adjacent to the pipeline alignment in North China Bay is small, and not likely to be used by significant numbers of shorebirds. The area is already subject to high levels of existing disturbance and has not been identified as key shorebird habitat around Port Curtis.

The mainland tunnel launch site is not identified as key shorebird habitat within the Regional Coastal Plan. While shorebirds are likely to utilise the mudflats at this site, the area of habitat lost through direct loss or disturbance is small, compared to similar available habitat within the Port Curtis region. Construction and operation activities at this site are likely to displace birds from the mudflats immediately adjacent to the project site, although implementation of appropriate lighting techniques and the enforcement of no-go areas will reduce the impacts at this site.

The mangroves will act as a visual buffer between the area of key shorebird foraging habitat and construction and operations works at the mainland tunnel launch shaft site. There may be a temporary displacement of birds from the area of mudflat adjacent to the worksite for less tolerant shorebird species, however, areas to the north and southeast on these mudflats will be relatively undisturbed and still provide foraging habitat for species disturbed from the areas closest to works. The shorebird roost at Flying Fox Creek is over 1 km to the southeast and likely to be unaffected.

Effective implementation of proposed mitigation measures means that it is unlikely that the Arrow LNG Plant feed gas pipeline will have a significant impact on listed migratory species.

6.5 Cumulative Impacts

A summary of cumulative impacts related to MNES and the Arrow LNG Plant are presented below.

6.5.1 Landscape and Visual

The cumulative impact assessment considered impacts on landscape and visual amenity and of lighting from the increased number of developments planned and under construction in the Gladstone region (see Appendix 17, Landscape and Visual Impact Assessment). The method described in Chapter 23, Landscape and Visual Impact Assessment, was also used to assess cumulative impacts and adopted a qualitative approach consistent with established impact assessment guidelines. The impact assessment in Chapter 23 has already taken into account the QCLNG and GLNG projects on Curtis Island.

Landscape and Visual Cumulative Impacts

Large-scale industrial development is anticipated to expand in the Gladstone region over the next 30 years and is likely to be accompanied by large-scale supporting infrastructure. The Arrow LNG Plant will be situated within the Gladstone State Development Area, which is increasingly being characterised by industrial development.

Twelve other projects were considered in the assessment. It is possible, albeit unlikely, that construction of all projects will take place concurrently. During the construction phase, there will be major, albeit short-term, cumulative impacts on landscape character, views and visual amenity. As some projects pass from the construction to the operational phase, their impacts will diminish, e.g., underground pipelines, whereas the impacts of others may increase, e.g., operational LNG plant. Key cumulative impacts will include:

- Contrast with the current local landscape character from the presence of construction traffic and crews, construction compounds, large-scale machinery including tall cranes, and exposed soil due to cut-and-fill activities. These construction activities are likely to be perceived adversely by sensitive viewer groups.
- Changes to the landscape character and views from the mainland as the forested Curtis Island is cleared and uncharacteristic construction equipment is introduced. The Arrow LNG Plant and APLNG, GLNG and QCLNG projects will have a noticeable impact on landscape character and views.

While still significant, the cumulative impacts described above of construction on the character of the mainland will be perceived to be lower, as this area is already significantly developed for industry and zoned for further development associated with the Gladstone State Development Area.

During the operation phase, the character of a large area around Gladstone is expected to change significantly, as many of the proposed developments are located on undeveloped sites. Although industrial development is already a key characteristic of the Gladstone area, the proposed developments will be highly visible.

Appendix 17, Landscape and Visual Impact Assessment, identified several landscape character types (LCTs) in the Gladstone region (see Figure 23.2) and the impacts described below generally relate to impacts on these areas. Key cumulative impacts during operation will include:

- Considerable intensification and extension to the area of LCT 5: Industrial or extractive industries, with associated loss of some of the more ‘natural’ character areas including LCT 2: Undulating or flat forest, LCT 7: Coastal or estuarine plain, and LCT 8: Waterscape. This alteration in character is consistent with the proposals for the Gladstone State Development Area.
- Substantial alteration of the character of the Curtis Island landscape from a natural to industrial landscape. This change is significant for visual amenity of many vantage points located in Gladstone and for impacts on designated landscapes, particularly The Narrows. The proposal by

Arrow Energy to construct a tunnel beneath Port Curtis means the Arrow LNG Plant will not contribute to cumulative visual impacts on The Narrows.

There will be significant impacts on a large number of landscape and visual receptors should the majority of the developments considered in the cumulative assessment take place. Key receptors to be impacted include:

- Designated landscapes including the Great Barrier Reef World Heritage Area, areas listed on the Australian Heritage Commission Register of National Estate (The Narrows, Garden Island Conservation Park) and significant landscapes of the Curtis Coast Regional Coastal Management Plan (Islands and Offshore Features: Curtis Island; Coastal Wetlands: Curtis Island and The Narrows, and Coastal Mountain Ranges: Curtis Island strike ridge and Mount Larcom Range) (see Figure 23.1).
- Three landscape character types, LCT 1: Forested mountain or ridge, LCT 2: Undulating or flat forest, and LCT 7: Coastal or estuarine plain.
- Nine viewpoints (Viewpoints 1, 2, 4, 6, 7, 8, 10, 11 and 12) (see Figure 23.3).

The impacts on visual receptors are likely to be more significant than those on landscape resources due to the large extent of prominent industrial development proposed. This development will affect many views of the Port Curtis landscape. The four LNG projects will extend industrial development from the mainland to the island. Even though some of the character of Port Curtis is influenced by existing industrial development on the mainland, Curtis Island is currently viewed as an inherently natural landscape feature and cumulative impacts on views of the island, including to the prominent strike ridge, will be significant.

