



APPENDIX 10

ARROW LNG PLANT

Pest Management Plan

A close-up photograph of a fox's face, showing its orange fur, white muzzle, and dark eyes. The fox is looking slightly to the right. The background is a blurred natural setting with green grass and brown seed heads.

ecosure

final

arrow LNG plant

terrestrial ecology pest management plan

september 2011

Arrow CSG (Australia) Pty Ltd and
Coffey Environments Australia Pty Ltd

Acronyms

Abbreviation	Description
AQIS	Australian Quarantine Inspection Services
DEEDI	Department of Employment, Economic Development and Innovation (Queensland)
DEH	Department of Environment and Heritage (Commonwealth)
DEWHA	Department of Environment, Water, Heritage and the Arts (Commonwealth) (now DSEWPC)
DPI&F	Department of Primary Industries and Fisheries (Queensland) (former State Agency, now a unit of DEEDI)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)
EMP	Environmental Management Plan
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
GRC	Gladstone Regional Council
LNG	Liquefied natural gas
LP Act	<i>Land Protection (Pest and Stock Route Management) Act 2002</i> (Queensland)
MOF	Marine offloading facility
ND	Non declared pest species under legislation (LP Act)
PMP	Pest management plan
QLD	Queensland
TWAF	Temporary workforce accommodation facility
WoNS	Weeds of National Significance

Glossary

Term	Description
1080 baiting	1080 is the common name given to the poison sodium fluoroacetate that is used as a vertebrate pesticide. 1080 is registered for the control of wild dogs, feral pigs, rabbits and foxes in Queensland and is currently the most efficient, economical and species-selective chemical currently available for pest animal control.
Arbovirus	Viruses which develop in and are carried by arthropods, e.g., mosquitoes, ticks. These viruses are transmitted to vertebrate species via bite from the arthropod. Such viruses include Dengue Fever and Malaria.
Biosecurity Queensland	Biosecurity Queensland sits within Department Employment, Economic Development and Innovation and combines the biosecurity resources and functions of the former Queensland Department of Primary Industries and Fisheries, Department of Natural Resources and Water and Environmental Protection Agency. It is responsible for protecting Queensland's primary industries, environment and way of life. Invasive plant and animal management and disease are the main areas of expertise of Biosecurity Queensland.
Class 1 Pest	Pest species not commonly found in Queensland and if introduced, would cause an adverse economic, environmental or social impact. Class 1 pests are subject to eradication from Queensland.
Class 2 Pest	Pest species established in Queensland which has, or could have an adverse economic, environmental or social impact. The management of Class 2 pests requires coordination and they are subject to programs implemented by local government, the community or landowners. Landholders must take all reasonable steps to keep land free from Class 2 pests.
Class 3 Pest	Pest species commonly found in Queensland. Control is required under legislation, however only if the plant is impacting on, or may impact on, an environmentally significant area, such as a national park. It is an offence to introduce, release or supply these plants.
Declared Pest	A species (plant or animal) declared under the <i>Land Protection (Pest and Stock Route management) Act 2002</i> (Queensland). These species are targeted for control under state legislation and are species that have, or may have, a serious impact on Queensland's economy, environment or society. Landholders must control declared species.
Ecosystem	The physical and biological components of an environment that function as a combined unit.
Environmental Weed	Any plant, either introduced or native, that impacts on native ecosystems and adversely affects indigenous flora and fauna.
Fauna	Animal life.
Fire ant restricted area	Areas where restrictions apply for soil disturbance and movement of high-risk materials within Queensland. All fire ant restricted areas are currently within south-east Queensland.
Flora	Plant life.
Integrated Pest Management	A pest control strategy which incorporates a range of complementary approaches including physical, biological, chemical and mechanical controls.
Key Threatening Process	The <i>Environment Protection and Biodiversity Conservation Act 1999</i> provides for the identification and listing of key threatening processes. These are a process which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.
Liquefied Natural Gas	Natural gas that has been converted to liquid form by cooling to a very low temperature. Liquid natural gas is easier than gas to store and transport and takes up approximately 1/600 th the volume of natural gas at a stove burner tip.

Term	Description
Myrtaceous	Trees and/or shrubs of the Order Myrtaceae.
Non-declared Animal	An animal listed as non-declared under the LP Act including non-native mammals, reptiles or amphibians that are widespread but do not have significant commercial, environmental or social impacts or for which there is no effective control method available. This also includes animals kept for a commercial or social benefit.
Notifiable Pest	A species, which when suspected or identified, must be reported to Biosecurity Queensland.
Pest	A plant or animal which has, or may have, a significant impact/s on Queensland's primary industries, natural ecosystems, and human and animal health and is declared to be a pest under legislation.
Putrescible	Organic matter liable to decay and become putrid.
Rhizomatous	A horizontal stem, usually underground, which sends out roots and shoots, from which new plants develop.
Terrestrial Fauna	Land-based animal.
Terrestrial Flora	Land-based plant.
Vector	Animals which transmit disease from one host to another, however are usually unaffected by the disease

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1 Introduction

1.1 Purpose

This pest management plan (PMP) has been developed in accordance with the Terms of Reference for the project (Final Terms of Reference for the Shell Australia LNG Project [now Arrow LNG Plant] Environmental Impact Statement, as issued by the Coordinator General of the State of Queensland, January 2010) to address the management of terrestrial pest flora and fauna. Appendix E cross references each of the relevant requirements from the Terms of Reference with the information provided in this plan. This PMP reflects the pest management priorities of Gladstone Regional Council (GRC) and the Queensland State Government (Biosecurity Queensland - Department of Employment, Economic Development and Innovation [DEEDI]) for the identification and control of pest flora and fauna. Consultation was undertaken with both Biosecurity Queensland and Gladstone Regional Council during development of this plan.

The purpose of the PMP is to:

- Identify declared pest species within, and/or immediately adjacent to the study area.
- Identify potential pest species which may be introduced to the study area or immediate surrounds, by the construction and/or operation of the LNG plant and associated infrastructure.
- Describe the potential impacts of identified pest species on terrestrial ecological values.
- Detail measures for the mitigation and management of identified pest flora and fauna including existing plans, policies, strategies and/or guidelines.
- Describe procedures for the monitoring of pest flora and fauna.
- Detail reporting requirements with regard to the identification and management of pest flora and fauna.

The PMP applies to the construction, operational and decommissioning phases of the project. All relevant organisations and individuals, including the proponent, direct employees, contractors and visitors to the project site must act in accordance with the PMP.

The PMP should be considered in the development of the project Environmental Management Plan (EMP) and Induction Procedures.

This report needs to be read in conjunction with the Terrestrial Ecology Impact Assessment (Ecosure, 2011). Ecosure (2011) establishes the terrestrial ecological values present in the study area, along with their sensitivity. It also identifies the issues and potential impacts, which include pest flora and fauna, likely to affect existing values. The significance of impacts on each value was assessed in Ecosure (2011) before and after application of mitigation measures.

1.2 Objectives

The specific objectives for pest management during the project are:

- To prevent the introduction of new pest flora and fauna species to the project site and adjacent areas, including access routes and receiving waterways.
- To assist in the eradication of any high priority pest flora and fauna (as identified by GRC and/or DEEDI) within and/or immediately adjacent to the project site.
- To eradicate where possible, or contain and reduce, other pest flora and fauna within and/or immediately adjacent to the project site.
- To work in cooperation with other LNG proponents within the LNG development corridor to ensure the efficient control of pest flora and fauna.
- To undertake regular reporting of pest management activities and advise of new infestations as required.