In noting the above, the construction of the other LNG projects on Curtis Island commenced in 2011. Construction of the Arrow LNG Plant is not planned until 2014. The cumulative visual impact of the Arrow LNG Plant will be low, as construction activities within the Curtis Island Industry Precinct become a familiar sight to residents of Gladstone over the next three years.

Opportunities to mitigate cumulative impacts to landscape and visual values are limited, and are confined to mitigating impacts directly associated with the Arrow LNG Plant as described in Chapter 23, Landscape and Visual of the EIS.

Lighting

Impacts from lighting are associated with the changes to the night-time visual landscape. Many of the proposed developments considered in the cumulative impact assessment will introduce light into inherently darker landscapes. These projects will substantially increase overall artificial light levels and lead to an increase in the overall levels of sky glow, glare and light trespass throughout the Port Curtis area. Sky-glow impact may extend into areas some distance from the facilities themselves.

As with impacts to landscape and visual values, mitigation measures for cumulative impacts of lighting are limited to mitigating impacts directly associated with the Arrow LNG Plant, as described in Chapter 23, Landscape and Visual of the EIS.

6.5.2 Terrestrial Environment

This section describes cumulative impacts to the terrestrial environment, specifically the landform within which the project sits and terrestrial and freshwater ecology. The assessment is based on information in Appendix 2, Geology, Soils and Landform Impact Assessment, and Appendix 9, Terrestrial Ecology Impact Assessment.

Similar impacts on terrestrial ecology values in the Gladstone region were identified by most of the projects considered in the cumulative assessment. These included vegetation clearance, habitat fragmentation and disturbance to wildfire corridors, introduced flora and fauna, altered hydrology and pollution.

Specific impacts include an increase in the loss of habitat, particularly on Curtis Island, with reduced availability of habitat for species displaced by construction projects.

The combined clearing of regulated vegetation across all projects is likely to have the most significant cumulative impact on the flora and fauna of region. Table 6.4 details the cumulative impact of clearing regulated vegetation within the Gladstone region and within Queensland, as a result of current and approved projects within the Gladstone region.

Table 6.4 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5008	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
11.11.15 (LC, -) *Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics.	0	149.30	0.00	0.38	0.03	0.03
11.11.18 (E, -) SEVT on old sedimentary rocks with varying degrees of metamorphism and folding.	0	0.80	0.00	0.04	0.02	0.02
RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	16.74	486.90	9.50	8.09	0.26	0.26
RE 12.1.2 (LC, -) Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains.	52.96	121.10	49.10	0.77	0.42	0.42
RE 12.1.3 (LC, -) Mangrove shrubland to low closed forest on marine clays and estuaries.	0	20.48	28.30	0.12	0.04	0.04
RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics.	15.93	199.90	61.70	5.72	0.67	0.66

Table 6.4 Cumulative impact of clearing regulated vegetation within the Gladstone region and the state (cont'd)

Regional Ecosystem (RE) and Status	Total Area Proposed to be Cleared under Referral 2009/5008	Total Area Proposed to be Cleared by all Projects Including Arrow LNG Plant (ha)	Percentage of Area Proposed to be Cleared for Arrow LNG Plant Compared to Third-party Projects (%)	Proportion of Area to be Cleared Compared to Extent of RE in Gladstone Regional Council Area (%)	Proportion of Area to be Cleared Compared to Extent of RE in Southeast Queensland Bioregion (%)	Proportion of Area to be Cleared Compared to Extent of RE in Queensland (%)
RE 12.11.6 (LC, -) *Corymbia citriodora, Eucalyptus creba* open forest on metamorphics ± interbedded volcanics.	1.92	483.40	14.80	0.52	0.21	0.20
RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics.	0	3.90	100.00	0.13	0.13	0.10
RE 12.2.2 (OC, CE) Microphyll/notophyll vine forest on beach ridges.	0	0.4	0.00	0.02	0.01	0.01
RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains.	0	202.60	16.00	0.98	0.47	0.47
RE 12.3.6 (LC, -) *Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens* woodland on coastal alluvial plains.	0	3.60	100.00	0.09	0.03	0.01
RE 12.3.7 (LC, -) *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest.	0	7.10	59.20	0.08	0.01	0.01

Notes: Where heterogeneous polygon exists in the literature and the percentage mix was not given (i.e., 12.11.14/12.11.4 and 12.11.6/12.11.14), the dominant RE area was chosen (in this case, 12.11.14 and 12.11.6 respectively).

[1] Regional Ecosystem status: CE = critically endangered, E = endangered, OC = of concern, LC = least concern (Vegetation Management Act, EPBC Act).

[2] Projects included APLNG Project, WBDD 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 Island Community Project, Boyne Island Aluminium Smelter Extension of Reduction Lines Project, GLNG Project, QCLNG Project, Yarwun Alumina Refinery Expansion Project.

Table 6.4 shows that, of the overall area of regional ecosystems in the Gladstone Regional Council area, the proportion to be cleared as a result of identified projects is generally low, being less than or equal to 1.0% in most cases.

Regional Ecosystem 11.3.4 (of concern), *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains, will be the most significant loss of a regional ecosystem type within the Gladstone Regional Council area. The loss as a result of all projects in the cumulative assessment will be approximately 8.1%. At a state level, this loss is approximately 0.26%.