1.3 Project Description

1.3.1 Proponent

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

1.3.2 Arrow LNG Plant

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

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

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

LNG Plant

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

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

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

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

Construction Schedule. The plant will be constructed in two phases. Phase 1 will involve the construction of LNG trains 1 and 2, two LNG storage tanks (each with a capacity of between 120,000 m³ and 180,000 m³), Curtis Island construction camp and, if additional capacity is required, a mainland workforce accommodation camp. Associated marine infrastructure will also be required as part of Phase 1. Phase 2 will involve the construction of LNG trains 3 and 4 and potentially a third LNG storage tank. Construction of Phase 1 is scheduled to commence in 2014 with train 1 producing the first LNG cargo in 2017. Construction of Phase 2 is anticipated to commence approximately five years after the completion of Phase 1 but will be guided by market conditions and a financial investment decision at that time.

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

LNG Plant Power

Power for the LNG plant and associated site utilities may be supplied from the

electricity grid (mains power), gas turbine generators, or a combination of both, leading to four configuration options that will be assessed:

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

Liquefaction Process

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

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

A propane, precooled, mixed refrigerant process will be used by each LNG train to liquefy the predominantly methane coal seam gas. The liquefaction process begins with the propane cycle. The propane cycle involves three pressure stages of chilling to pre-cool the coal seam gas to -33°C and to compress and condense the mixed refrigerant, which is a mixture of nitrogen, methane, ethylene and propane. The condensed mixed refrigerant and precooled coal seam gas are then separately routed to the main cryogenic heat exchanger, where the coal seam gas is further cooled and liquefied by the mixed refrigerant. Expansion of the mixed refrigerant gases within the heat exchanger removes heat from the coal seam gas. This process

cools the coal seam gas from -33°C to approximately -157°C. At this temperature the coal seam gas is liquefied (LNG) and becomes 1/600th of its original volume. The expanded mixed refrigerant is continually cycled to the propane precooler and reused.

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

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

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

Workforce Accommodation

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

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

Two workforce construction camp locations are proposed: the main construction camp at Boatshed Point on Curtis Island, and a possible mainland overflow construction camp, referred to as a temporary workers accommodation facility (TWAF). Two potential locations are currently being considered for the mainland TWAF; in the vicinity of Gladstone city on the former Gladstone Power Station ash pond No.7 (TWAF7) or in the vicinity of Targinnie on a primarily cleared pastoral grazing lot (TWAF8). Both potential TWAF sites include sufficient space to accommodate camp infrastructure and construction laydown areas. The TWAF and its associated construction laydown areas will be decommissioned on completion of the Phase 1 works.

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

expected to relocate to Gladstone with the majority housed in company facilitated accommodation.

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

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

Marine Infrastructure

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

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

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

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

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

- South Hamilton Point (MOF 2): This MOF option would be located at the southern tip of Hamilton Point. The haul road from this site would traverse the saddle between the hills of Hamilton Point to the southwest boundary of the LNG plant site. The quarantine area for this option will be located southwest of the LNG plant near the LNG storage tanks.
- North Hamilton Point (MOF 3): This option involves shared use of the MOF being constructed for the Santos Gladstone LNG Project (GLNG Project) on the northwest side of Hamilton Point (south of Arrow Energy's proposed LNG jetty). The GLNG Project is also constructing a passenger terminal at this site, but it will not be available to Arrow Energy contractors and staff. The quarantine area for this option would be located to the north of the MOF. The impacts of construction and operation of this MOF option and its associated haul road

were assessed as part of the GLNG Project and will not be assessed in this EIS.

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

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

The two location options for the mainland launch site are:

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

Feed Gas Pipeline

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

- A short length of feed gas pipeline will run from the proposed Arrow Surat Pipeline to the tunnel launch shaft, which will be located on a mudflat south of Fishermans Landing, just south of Boat Creek. This section of pipeline will be constructed using conventional open-cut trenching methods within a 40-m wide construction right of way.
- The next section of the feed gas pipeline will traverse Port Curtis harbour in a tunnel to be bored under the harbour from the mainland tunnel launch shaft to a receival shaft on Hamilton Point. The tunnel under Port Curtis will have an excavated diameter of up to approximately 6 m and will be constructed by a tunnel boring machine that will begin work at the mainland launch shaft. Tunnel spoil material will be processed through a de-sanding plant to remove the bentonite and water and will comprise mainly a finely graded fill material, which will be deposited in a spoil placement area established within bund walls constructed adjacent to the launch shaft. Based on the excavated

diameter, approximately 223,000 m³ of spoil will be treated as required for acid sulfate soil and re-used as fill at this location.

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

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

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

Dredging

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

- Dredge site 1 (dredge footprint for launch site 1): The dredging of this site would facilitate the construction and operation of launch site 1. This dredge site is located in the Calliope River and extends from the intertidal area abutting launch site 1, past Mud Island to the main shipping channel. The worst-case dredge volume estimated at this site is approximately 900,000 m³.
- Dredge site 2 (dredge footprint for launch site 4N): The dredging of this site would facilitate the construction and operation of launch site 4N. This dredge site would abut launch site 4N and extend east from the launch site to the shipping channel. The worst-case dredge volume identified at this site is approximately 2,500 m³.
- Dredge site 3 (dredge footprint for Boatshed Point MOF 1): The dredging of this site would facilitate the construction and operation of the personnel jetty and MOF at Boatshed Point. This dredge site would encompass the area around the marine facilities, providing adequate depth for docking and navigation. The worst-case dredge volume identified at this site is approximately 50,000 m³.
- Dredge site 4 (dredge footprint for Hamilton Point South MOF 2): The dredging of this site would facilitate the construction and operation of the MOF at Hamilton Point South. This dredge site would encompass the area around the marine facilities, providing adequate depth for docking and navigation. The worst-case dredge volume identified at this site is approximately 50,000 m³.
- Dredge site 5 (dredge footprint for LNG jetty): The dredging of this site will facilitate the construction of the LNG jetty at Hamilton Point. This dredge site extends from the berth pocket to be dredged as part of the Western Basin

Strategic Dredging and Disposal Project to the shoreline and is required to enable a work barge to assist with construction of the jetty. The worst-case dredge volume identified is approximately 120,000 m³.

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

1.4 Study Area

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

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

1.5 Project Area

The balance of the project area is located upon the southwestern extent of Curtis Island and includes Hamilton Point, Boatshed Point and the area southwest of Ship Hill. On the mainland, the mainland tunnel entry shaft and tunnel spoil disposal area is southeast of Boat Creek and on the coastal side of Gladstone-Mount Larcom Road. TWAF7 is on the Calliope River to the north of Gladstone-Mount Larcom Road and TWAF8 lies to the west of Targinie State Forest. Launch site 1 is northeast of TWAF7 and is located at the entrance to the Calliope River. The project area is shown on Figure 1.

1.6 Pest Risk

This project may have a number of impacts on the ecological values of the study area and surrounds, one of which is the potential introduction and/or increased presence of pest flora and fauna species.

A number of key project activities, throughout the construction and operational phases, may potentially facilitate the introduction/spread of weeds and pest animals, or plant diseases, namely:

- Vehicle, equipment and personnel movement between mainland sites and between the mainland and the Curtis Island facility.

- Direct shipping to MOFs.
- Importing of fill and/or plants to the project area.
- Vegetation clearing activities.
- Vehicle washdown and inspection.
- Waste management.
- Changes to hydrology including the introduction of areas of ponded water.

Significant resources are invested by state and local Governments in the ongoing management of pest species. Arrow Energy has requirements, under the *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act), to implement measures aimed at preventing the introduction and spread of pest species throughout the duration of this project.

1.6.1 Biosecurity

Limited primary production areas of terrestrial plant communities of commercial significance were identified within the study area, during field and desktop surveys. Observations based on field survey data and project area locations indicated that the project will not access these areas.

In addition, desktop investigations did not identify any diseases or animal pathogens which may impact upon such primary production areas. It was therefore considered that a Biosecurity Management Plan for the mitigation of potential impacts on primary production areas of plant communities of commercial significance was not required.

Biosecurity issues relevant to MOFs are referred to in the Marine and Estuarine Ecology Impact Assessment for this project (Coffey Environments, 2011) and activities at quarantine facilities will be governed by a Quarantine Management Plan. The scope of this Pest Management Plan (PMP) includes terrestrial pest species which may enter the MOFs via ships.

Figure 1 Study and Project Area

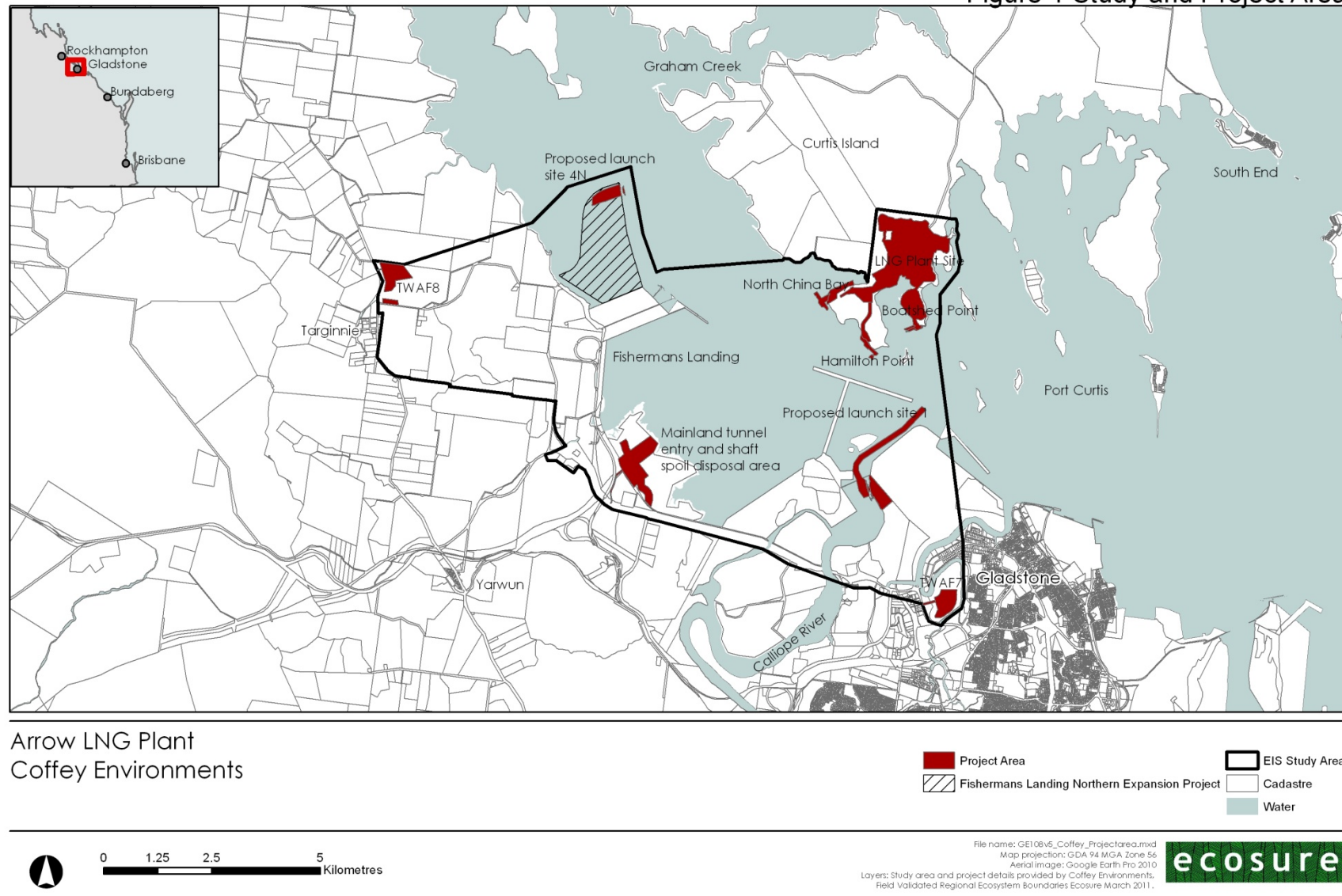


Figure 1 Arrow LNG Plant study and project area.

1.7 Legislative Context

There are numerous legislative instruments which influence the management of pest flora and fauna in Australia and, specifically, Queensland. A summary of those most relevant to pest management aspects of the project is provided below.

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth): The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's primary piece of environmental legislation. It provides a legal framework to protect and manage matters of national environmental significance.

The EPBC Act provides for the identification and listing of key threatening processes, defined as a process which threatens, or may threaten the survival, abundance or evolutionary development of a native species or ecological community (DSEWPC, 2009). Pest species are a common component of key threatening processes, for example, predation by the European red fox and damage to native vegetation by feral rabbits or unmanaged goats.

Land Protection (Pest and Stock Route Management) Act 2002 (Qld): The *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) requires the control and/or eradication of species of flora and fauna identified by state or local law as having a significant adverse impact on the environment and primary production areas.

Plant Protection Act 1989 (QLD): The main objectives of the *Plant Protection Act 1989* are to:

- Prevent, control or remove infestations of pest plants.
- Enable the state (Queensland) to assist other jurisdictions in the prevention, control or removal of plant pests, diseases, pest infestations, infections or conditions.
- Facilitate the movement of plants into, and out of, Queensland.

The act provides for the declaration of a pest species as a 'notifiable pest'.

Australian Weeds Strategy (Natural Resource Ministerial Council, 2006): The purpose of the Australian Weeds Strategy is to reduce the detrimental impact of weeds on agriculture and the environment. The strategy addresses weed issues of national significance, in particular those that threaten Australia's agricultural industries and biodiversity. Under the strategy, a number of Weeds of National Significance (WoNS) have been identified and specific strategies developed to manage these weeds.

Queensland Weeds Strategy 2002-2006 (Land Protection, 2002a): The Queensland Weeds Strategy is linked to the Australian Weeds Strategy and establishes a statewide planning framework for the management of weeds by government, community, industry and individuals. The strategy is based on best practice principles of pest management and provides for the management of impacts on agriculture, ecosystems, human health and natural resources.

The Queensland Weeds Strategy is a statutory requirement under the LP Act and is currently under review by the Biosecurity Queensland.

Queensland Pest Animal Strategy 2002-2006 (Land Protection, 2002b): The Queensland Pest Animal Strategy establishes a statewide planning framework for the management of pest animals by government, community, industry and individuals. The strategy is based on best practice principles of pest management and provides for the management of impacts on primary industries, ecosystems, human health and natural resources.

The Queensland Pest Animal Strategy is a statutory requirement under the LP Act and is currently under review by Biosecurity Queensland.

Gladstone City Council Pest Management Plan 2007-2012 (Gladstone City Council, 2007) and Calliope Shire Council Pest Management Plan 2005-2008 (Calliope Shire Council, 2005): These PMPs identify the pest management priorities of each local authority and describe the obligations of landholders for the management and reporting of pest flora and fauna. Since the amalgamation of these local authorities, the PMPs have been under review to facilitate the development of single PMP for GRC. Until such a time as a single plan is adopted, landholders must consider the priorities and reporting requirements of each PMP, in consultation with GRC.