Regional Ecosystem 12.11.14 (of concern), *Eucalyptus crebra*, *Eucaplyptus tereticornis* woodland on metamorphics with or without interbedded volcanics, will be reduced by approximately 5.7% within the Gladstone Regional Council area, and 0.66% at a state level.

The following impacts are likely to be more apparent within these ecosystems as a result of cumulative losses:

- Reduced existing habitat patches including the loss of habitat function 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 required by a wide range of terrestrial fauna species for shelter and breeding, including arboreal mammals, microbats, owls, parrots and ducks. This could result in impacts on several threatened species, including the powerful owl, glossy black-cockatoo and several species of listed microbat.
- The cumulative loss of mangrove habitat, which supports several species of threatened fauna. Increased fragmentation of the coastal mangrove corridor may increase impacts to the water mouse and several species of migratory and non-migratory shorebird (including eastern curlew and beach stone-curlew).

Overall, the cumulative impact of the Arrow LNG Plant on habitat loss is considered low. In the case of LNG projects, development will take place within the Curtis Island Industry Precinct, which covers less than 3% of Curtis Island and lies adjacent to an Environmental Management Precinct. The Curtis Island National Park lies further to the north. These undeveloped areas provide alternative habitat opportunities. Similarly, on the mainland, most industrial development is proposed along the coastal strip and typically away from heavily forested areas.

Arrow Energy will provide environmental offsets for unavoidable impacts arising from the development of the Arrow LNG Plant. Similar conditions have been placed upon other LNG projects on Curtis Island. Areas requiring offsets will be further defined in consultation with regulatory agencies following completion of the Arrow LNG Plant front end engineering and design and prior to the commencement of construction (see Chapter 17, Terrestrial Ecology of the EIS).

7. OUTLINE OF ENVIRONMENTAL MANAGEMENT PLAN

Environmental management and mitigation measures specific to EPBC listed species and communities are set out below. Further details are provided in Attachment 6, Environmental Management Plan.

7.1 Structure of Environmental Management Plan

The environmental management plan (EMP) details environmental values, issues and impacts, and associated management measures for Arrow Energy to implement during construction, operation and decommissioning of the project. The plan has been developed in accordance with the project terms of reference and addresses environmental issues identified during the environmental impact assessment process. While the EMP is part of the EIS it is designed as a stand-alone document for reference and use during the project. As such, the plan is a 'living' document intended to be updated as the project proceeds through construction to operation and finally to decommissioning.

The key objectives of the EMP are:

- To document acceptable environmental management strategies and control actions and environmental protection commitments to manage identified potential impacts on the environment as a result of proposed activities, and in doing so, help the administrating authority decide on the conditions of the environmental authority for the project.
- To develop the project with minimal adverse impacts on the environment by selecting and applying mitigation measures that reduce impacts to levels that are as low as reasonably practical.
- To address any other matters required under a local, state or federal environmental protection policy or regulation.
- To provide a document that can be referred to during the design of the LNG plant and ancillary facilities, and form the basis in preparing construction planning and standard operating procedures.
- To provide the community with evidence that the environmental management of the project is acceptable.

The environmental protection commitments of the EMP are based on the preferred project options, derived from site-specific environmental assessments from specialists, environmental best practices and proven research where available.

7.1.1 Environmental Management Plan Scope

The EMP describes Arrow Energy's approach to the management of environmental impacts associated with the planning, construction, operation and decommissioning/ rehabilitation of the project. Broadly the EMP describes the following:

- Arrow's Health, Safety and Environmental Management System (HSEMS).
- Existing and proposed activities associated with the project.
- Existing environment of the project area and surrounds, including relevant environmental values.
- Potential impacts of project activities on identified environmental values.

- Environmental management measures for each of the following environmental elements to minimise the identified potential environmental impacts:
  - Climate and climate change.
  - Greenhouse Gas
  - Geology, landform and soils.
  - Land contamination and acid sulfate soils.
  - Surface water hydrology and water quality.
  - Groundwater.
  - Coastal processes.
  - Marine water quality and sediment.
  - Terrestrial ecology.
  - Freshwater ecology.
  - Marine and estuarine ecology.
  - Greenhouse gas.
  - Air quality.
  - Noise and vibration.
  - Landscape and visual.
  - Indigenous cultural heritage.
  - Non-Indigenous cultural heritage.
  - Social
  - Economic
  - Traffic and transport.
  - Hazard and risk.
  - Land use and planning.
  - Waste management.
  - Decommissioning and rehabilitation.

Each element of the plan provides a short summary of the existing environment and impacts pertaining to that discipline. Management measures for all project-related activities from design and planning through to decommissioning are detailed for each element, under the following structure:

- Environmental objectives.
- Performance criteria.
- Implementation strategy.
- Inspection and Monitoring.
- Auditing.
- Reporting.
- Corrective action.

7.2 Environmental Offsets

Environmental offsets are applied at the federal and state level where impacts on ecological assets cannot be avoided or adequately mitigated. Offsets could be direct, indirect, or both. Direct offsets are preferred under the majority of offset policies as they are more likely to deliver conservation outcomes.

Direct offsets may encompass securing in perpetuity existing habitat, restoring and securing degraded habitat or re-establishing habitat. Indirect offsets might include contributions to research programs, implementing recovery plan actions, removing threatening processes or contributing to trust funds for consolidated purchase and restoration of strategic habitat.

The level of offsets required for the project has not been specified at this stage. An Offsets Strategy will be developed for the project. Areas where offsets may be required will be further defined in consultation with DERM and the Department of Sustainability, Environment, Water, Population and Communities and other government stakeholders prior to commencement of construction [C17.02].

Table 7.1 describes those terrestrial ecological values which may require an offset and the likely difficulty of finding a suitable offset receiving site. This table refers to infrastructure associated with both this referral and referral 2009/5007 (LNG plant and ancillary infrastructure) and will be further refined during FEED and the development of the offset strategy for the project as the project footprint is refined.

Table 7.1 Potential offset requirements and degree of difficulty of replacement

Value	Regional Ecosystem and Status	Area to be Cleared (ha)	Likely Offset Policy Trigger	Degree of Difficulty in Replacing
Regional Ecosystem	RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	46.4	Policy for Vegetation Management Offsets	Low
Regional Ecosystem	RE 12.11.14 (OC, -) *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics	123.38	Policy for Vegetation Management Offsets	Low/Medium
Regional Ecosystem	RE 12.11.4 (OC, -) SEVT on metamorphics ± interbedded volcanics	3.91	Policy for Vegetation Management Offsets	Medium/High
Regional Ecosystem	RE 12.3.3 (E, -) *Eucalyptus tereticornis* woodland to open forest on alluvial plains	25.69	Policy for Vegetation Management Offsets	Medium/High
High Value Regrowth	RE 11.3.4 (OC, -) *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	8.03	Regrowth Vegetation Code	Low
Essential Habitat	For koala/coastal sheathtail bat	46.4	Policy for Vegetation Management Offsets	Low
Cupaniopsis sp. indet	Status pending		Biodiversity Offsets Policy (Qld) and/or EPBC Act	High

Notes: Regional Ecosystem Status (VMA) E = Endangered, OC = Of Concern.

A marine offsets strategy will be established for the project to compensate for the loss of marine and estuarine habitat as a result of the project. Offsets developed under the strategy will follow the principles outlined under the Commonwealth offsets policy and may include:

- Rehabilitation of ‘like-for-like’ habitats that demonstrate ecological equivalence in the Gladstone region.
- Creation of artificial habitats that provide as-similar-as-possible ecological functions as the area that is to be lost in the Gladstone region.
- Facilitate, or otherwise manage under agreement, unprotected habitat and actively manage and protect the habitat as a conservation area. The habitat must demonstrate ecological equivalence to the area that is to be lost. Habitat should be purchased in the Gladstone region if possible; however, if this is not feasible, greater conservation value may come from locating offsets elsewhere.

Arrow Energy will comply with environmental and legal criteria of the Queensland Government environmental offsets policy as the overarching framework for a specific-issue offset policy (see Fish Habitat Management Operational Policy FHMOP 005). The policy follows similar principles to the Commonwealth policy and provides specific information on fish habitat areas.

Locations for offsets have not yet been identified and will require further assessment based on environmental suitability for ecological equivalence, feasibility and stakeholder engagement responses. The specific details of the offsets for the project will be provided in the marine offsets strategy.

8. APPROVALS AND CONDITIONS

In accordance with the Commonwealth Minister's decision, as well as the Coordinator General declaring the project a 'significant project', the Arrow LNG Plant will be assessed under a bilateral agreement between the Queensland and Commonwealth governments. Under this agreement, the Commonwealth Government has accredited the Queensland SPDWO Act and EIS process to meet the impact assessment requirements under Commonwealth legislation.

Pursuant to this agreement, the EIS will be coordinated by the Queensland Department of Employment, Economic Development and Innovation (DEEDI). Relevant Commonwealth, Queensland and local government authorities have been invited to participate in the EIS process as advisory agencies.

The following section details the principle project approvals required for the construction and operation of the LNG plant.

8.1 Principal Project Approvals

The principal project approvals required for the construction and operation of the LNG plant include the following:

- Petroleum Pipeline Licence. The project requires a petroleum pipeline licence under the Petroleum and Gas (Production and Safety) Act for the construction and operation of the proposed feed gas pipeline and tunnel.
- Petroleum Survey Licence. The project requires a petroleum survey licence under the Petroleum and Gas (Production and Safety) Act to provide for investigative survey work to be conducted in relation to the petroleum facility and petroleum pipeline.
- Environmental Authority. Under the Queensland Environmental Protection Act 1994 (Qld), petroleum activities are classified as either level 1 or level 2 chapter 5A activities for which an environmental authority is required. The project (with the exception of the environmental authority to support the petroleum survey licence) requires a level 1 chapter 5A environmental authority for petroleum activities to provide for the proposed feed gas pipeline along with other environmentally relevant activities (ERAs) associated with the project.
- Material Change of Use of Premises. The feed gas pipeline on Curtis Island will be constructed on land within the Curtis Island Industry Precinct as identified in the Development Scheme for the Gladstone State Development Area (GSDA). Additional material change of use of premises and development permits may be required for any associated infrastructure as specified under the SP Act and the SDPWO Act.
- Major Hazard Facility. The project requires a major hazard facility development permit as specified under the Sustainable Planning Act 2009 (SP Act) and the Dangerous Goods Safety Management Act 2009 (Qld).