Gladstone Regional Council – Local Laws (Gladstone City Council, 2007): Under the LP Act, a local authority also has the legislative ability to declare, under Local Law, pest plants and animals, within its Local Government area. Local laws can enforce control requirements of these identified pests. No such policy or laws have been gazetted at this time.

1.8 Review

This PMP will be subject to regular review by the proponent to ensure management, monitoring and reporting procedures continue to be carried out in accordance with legislative requirements and best practice pest management procedures. This should encompass a review of DEEDI weed mapping to ensure any changes to the distribution of new and existing species is considered within the context of the project area.

1.9 Methods

Pest flora and fauna within and adjacent to the study area were recorded/observed during desktop investigations and surveys for the terrestrial ecology component of this study. Refer to Section 3 of the Arrow LNG Plant Project Terrestrial Ecology Impact Assessment (Ecosure, 2011) for detailed methods.

The literature review for the PMP has included Biosecurity Queensland's Annual Pest Distribution Survey data (DEEDI, 2009a) and Queensland Herbarium naturalised flora data (Bostock and Holland, 2010).

Specific species management measures are not detailed in this plan as best practice management information and guidelines have been developed by the state and Commonwealth governments. Rather than replicate this information, detailed references and links to relevant documents have been included. This also ensures management measures will remain current as these documents are reviewed regularly by these entities.

2 Pest Flora

A number of declared pest plants, under the LP Act, have been identified throughout the Gladstone region by GRC and DEEDI. In addition, various environmental weeds have also been identified by GRC as posing a significant risk to the environment, although these are not currently declared under legislation.

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

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

Local authorities may also declare species which have not been declared under the LP Act, through Local Law provisions (DEEDI, 2011a).

Desktop and field surveys were undertaken between 2009 and 2011 to identify the presence of pest flora within, and adjacent to the study area (Ecosure, 2011). Of the 56 weed species identified within the study area (Appendix A), three are declared species under the LP Act, of which two are listed as WoNS.

Pest species which have not been observed in the study area, but which are a recognised priority of GRC and DEEDI have also been considered in this PMP. These species are included as they are considered likely to occur in the study area and/or may potentially spread as a result of new development within the region, including the Arrow LNG Plant. Any pest flora species which is found to occur, but which has not been specifically included in this management plan, should be managed in accordance with DEEDI and best practice guidelines.

2.1 Potential Impacts of Pest Flora

The construction, rehabilitation works, operation and maintenance of the proposed LNG plant and associated infrastructure have the potential to introduce new, and spread existing, weed species and plant diseases.

Of primary concern are:

1. The potential introduction of declared and environmental weeds to natural areas.
2. The introduction and spread of weeds to adjacent/nearby primary production areas.

Impacts associated with the introduction and spread of the weed species listed below may include:

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

2.2 Identified Pest Flora Species

Table 1 lists those declared pest species identified within and adjacent to the study area, through desktop and field surveys. This table also lists pest species known to occur in the Gladstone region (DEEDI, 2009a) and therefore likely to occur in the study area.

Table 1 Declared pest flora observed in or adjacent to the study area

Botanical Name	Common Name	Status	Status	GRC Priority	Source
		(WONS)	(LP Act)		
<i>Asparagus plumosus</i>	Feathered Asparagus Fern (similar to Climbing Asparagus)		Class 3	1	Surveyed ^{out}
<i>Bryophyllum delagoense</i> (syn. <i>B. tubiflorum</i> and <i>Kalanchoe delagoensis</i>)	Mother of Millions		Class 2	1	Surveyed ^{out} , DEEDI
<i>Cryptostegia grandiflora</i>	Rubber Vine	*	Class 2	1	Surveyed ⁱⁿ , DEEDI
<i>Hymenachne aplexicaulis</i>	Hymenachne	*	Class 2	1	Surveyed ^{out}
<i>Lantana camara</i> var. <i>camara</i>	Lantana	*	Class 3	2	Surveyed ⁱⁿ
<i>Lantana montevidensis</i>	Creeping Lantana		Class 3	2	Surveyed ^{out}
<i>Macfadyena unguis-cati</i>	Cats Claw Creeper		Class 3	2	Surveyed ^{out}
<i>Opuntia stricta</i>	Prickly Pear		Class 2	1	Surveyed ⁱⁿ
<i>Opuntia tomentosa</i>	Velvet Tree Pear		Class 2	1	Surveyed ^{out}
<i>Parthenium hysterophorus</i>	Parthenium	*	Class 2	1	DEEDI

Botanical Name	Common Name	Status	Status	GRC Priority	Source
		(WONS)	(LP Act)		
<i>Sporobolus pyramidalis</i>	Giant Rat's Tail Grass		Class 2	1	Surveyed ^{out}
<i>Thevetia peruviana</i>	Yellow Oleander		Class 3	2	Surveyed ^{out}

Surveyedⁱⁿ – observed within the study area

Surveyed^{out} – observed outside the study area

DEEDI – from DEEDI 2009a

Figure 2 provides an overview of the distribution within the study area of declared plant species identified through field surveys. This includes data from DEEDI, who undertake annual mapping of Class 1 and 2 declared pest species throughout the Gladstone region (DEEDI, 2009a).

Appendix A provides a list of all weed species observed within the study area and Appendix B details the vegetation assessment sites where observations were made.