8.2 Additional Environmental Permits and Approvals

In addition to the principal project approvals, other permits and approvals will need to be obtained before certain aspects the project can proceed. These will include but are not limited to:

- A Native Title Agreement may be required under the Native Title Act 1993. Arrow will need to seek agreements with relevant Aboriginal groups to conduct petroleum activities on land where native title may exist.
- A cultural heritage management plan will need to be developed and approved in accordance with the Aboriginal Cultural Heritage Act 2003 (Qld).
- A number of approvals will be required under the Coastal Protection and Management Act 1995 (Qld) (CPMA). This may include approval to damage vegetation on state coastal land, as well as approval for the placement or removal of quarry material below the high water mark.
- An operational works permit will be required under the Fisheries Act 1994 to remove, destroy, or damage marine plants in the event that Arrow needs to establish waterway barrier works to carry out activities through watercourses.
- A clearing permit is required to take or move protected plants under the Nature Conservation Act 1992. For the purposes, protected plants include any plant prescribed under the act as threatened, rare or near threatened that is in the wild.
- Hydrostatic test water for the proposed feed gas pipeline will most likely be seawater or fresh water. Approval to take seawater would be required under the Water Act 2000 (Qld) for the hydrostatic testing of the feed gas pipeline.
- A licence is required to store flammable and combustible liquids under the *Dangerous Goods Safety Management Act 2001*. The Dangerous Goods Safety and Management Act sets standards for the storage and handling of substances (such as flammable and combustible liquids).
- A rehabilitation permit under Division 6 of the Nature Conservation (Wildlife) Regulation 2006 may be required to allow the movement of wildlife in instances not otherwise authorised under the Nature Conservation Act. Such a permit may be required to allow relocation of wildlife accidentally trapped during construction.

A list of Commonwealth, Queensland and regional legislation, regulations, policies, strategies, guidelines, international treaties, protocols and accepted codes of practice that will guide and direct the approval of the project is provided in Attachment 1 (Relevant Legislation, Policies and Approvals).

9. ENVIRONMENTAL RECORD

Arrow is committed to the sound management of health, safety and the environment throughout all of its business activities. The company maintains a comprehensive and integrated Health, Safety and Environmental Management System (HSEMS) based on the principles of the International Standard for Environmental Management Systems - AS/NZS ISO 14001(AS/NZS, 2004) and the Australian Standard for Occupational Health and Safety Management System - AS/NZS 4801:2000 AS/NZS, 2001.

Arrow Energy Holdings Pty Ltd (Arrow) and/or its subsidiaries have received two penalty infringement notices (PINs) relating to non-compliances with Environmental Authority conditions issued under the Queensland Environment Protection Act 1997. The PINs related to:

1. Unauthorised clearing of a Category B Environmentally Sensitive Area; and
2. Unauthorised release of coal seam gas water to land.

Arrow is not aware of any other fines or prosecutions for breaches of environmental legislative requirements in the past five years.

10. CONCLUSIONS

The MNES components likely to be affected by the project have been assessed. The mitigation measures proposed to address these impacts have been identified. A summary of impacts and their significance on MNES are discussed below.

GBRWHA and Port Curtis National Heritage place

Activities within the GBRWHA, such as vegetation clearance are unlikely to have a significant effect on the health and functioning of the ecosystem within the GBRWHA and Port Curtis, or cause any values of the GBRWHA to be lost, degraded or damaged. Clearing within the GBRWHA on Curtis Island for the pipeline corridor is minimal compared with similar habitat in adjacent areas to the north of the project area on Curtis Island in the Curtis Island Environmental Management Precinct.

Various attributes of the GBRWHA within Port Curtis will be modified as a result of the project, but with successful mitigation, the impacts on the GBRWHA and Port Curtis Natural Place from the project are not significant.

Threatened Ecological Communities

No threatened ecological communities are likely to be impacted by project infrastructure relating to this referral. The critically endangered community "*Littoral rainforest and coastal vine thickets of eastern Australia*" is vulnerable to introduced pest flora and fauna species as a result of increased traffic to surrounding areas, but by prohibiting access to vehicles and workers, and implementation of pest control measures, this critically endangered community will be protected and the impacts from the project will not be significant.

Listed Threatened Species

Terrestrial fauna species are likely to be impacted primarily through vegetation clearance and loss of habitat. The occurrence of suitable habitat within the Gladstone area is likely to reduce the impacts on these species, as the proportion of regulated vegetation cleared within the region is low.

Eucalypt woodland will be cleared on the mainland and Curtis Island for the pipeline construction right of way and associated access tracks. No threatened species were identified in these areas throughout the course of fieldwork or the desktop review, and should any protected species be found during pre-clearance surveys for the project, appropriate mitigation measures will be developed.

Listed Migratory Species

Potential impacts from the Arrow LNG Plant include disturbance of migratory bird species at the mainland tunnel launch site, although the area is not identified as key shorebird habitat within the regional coastal plan. However, shorebirds are likely to utilise the mudflats at this site, but the area of habitat lost through direct loss or disturbance is small, compared to similar available habitat within the Port Curtis region.

Effective implementation of proposed mitigation measures means that it is unlikely that the Arrow LNG Plant will have a significant impact on listed migratory species.

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APPENDIX 1: COMMITMENTS RELATING TO MANAGEMENT OF IMPACTS ON MNES

Table A1 Mitigation measures applied to the management of impacts on MNES

No.	Commitment
Geology, Landform and Soils	
C11.01	Prior to construction, carry out detailed geotechnical ground investigations to assess site specific ground conditions and provide recommendations on slope placement, geometry and drainage.
C11.04	Design the tunnel spoil placement area to minimise adverse impacts associated with ground compaction, erosion and surface water runoff such that a self sustaining landform is achieved. Incorporate appropriate drainage measures into the design.
C11.05	Limit clearing of vegetated areas to the project area. Areas will be stabilised and progressively rehabilitated to reduce prolonged exposure of soils.
C11.07	Manage surface runoff to reduce concentration of surface flow, particularly in erodible soils. Provide drainage channels with suitable design features to minimise erosion where surface runoff is disrupted by roads, tracks, fencing and buildings. Place structures within drainage channels to reduce flow velocity where appropriate. Common with Chapter 13, Surface Water Hydrology and Water Quality.
C11.11	Implement sediment and erosion control measures upslope of watercourses, wetlands and coastal areas or in areas with sodic soils to minimise increases in natural sediment discharge. Measures may include sediment traps, silt fencing, riprap, contour banks, detention dams, sediment ponds and vegetation and diversion berms. Common with Chapter 13 Surface Water Hydrology and Water Quality.
C11.14	For pipeline trenching activities reinstate soil profiles to pre-disturbance orientation, where practical, using excavated topsoil.
C11.16	Prior to construction commencing, develop a site drainage plan to define how the civil construction will address site drainage, stormwater management, erosion control and stockpile placement. Risks relating to flood events will also be addressed with appropriate mitigation measures to minimise erosion and surface water quality issues. Common with Chapter 13, Surface Water Hydrology and Water Quality.
C11.22	Design and construct a barrier and sediment control pond to trap sediment leaving the LNG plant site before it enters the Port Curtis marine environment or other surface waters.
C11.29	Re-profile and reinstate topsoil, vegetation and re-establish a stable surface, where practical, during decommissioning and rehabilitation of the LNG plant site. Common with Chapter 13, Surface Water Hydrology and Water Quality.
Land Contamination and Acid Sulfate Soils	
C12.01	Prior to construction, the extent of contamination will be further defined where required, and mitigation measures will be refined as appropriate.
C12.11	Chemicals and fuel use or storage: Construct facilities in accordance with relevant Australian standards.
C12.13	Future chemicals and fuel use or storage: Immediately clean up any spills and conduct investigations into any relevant releases.
C12.17	Develop an ASS management plan prior to construction work. In the plan, specify how onsite ASS disturbances should be managed in accordance with SPP2/02 and the methods set out in Queensland acid sulfate soil technical manual soil management guidelines (Dear et al., 2002). Common with Chapter 14, Groundwater.
Surface Water Hydrology and Water Quality	
C13.07	Keep the footprint of the mainland tunnel entry shaft and tunnel spoil disposal area to a minimum of 500 m clear of Boat Creek. Common with Chapter 18, Freshwater Ecology.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Surface Water Hydrology and Water Quality (cont'd)	
C13.08	Treat stormwater generated from TWAF 7, TWAF 8, launch site 1, the tunnel shaft entry site and tunnel spoil disposal area in temporary sediment basins located at each site.
C13.10	Manage all surface water generated from the LNG plant site by a stormwater treatment system to ensure discharged water complies with regulatory requirements. Common with Chapter 31, Waste Management.
C13.11	Provide secondary containment for any fuel, oil or chemicals in above ground storage facilities in accordance with applicable Australian standards.
C13.12	Develop appropriate spill prevention and response plans to cover project activities and the types and quantities of fuel, oil and chemicals held at each site. Common with Chapter 14, Groundwater and Chapter 31, Waste Management.
C13.13	Train all relevant personnel in spill response and recovery procedures. Common with Chapter 31, Waste Management.
C13.15	Do not abstract freshwater from watercourses, or dispose of effluent directly into freshwater watercourses, except clean stormwater. Common with Chapter 18, Freshwater Ecology.
C13.16	Where waterway crossings are necessary, cross ephemeral streams in preference to permanent streams, where practical. Where pipeline waterway crossings are necessary, approach stream crossings perpendicular to the stream where possible, to reduce bank erosion risk and minimise the footprint within the bed and riparian zone. Common with Chapter 18, Freshwater Ecology.
C13.22	Where works are required in watercourses, they will be confined to reduced width construction right of ways that preserve, to the extent possible, the integrity of the riparian vegetation and any associated wildlife corridors. Common with Chapter 18, Freshwater Ecology.
C13.24	Treat all surface water and stormwater generated within the LNG plant site in a stormwater system to ensure discharged water meets regulatory requirements.
C13.25	Collect contaminated stormwater for treatment before discharge.
Groundwater	
C14.01	Design the facility drainage system such that accidental releases of hazardous substances are collected to reduce the chance of contamination seeping into the groundwater system.
C14.02	Prepare a materials handling and waste management plan to manage any potential contaminants, soils or materials that might result in impacts to shallow groundwater through either short term or long term leaching.
C14.04	Store fuels, chemicals and hazardous wastes in appropriately sized, bunded storage facilities (in leak proof sealed containers). Common with Chapter 31, Waste Management.
Coastal Processes	
C15.02	Develop a dredge management plan that considers the appropriate water and sediment monitoring data (e.g., current WBDD Project data) and will include:
C15.03	• Requirements for monitoring of water quality.
C15.04	• Actions to be taken to minimise impacts of dredging on sensitive areas should water quality monitoring data show performance criteria are exceeded. Finalise specific actions in the dredge management plan. Common with Chapters 16, Marine Water Quality and Sediment and Chapter 19, Marine and Estuarine Ecology.
C15.05	Implement management measures from the dredge management plan to address impacts from maintenance dredging.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Marine Water Quality and Sediment	