Figure 2 Pest Flora

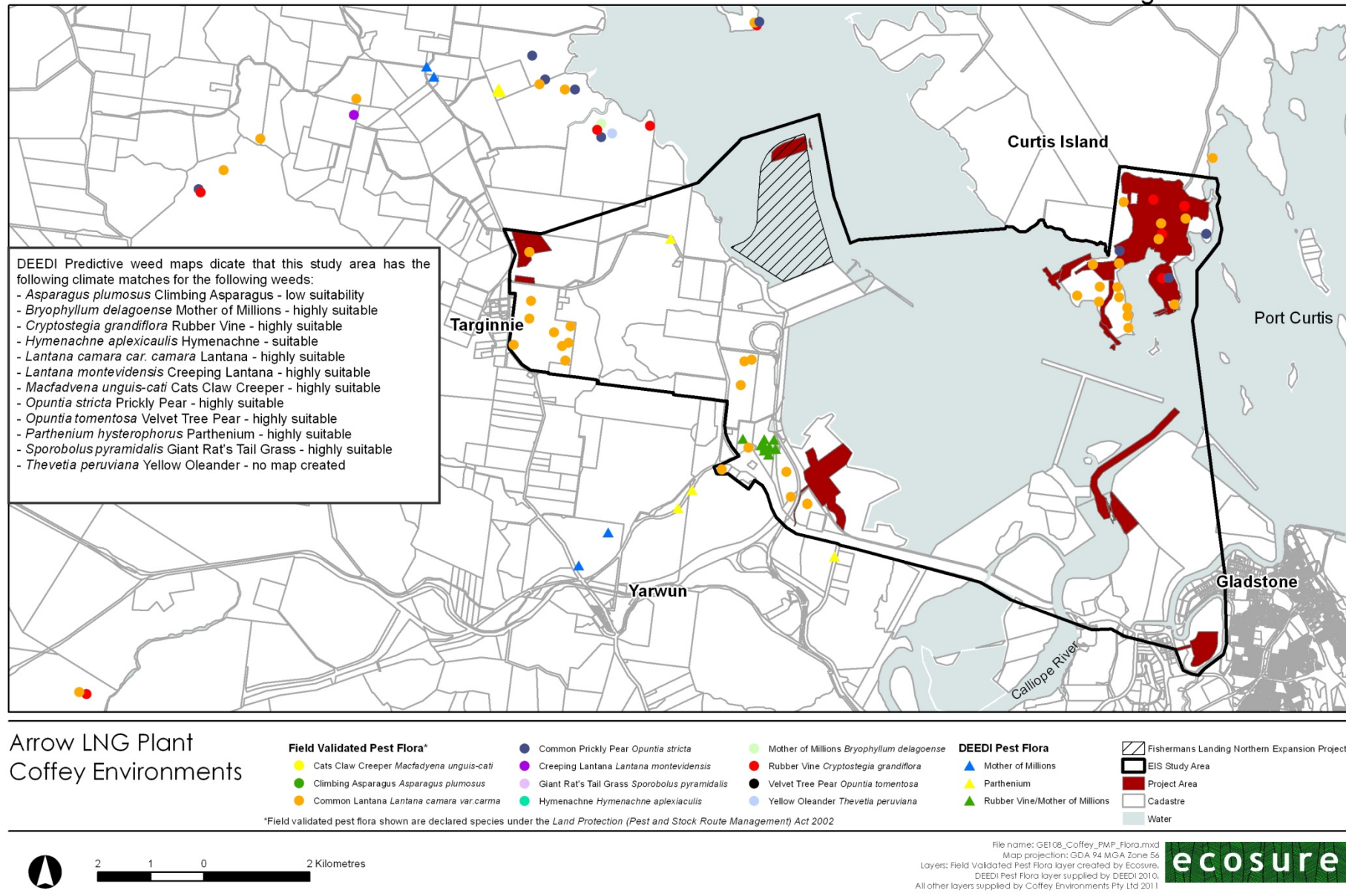


Figure 2 Pest Flora

2.2.1 Area Specific Occurrence

Table 2 provides an overview of the likely occurrence of pest flora at specific project sites (based on field and desktop surveys data). This will assist in determining location specific management measures for the pest management component of the EMP. Those species not identified as known or likely to occur may still be found at any of the project sites. The nature of these pest species is such that they are able to exploit disturbed ground across a variety of habitats.

Table 2 Likely occurrence of pest flora at project sites (project sites identified in Figure 1)

	Feathered Asparagus Fern	Mother of Millions	Rubber Vine	Hymenachne	Lantana	Creeping Lantana	Cats Claw Creeper	Prickly Pear	Velvet Tree Pear	Parthenium	Giant Rats Tail Grass	Yellow Oleander
Mainland tunnel entry shaft and tunnel spoil disposal area		L	L		K					L		
Boatshed Point			K	L	K			K				
North China Bay					K			K				
Hamilton Point					K							
LNG Plant Site			K	K	K			K				
TWAF7												
TWAF8					K					L		L
Launch Site 1		L	L		L							

K – known to occur

L – likely to occur

3 Pest Fauna

A number of declared pest animals have been identified throughout the Gladstone region by GRC and DEEDI. These include species identified under the EPBC Act as a designated 'Key Threatening Process'.

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

- Class 1 – these species are not well established within Queensland, however have the potential to become a significant pest. All Class 1 animals are subject to eradication within Queensland and it is an offence to introduce, keep or supply these animals without a permit.
- Class 2 – pest animals already established within Queensland that have, or could have, substantial impacts. Coordinated control programs (led by government, the community or landholders) are required to eradicate or prevent the spread of these species. Landholders are obligated, under legislation, keep their land free of these animals and it is an offence to introduce, keep or supply these animals without a permit.
- Class 3 – these animals are common in areas of the state. Control is required under legislation, however only if the animal is impacting on, or may impact on, an environmentally significant area, such as a national park. It is an offence to introduce, feed or supply these animals.

Local authorities may also declare species which have not been declared under the LP Act, through Local Law provisions (DEEDI, 2011a).

Numerous non-declared pest fauna have also been identified as priorities for control by these entities. Non-declared species are those listed under the LP Act which are not considered to have significant environmental or social impacts or which are species for which no effective control method exists (DEEDI, 2009d).

Curtis Island has been identified (Ecosure, 2009) as being a high conservation status offshore island and is within the top 50 priority Australian offshore islands in terms of biodiversity value and impacts from feral species. The *Prioritisation of high conservation status of offshore islands* report to DEWHA recommends actions to maintain the integrity and ecological functioning of key areas. Key amongst these is building on the existing knowledge base for the area as well as considering the biosecurity implications of pest eradication.

The desktop review and findings of field surveys have indicated the presence of a range of pest animals which are known or likely to occur within and/or adjacent to the study area. Of the eight species identified, six are listed as a 'Key Threatening Process' under the EPBC Act, five are declared species and three are non-declared species under the LP Act.

Pest fauna present within the Gladstone region, however not identified within the study area, have also been considered due to the potential risk of intrusion as a result of the project. Any pest fauna

species which is found to occur, but which has not been specifically included in this management plan, should be managed in accordance with DEEDI and best practice guidelines.

3.1 Potential Impacts of Pest Fauna

Field data and the literature review indicate the widespread presence of a range of pest species throughout the study area and the greater Gladstone region. It is therefore possible that the construction, operation and maintenance of the project infrastructure will have the potential to introduce new, and facilitate the spread of existing, pest animal species.

Pest animals may have significant environmental and economic impacts in addition to the potential threat they may pose for human and animal health. These may include:

- Reduction of ecological values as a result of predation, competition, habitat degradation and the introduction of disease.
- Reduced productivity of primary production areas outside of the study area, or future primary production areas within the study area.
- Predation of livestock.
- Costs associated with control.
- Damage to infrastructure.

3.2 Identified Pest Fauna Species

Table 3 lists pest species identified within the study area through desktop and field surveys, which may require active management. This table also lists pest species known to occur in the Gladstone region and therefore likely to occur in the study area (DEEDI, 2009a). Other pest fauna species, such as the common myna (*Acridotheres tristis*) and common starling (*Sturnus vulgaris*) are likely to occur however were not sighted.

Table 3 Pest fauna known to occur in, or adjacent to, the study area

Common Name	Scientific Name	Key Threatening Process (EPBC Act)	Status (LP Act)	Source
Cane Toad	<i>Rhinella marina</i>	* (biological effects, including lethal toxic ingestion)	ND	FS DR
Wild Dog (other than a domestic dog) and Dingo	<i>Canis familiaris</i> and <i>Canis familiaris dingo</i>		Class 2	FS DR
Horse	<i>Equus caballus</i>		ND	FS DR
Feral Cat (other than a domestic cat)	<i>Felis catus</i>	* (predation)	Class 2	DR
European Hare	<i>Lepus capensis</i>		ND	FS
European Rabbit	<i>Oryctolagus cuniculus</i>	* (competition, land degradation)	Class 2	DR
Black Rat	<i>Rattus rattus</i>	* (impacts on native biodiversity on offshore islands)	ND	FS DR

Common Name	Scientific Name	Key Threatening Process (EPBC Act)	Status (LP Act)	Source
Feral Pig	<i>Sus scrofa</i>	* (predation, habitat degradation, competition, disease transmission)	Class 2	FS(indicated) DR
European Red Fox	<i>Vulpes vulpes</i>	* (predation)	Class 2	FS DR

FS – Field survey

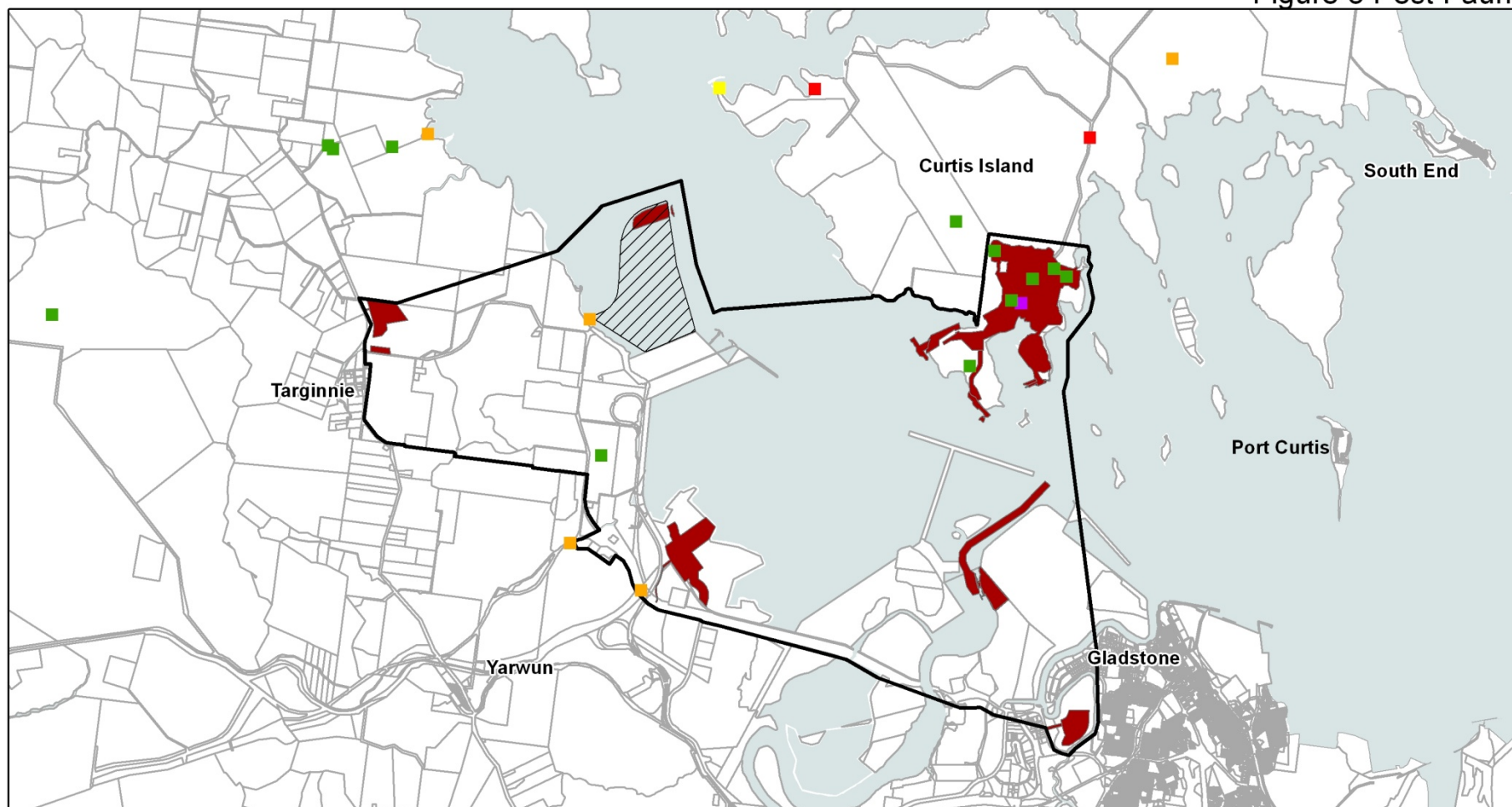
FS (indicated) – evidence of presence however not observed

DR – Desktop review (of other surveys conducted in the area)

Figure 3 provides an overview of the distribution of those pest species identified through field surveys. Specific survey information, including abundance and location, is detailed in Appendix C.

DEEDI undertake annual mapping of Class 1 and 2 declared pest species which indicates the distribution of these species throughout the Gladstone region (DEEDI, 2009a). Predictive mapping is also undertaken however is limited to rabbit and cane toad due to the mobility of most fauna species (DEEDI, 2008). This information has also been included in Figure 3, where available.

Figure 3 Pest Fauna



Arrow LNG Plant Coffey Environments

Field Validated Pest Fauna

- Black rat *Rattus rattus*
- Cane toad *Rhinella marinus*
- Dog *Canis lupus*
- Horse *Equus caballus*
- Red fox *Vulpes vulpes*

- Fishermans Landing Northern Expansion Project
- EIS Study Area
- Project Area
- Cadastre
- Water

According to DEEDI predictive pest animal maps the climate of the study area is 'highly suitable' for the cane toad (*Rhinellamarinus*) and has the potential to have a rabbit (*Oryctolagus cuniculus*) distribution of 1-5 rabbits per square kilometre. Data showing this distribution was unavailable at the time of map creation.



1 0.5 0 1 Kilometres

File name: GEI08_Coffey_PMP_Fauna.mxd
Map projection: GDA 94 MGA Zone 56
Layers: Field validated pest fauna layer Ecosure created 2011,
all other layers supplied by Coffey Environments Pty Ltd 2011

ecosure

Figure 3 Pest Fauna

3.2.1 Area Specific Occurrence

Table 4 provides a broad overview of the likely occurrence of pest fauna at specific project sites (based on field and desktop survey data). This will assist in determining location specific management measures for the pest management component of the EMP. Those species which are not identified as known or likely to occur may still be found at any of the project sites. The nature of these pest species is such that they are able to exploit a variety of habitats

Table 4 Likely occurrence of pest fauna at project sites (project sites identified in Figure 1)

	Cane Toad	Wild Dog	Horse	Feral Cat	European Hare	European Rabbit	Black Rat	Feral Pig	European Red Fox
Mainland tunnel entry shaft and tunnel spoil disposal area	L	L	U	L		L			
Boatshed Point	K		L	L		L	L	L	L
North China Bay	L		L	L		L	L	L	L
Hamilton Point	K		L	L		L	L	L	L
LNG Plant Site	K	L	K	L		L	L	L	L
TWAF7	L			L	L	L	L		L
TWAF8	L	L		L		L			
Launch Site 1	L			L	L	L	L		L

K – known to occur

L – likely to occur

4 Mitigation, Monitoring and Reporting

4.1 Performance Criteria

To ensure the purpose and objectives of this plan are achieved, the following performance criteria should be met through the application of appropriate mitigation and corrective measures:

- Prevent new weed infestations in, or adjacent to, the project area as a result of construction, operational, rehabilitation or maintenance activities.
- Avoid the introduction of previously unobserved pest fauna species into the project area.
- Prevent the spread of weed species to previously unaffected natural or primary production areas.
- Restoration activities should be carried out in accordance with legislative requirements and current best practice, including measures which minimise the potential for intrusion by pest flora and fauna species.

4.2 Pest Flora: Species Specific Management and Monitoring Actions

Integrated pest management, the combination of a range of control measures to manage infestations, is generally the most efficient means of controlling or eradicating pest flora (DEEDI, 2010a). These measures may include:

- Environmental management – e.g., controlled burns.
- Chemical control – herbicide application (e.g., foliar, spot, blanket or boom spraying, basal bark application, cut, scrape and paint, stem injection).
- Mechanical control – e.g., slashing.
- Biological control – e.g., the use of insects or plant pathogens.
- Manual control – e.g., hand pulling.

Table 5 below summarises the management measures for each of the declared pest species known to occur in or adjacent to the study area. In every case, a combination of techniques will give the best results. Techniques need to be site and situation specific. The relevant best practice documents should be referred to at the time of management to ensure that the most up to date information is considered. Chemical application rates and more detail on management practices can be found in the documents referenced.

Management measures are discussed in Sections 4.2.1 to 4.2.7 for all Class 1 and 2 declared pest flora species and GRC Priority 1 species for control, identified within or adjacent to the study area.