C16.03	Prior to discharge to Port Curtis, test and treat excess water at the mainland tunnel launch site in an on-site water treatment plant to meet water quality criteria.
C16.04	Test and treat all discharges to Port Curtis to meet water quality criteria, as required, prior to discharge.
C16.05	Develop spill response plans to cover marine activities, including all vessel operations.
C16.10	Store on board wastes produced by vessels that cannot be discharged under the MARPOL Convention and then transfer to an approved onshore facility for treatment, reuse, recycling or disposal.
C16.11	Where practical, schedule the timing of maintenance dredging to coincide with the most favourable climatic conditions for minimising impacts to water quality and sediment (i.e., during neap tides when water currents are weakest or periods of calm winds and waves).
Terrestrial Ecology	
C17.01	Prepare construction and operations environmental management plans. These documents are to include detailed information about significant flora and fauna species and their management and ongoing conservation. Include site-specific mitigation and details of monitoring and inspection to be undertaken, in the environmental management plans consistent with advice provided by government.
C17.02	Determine areas (if any) requiring to be offset in consultation with DERM and DSEWPC and other government stakeholders prior to commencement of construction. This is likely to include the two areas of 'endangered' (Vegetation Management Act) remnant vegetation (RE 12.3.3; Assets 27 and 31) within the LNG plant site, and the *Cupaniopsis* sp.indet population.
C17.03	An area of semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained by the project on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of the semi-evergreen vine thicket community will be fenced off with a 20-m buffer between the semi-evergreen vine thicket community (including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi-evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. Do not develop within the fenced area of the retained semi-evergreen vine thicket community. Establish roles and responsibilities for the management of the retained semi-evergreen vine thicket community.
C17.05	Route the haul road for the Hamilton Point MOF option away from the eastern margin of the headland to avoid the 'critically endangered' RE 12.2.2 (Microphyll/notophyll vine forest) on beach ridges.
C17.06	Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works.
C17.07	Develop fauna relocation protocols as part of fauna management measures including procedures if fauna is found during clearing activities, including in hollows of trees to be felled.
C17.10	Liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Notify Gladstone Regional Council of any new declared or notifiable pest species. These programs should particularly focus on the boundaries of the project site with the Environmental Management Precinct.
C17.13	Include measures in the pest management plan to control invasive plant species that may colonise the mudflats and degrade remaining habitat.
	Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
C17.16	Shield/direct the light source onto work areas where practical. Common with Chapter 19, Marine and Estuarine Ecology and Chapter 23, Landscape and Visual.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Terrestrial Ecology (cont'd)	
C17.17	Use long-wavelength lights, where practicable, including use of red, orange or yellow lights. Common with Chapter 19, Marine and Estuarine Ecology.
C17.18	Lower the height of the light sources as far as practical. Common with Chapter 19, Marine and Estuarine Ecology.
C17.19	Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practicable). Common with Chapter 19, Marine and Estuarine Ecology.
C17.20	Design lighting around the perimeter of the LNG plant to minimise impacts on roosting shorebirds, where practical. Lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal zones, where practical.
C17.21	Design construction lighting on the causeway at the mainland tunnel entry shaft and tunnel spoil disposal area to minimise impacts on roosting shorebirds. The lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas, where practical.
C17.22	Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present.
C17.23	Clearly mark no go zones, where required, including the semi evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the 'critically endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected).
C17.24	Prohibit access to the saltpans and fringing mangroves (RE 12.1.2 and 12.1.3) outside the planned area of disturbance of the mainland tunnel entry shaft and tunnel spoil disposal area.
C17.25	Conduct pre-clearance surveys across project areas to be cleared of vegetation. The surveys will aim to determine whether any threatened species are present at each site. Appropriate mitigation measures will be implemented if threatened species are confirmed within the area.
C17.27	Reduce vegetation clearing where practical and only after all other options such as selective clearing and trimming of vegetation have been considered.
C17.34	Undertake all handling and management of fauna in compliance with permits issued by DERM.
C17.35	Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access).
C17.36	Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench.
C17.38	Identify areas to be rehabilitated and develop procedures for restoration and maintenance.
Freshwater Ecology	
C18.01	Implement strategies and protocols relevant to the protection of freshwater aquatic communities, habitat and processes, as detailed in the Australian Pipeline Industry Association Code of Environmental Practice: Onshore Pipelines (APIA, 2009) as part of the project.
Marine and Estuarine Ecology	
C19.01	Develop a construction management plan, which contains specific mitigation measures, performance indicators and management actions required to reduce impacts to the marine and estuarine ecological values.
C19.02	Establish a marine offsets strategy for the project to compensate for the loss of marine and estuarine habitat as a result of the project.
C19.04	Contribute to the development of a Port of Gladstone shipping activity strategy and management plan. Comply with applicable speed limits for the Port of Gladstone-Rodds Bay Zone B dugong protection area, as detailed in the management plan.
C19.05	Install (where feasible) propeller guards (or equivalent) on high-speed vessels to reduce the impact of injury in the event of boat strike.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Marine and Estuarine Ecology (cont'd)	
C19.06	Implement soft-start procedures where a sequential build-up of warning pulses will be carried out prior to commencement of full-power pile-driving activities.
C19.07	Undertake fauna observations prior to and during pile-driving and dredging activities to check for the presence of marine turtles, dugongs and cetaceans. Should fauna be spotted within the area of the works, implement procedures to minimise impact, such as reverting to soft-start piling or stopping temporarily to allow animals to move away from the area.