Table 5 Summary of management measures for each of the declared flora species known to occur in or around the study area

Botanical name	Common name	Flowering period (best time to monitor)	Seeding period (best to treat before this time)	Relevant references	Recommended treatment techniques			
					Manual	Chemical	Biological	Mechanical
<i>Asparagus plumosus</i>	Feathered Asparagus Fern (similar to Climbing Asparagus)	Spring	Summer - Winter	Brisbane City Council, 2011; Land Protection, 2007	Dig out, ensure entire underground system removed. Dispose of berries responsibly to stop birds from eating and spreading seed.	Basal bark spray, paint/spot spray crowns		Dig out mechanically.
<i>Bryophyllum delagoense</i> (syn. <i>B. tubiflorum</i> and <i>Kalanchoe delagoensis</i>)	Mother of Millions	May - October	Reproduces via plantlets, all year round. Best to treat in Winter when infestations easiest to see.	DEEDI, 2010b; Biosecurity Queensland, 2004a	Pull by hand, burn. Alternatively, bag and dispose of at a refuse tip - do not dispose of as green waste, which may be mulched and cause this species spread.	Foliar spray.	South African citrus thrips present in Queensland. Complement chemical and mechanical control techniques.	Fire may be suitable and can in fact be the most economical form of control. Contact Queensland Primary Industries and Fisheries to determine suitability, and Gladstone Rural Fire Service for permit.

Botanical name	Common name	Flowering period (best time to monitor)	Seeding period (best to treat before this time)	Relevant references	Recommended treatment techniques			
					Manual	Chemical	Biological	Mechanical
<i>Cryptostegia grandiflora</i>	Rubber Vine	Anytime (except winter)	Throughout the year	DSEWPC, 2010a; Agriculture and Resource Management Council of Australia and New Zealand, 2001a; DEEDI, 2011b; Biosecurity Queensland, 2004b		Foliar spray, basal bark, cut stump.	A moth and rubber vine rust are the two widespread biological controls in Queensland.	Hot fire is suitable control, contact Queensland Primary Industries and Fisheries to see if appropriate. Obtain fire management permit from Rural Fire Service, Gladstone.
<i>Hymenachne aplexicaulis</i>	Hymenachne	Apr-Jun	Late Autumn/early Spring (longer in years with higher than average rainfall)	National Weeds Strategy Executive Committee, 2000; DEEDI, 2010c; Biosecurity Queensland, 2004c		No herbicides currently registered for control of hymenachne in Queensland. May apply for an off-label use permit through local council weed inspector.		Use of heavy earth moving equipment has met with some success in north Queensland drains. Fire during the dry season may also be used, consult with Queensland Primary Industries and Fisheries and obtain relevant permit from Rural Fire Service.
<i>Lantana camara</i> var. <i>camara</i>	Lantana	Year round	Year round	DEEDI, 2011c; DEEDI, 2009b; Australian Weeds Committee, 2011		Splatter gun, cut stump, foliar spray.	Biological such as sap-sucking bug <i>Teleonemia</i>	Fire, during active growth period. Removal using machines (i.e., Posi track) may be used

Botanical name	Common name	Flowering period (best time to monitor)	Seeding period (best to treat before this time)	Relevant references	Recommended treatment techniques			
					Manual	Chemical	Biological	Mechanical
<i>Lantana montevidensis</i>	Creeping Lantana						<i>scrupulosa</i> , the leaf-mining beetles <i>Octotoma scabripennis</i> and <i>Uroplata girardi</i> , the seed-fly <i>Ophiomyia lantanae</i> and the stem-sucking bug <i>Aconophora compressa</i> are known to have some success.	for large infestations but will remove fauna habitat, disturb soil, and potentially increase weed establishment.
<i>Macfadyena unguis-cati</i>	Cats Claw Creeper	Spring	Sep, Dec, Mar and Jul	Land Protection, 2007b	Cut all stems up the trees - everything above the cut will die, but underground tubers will continue to grow.	Foliar spray, cut stump, basal bark spray.		
<i>Opuntia stricta</i>	Prickly Pear		Year round	DEEDI, 2009c		Foliar spray, cut stump, stem inject.	There are a number of biological controls used in Queensland including the <i>Cactoblastis</i> insect.	Hot fire is suitable control, contact Queensland Primary Industries and Fisheries to see if appropriate. Obtain fire management permit from Rural Fire Service, Gladstone.

Botanical name	Common name	Flowering period (best time to monitor)	Seeding period (best to treat before this time)	Relevant references	Recommended treatment techniques			
					Manual	Chemical	Biological	Mechanical
<i>Opuntia tomentosa</i>	Velvet Tree Pear	Spring to Summer	Spring to Summer	Australian Weeds Committee, 2011b		Foliar spray, cut stump, stem inject.	There are two biological controls, the cochineal insect and the Cactoblastis insect.	
<i>Parthenium hysterophorus</i>	Parthenium	Flowers and seeds all year round (particularly when stressed)	Can set seed within four weeks when stressed	DSEWPC, 2010b; DEEDI, 2011d; Biosecurity Queensland, 2004d; Agriculture and Resource Management Council of Australia and New Zealand, 2001b	Hand pulling not recommended - health hazard from allergic reactions and may increase spread.	Spot or boom spray.	There are a number of biological controls including <i>Zygogramma bicolorata</i> which have been shown to reduce the density and vigour of this species.	
<i>Sporobolus pyramidalis</i>	Giant Rat's Tail Grass			DEEDI, 2011e; DPI&F, 2007; DPI&F, 2004.	Hand chip, bag and remove - burn.	Spot spray, blanket spray or boom spray.		
<i>Thevetia peruviana</i>	Yellow Oleander			DEEDI, 2009f.		Foliar spray, basal bark spray, cut stump, stem injection.		Fire may damage plant, but regrowth generally rapid. Individuals can be grubbed out with a tractor/dozer mounted blade. Regrowth must receive chemical treatment.

4.2.1 Asparagus Fern

Asparagus spp., including asparagus fern are highly invasive, introduced ornamental species and are difficult to control, particularly in native bushland (Department of Primary Industries and Fisheries {DPI&F}, 2010).

Asparagus fern outcompetes and smothers native vegetation as it may climb up to five metres on supporting vegetation.

The management of large infestations is complicated by rhizomatous root systems which form dense mats just below the soil surface and may extend for many metres beyond the visible area of the infestation. This root system also limits the establishment and survival of native plants (DPI&F, 2010a).

Small, isolated infestations may be managed by manual or mechanical removal, ensuring all rhizomes are removed in addition to the visible plant. Larger infestations are generally best controlled by a combination of mechanical and chemical control, with basal bark application of herbicide (Brisbane City Council, 2011). Table 5 details management options.

DEEDI do not currently produce a fact sheet or management guidelines for asparagus fern however management of this species is considered similar to that of climbing asparagus fern (*Asparagus africanus*), for which the following fact sheet has been produced:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Climbing-Asparagus-Fern-PP72.pdf (Land Protection, 2007a).

4.2.2 Mother of Millions

Mother of millions is an escaped ornamental species which is highly toxic to stock and very difficult to eradicate.

Best practice management consists of a combination of physical removal, fire and the application of herbicides. See Table 5 for a summary of management options.

The following documents provide further information and detail current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Mother-Millions-PP33.pdf (DEEDI, 2010b).

DEEDI Guideline: http://www.dpi.qld.gov.au/4790_8446.htm (Biosecurity Queensland, 2004a).