C19.08	Keep dredging activities within the identified dredge footprint area.
C19.09	Maintain a fauna-spotting function (where practical) during dredging activities. Do not commence dredging if marine mammals, turtles or crocodiles are spotted within the area of dredging, and stop temporarily if fauna is spotted within the area of the dredge head. In both cases, resumption of dredging must wait until fauna has moved away.
C19.10	Project vessels servicing the LNG plant that originate from overseas ports must comply with Commonwealth and local government ballast water management systems and implement Australian Quarantine and Inspection Service hull hygiene measures.
C19.11	All project vessels must comply with all applicable maritime law, especially when passing through the GBRMP. Project vessels will traverse the marine park via designated navigation routes with pilotage as required within port boundaries.
Greenhouse Gas	
C20.01	Develop and implement a greenhouse gas standard as part of Arrow's HSEMS.
Air Quality	
C21.01	Design the LNG plant to comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas.
C21.07	Reduce exposure time of bare soils on the ground surface as far as practicable, and undertake revegetation of bare surfaces as soon as practical following construction.
C21.08	Maintain construction vehicles and equipment regularly to reduce exhaust emissions.
C21.09	Where practical, use low-sulfur diesel fuel in diesel-powered equipment (i.e., not more than 0.01% sulfur by mass).
C21.11	Where practical, limit the volume of hydrocarbons flared or vented to the atmosphere from the LNG plant. Ensure that the flare is luminous and bright (i.e., show smokeless combustion at operating design gas flow rate) and the relative density of emitted smoke does not exceed No.1 Ringelmann Number.
C21.12	Do not vent boil-off gas to the atmosphere; instead route it to the feed gas inlet for reprocessing or sent to the end flash gas compressor for use in the high-pressure fuel gas system.
C21.13	Use low-sulfur fuel in diesel-powered generators will (not more than 0.01% sulfur by mass).
C21.14	Maintain equipment in accordance with manufacturer specifications in order to minimise fugitive emissions.
Noise and Vibration	
C22.01	Identify during the detailed design of the LNG plant, specific acoustic treatment to be applied to each noise source.
C22.04	Regularly maintain all machinery and equipment and check for excessive noise generation.
C22.07	Ensure that project related noise generated during operation complies with the project noise criteria at all assessment locations.
Landscape and Visual	
C23.01	Protect the tip of Boatshed Point from clearing and cutting to preserve areas of vegetation that help screen lower parts of the LNG plant and construction camp.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Landscape and Visual (cont'd)	
C23.02	Where practical, retain the vegetation along the eastern boundary of the LNG plant site to provide some screening to views from the east.
C23.03	Consider potential landscape and visual impacts where there are options for the siting of infrastructure.
C23.06	Investigate opportunities for further planting of a forested landscape buffer around the eastern, southern and western boundaries of the LNG plant site, using bush regeneration techniques and endemic tree species of local provenance consistent, to the greatest extent, with the bushfire strategy.
C23.07	Select materials that are sensitive to the site context where plant operability is not impacted.
C23.08	Use a colour palette for built form that blends with the predominant background colours and which reflects natural hues from the surrounding landscape where plant operability is not impacted.
C23.19	Undertake planting rehabilitation works at the earliest opportunity to minimise erosion and the presence of areas of bare soil (except where technical studies indicate an alternative approach).
C23.20	Minimise night-time working and associated lighting impacts for activities (including construction of the LNG plant). Limit construction activities that need to be highly lit to daytime hours (to the greatest extent practical).
Indigenous Cultural Heritage	
C24.01	Develop an approved CHMP or a native title agreement that addresses Aboriginal cultural heritage in consultation with the endorsed Aboriginal parties for the project.
C24.02	Comply with the approved CHMP or native title agreement that addresses Aboriginal cultural heritage.
Non-indigenous Cultural Heritage	
C25.01	Prepare a heritage management plan prior to construction and which specifies how known and unknown heritage sites are to be managed during construction.
Traffic and Transport	
C28.09	Develop a shipping activity management plan in consultation with Gladstone Regional Council, Gladstone Ports Corporation, Maritime Safety Queensland and all contractors operating within the Gladstone Port. Common with Chapter 29, Hazard and Risk.
C28.10	Operators of project vessels, Arrow Energy staff and contractors, to comply with the Gladstone port procedures manual, which details LNG operating parameters.
C28.11	Ensure that operators of project vessels, Arrow Energy staff and contractors comply with the LNG marine operations maritime safety management plan if/when this plan is agreed between Maritime Safety Queensland, Gladstone Ports Corporation and the other LNG proponents. Common with Chapter 29, Hazard and Risk.
Waste Management	
C31.01	Implement employee training and other programs that encourage employees to reduce waste.
C31.02	Ensure that contractors comply with Arrow's Health, Safety and Environmental Management System (HSEMS) and implement a waste management plan in accordance with the procedure.
C31.28	Design the effluent treatment plant package units to meet the final effluent discharge requirement.
C31.30	Monitor treated effluent and reroute any discharge that is off-specification back to the effluent treatment plant for retreatment.
C31.31	Make alternative storage and disposal options available during times of system failure and in conditions preventing discharge to land such as rain events. Distribute the effluent treatment plant discharge to tanks for re-use on site. The tanks can be by-passed and the treated effluent discharged to the marine outfall if necessary.

Table A1 Mitigation measures applied to the management of impacts on MNES (cont'd)

No.	Commitment
Waste Management (cont'd)	
C31.47	Develop an emergency response plan for the project and include spill contingency or emergency measures. Make material safety data sheets available at the LNG plant and other project sites to aid in the identification of appropriate spill clean-up and disposal methods.
C31.48	Ensure that specific spill prevention procedures cover the unloading and loading activities at the LNG jetty and MOF in accordance with applicable international standards and guidelines. Spill prevention procedures will specifically address advanced communications and planning with the receiving terminal.