4.2.3 Rubber Vine

Rubber vine is an escaped ornamental which may grow as a climbing weed or bushy

shrub. It has significant impacts on native vegetation, smothering riparian vegetation and impeding the movement of native fauna and stock.

Rubber vine infestations are prevalent along watercourses throughout central Queensland and dispersal is aided by the movement of seeds along rivers and streams.

Best practice management consists of biological and chemical controls. Table 5 details management measures.

The following documents provide further information and detail current best practice control methods:

WONS Information: http://www.weeds.gov.au/cgi-bin/weeddetails.pl?taxon_id=18913 (DSEWPC, 2010a).

National Strategic Plan:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Rubber-Vine-Nsplan.pdf (Agriculture and Resource Management Council of Australia and New Zealand, 2001a).

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Rubber-Vine-PP11.pdf (DEEDI, 2011b).

DEEDI Guideline: http://www.dpi.qld.gov.au/4790_8454.htm (Biosecurity Queensland, 2004b).

4.2.4 Hymenachne

Hymenachne is an introduced perennial grass species which may grow over two metres tall along watercourse banks, in shallow wetlands and irrigation channels.

Primary impacts include interference with irrigation and drainage infrastructure, habitat degradation and reduced water quality for recreational purposes. Impacts are compounded by the ready dispersal of seeds through watercourses and by birds.

Best practice management incorporates early intervention to prevent establishment and the use of combined mechanical and chemical controls (Table 5).

The following documents provide further information and detail current best practice control methods:

National Strategic Plan:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Hymenachne-Nsplan.pdf (National Weeds Strategy Executive Committee, 2000).

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-

[Hymenachne-PP54.pdf](#) (DEEDI, 2010c).

DEEDI Guideline: http://www.dpi.qld.gov.au/4790_8444.htm (Biosecurity Queensland, 2004c).

4.2.5 Lantana

Lantana is an introduced species, native to Central and South America. It forms dense, shrubby stands and can climb, strangle and/or smother native vegetation.

Management of lantana infestations is generally dependent on the location, topography and extent and density of the growth. A range of methods may be used independently or in combination, including physical removal, fire, mechanical removal, herbicide application and practical land management (Table 5).

The following documents provide further information and detail current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Lantana-PP34.pdf (DEEDI, 2011c).

Weeds Australia provides access to a number of management documents for Lantana - <http://www.weeds.org.au/WoNS/lantana/>. These include:

- Draft Lantana Strategic Plan (Australian Weeds Committee, 2011a).
- Lantana Best Practice Manual and Decision Support Tool (DEEDI, 2009b).
- National Management Maps.

4.2.6 Prickly Pear

Prickly pear is a general term applied to some plants of the Cactaceae family. *Opuntia stricta* and *Opuntia tomentosa* are two of a number of *Opuntia* spp., all of which invade pastoral land and thrive in hot, dry conditions, thereby displacing other species requiring plentiful water and temperate conditions.

Dispersal of Prickly Pear is widespread as many bird and other animal species eat the fruit and excrete viable seeds. Infestations are advancing at a rate of approximately 400,000 ha/year (DEEDI, 2010d).

Best practice management incorporates biological, mechanical and chemical measures (Table 5). Biological control is particularly advanced in Queensland, with nine insect and one mite control agents established (DEEDI, 2010d).

The following documents provide further information and detail current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Prickly-

[Pear-Control-PP29.pdf](#) (DEEDI, 2009c).

4.2.7 Parthenium

Parthenium weed is an annual herb which has significant financial impacts on agriculture and grazing and is an allergen to humans.

Best practice management combines chemical, biological and mechanical methods supported by appropriate land management practices (Table 5).

The following documents provide further information and detail current best practice control methods:

WONS Information: http://www.weeds.gov.au/cgi-bin/weeddetails.pl?taxon_id=19566 (DSEWPC, 2010b).

National Strategic Plan:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Parthenium-Nsplan.pdf (Agriculture and Resource Management Council of Australia and New Zealand, 2001b).

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Parthenium-PP2.pdf (DEEDI, 2011d).

DEEDI Guideline: http://www.dpi.qld.gov.au/4790_8449.htm (Biosecurity Queensland, 2004d).

4.2.8 Giant Rat's Tail Grass

Giant rat's tail grass is an aggressive, weedy grass which can significantly reduce pasture productivity and degrade natural areas.

Best practice management consists of a combination of mechanical control and herbicide application whilst maintaining dense pasture or native vegetation (Table 5).

The following documents provide further information and describe current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Giant-Rats-Tail-Grass-PP48.pdf (DEEDI, 2011e).

DEEDI Best Practice Manual: http://www.dpi.qld.gov.au/4790_9948.htm (DPI&F, 2007).

DEEDI Guideline: http://www.dpi.qld.gov.au/4790_8439.htm (DPI&F, 2004).

4.3 Plant Fungal Disease

4.3.1 Myrtle Rust

Myrtle rust is a serious fungal plant disease first identified in southeast Queensland in December 2010, affecting plants in the *Myrtaceae* family including, for example, *Callistemon spp.*, *Melaleuca spp.* and *Eucalyptus spp.*. It is easily spread through the movement of plants and animals, wind and contaminated materials.

To date, it has been confirmed at 104 sites in northern and southeast Queensland (Biosecurity Queensland, 2011)

Myrtle rust initially appears as small, raised spots or pustules, generally on young, soft, actively growing leaves, shoot tips and young stems, and the fruit and flower parts of myrtaceous plants. These spots develop into furry-looking, egg-yolk yellow spores (DEEDI, 2011f).

The disease may cause deformation of leaves, defoliation of branches, dieback, stunted growth and plant death. The rust poses no known threat to human health (DEEDI, 2011f).

DERM has established a Myrtle Rust Response Group which coordinates with Biosecurity Queensland to conduct surveillance at suspected or confirmed myrtle rust sites.

There is currently no effective eradication or control method for myrtle rust although AgriScience Queensland has begun research into identifying resistance to myrtle rust in priority *Eucalyptus spp.* (Biosecurity Queensland, 2011).

The following measures should be implemented throughout the construction, rehabilitation, operational and decommissioning phases of the project to prevent (where possible) and minimise the spread of myrtle rust:

- Myrtle rust identification and reporting procedures should form part of the EMP and induction
- Plants, soil and other materials to be used in rehabilitation works should be inspected for myrtle rust prior to being brought onto the site and certified free of myrtle rust by the supplier (where possible).

There are conditions for the entry of myrtaceous plants from another infected state (currently New South Wales only) to prevent further spread of myrtle rust in Queensland. Inspectors Approval 'IA 18.4 Introduction into Queensland of myrtaceous plants' applies to anyone bringing a myrtaceous plant from an infected state into Queensland (Biosecurity Queensland, 2011).

If myrtle rust is identified or suspected on the project site, the project's Environmental Manager should notify Biosecurity Queensland immediately.

For further information about myrtle rust, including identification information and pictures, refer to: http://www.dpi.qld.gov.au/4790_19788.htm (DEEDI, 2011f).

4.4 Pest Fauna: Species Specific Management and Monitoring Actions

The mobility of most pest fauna species makes control and eradication difficult, therefore successful management is generally reliant on the implementation of a combination of measures over a broad geographic area, in which the cooperation of local authorities and landholders is integral.

Control measures can generally be summarised into three categories:

- Chemical control – e.g., baiting.
- Biological control – e.g., the introduction of species specific diseases.
- Physical controls – e.g., fencing, shooting (DEEDI, 2010e).

Table 6 below summarises the management measures for each of the declared and non-declared pest species known to occur in or adjacent to the study area. In every case, a combination of techniques will give the best results. Techniques need to be site and situation specific. The relevant best practice documents should be referred to at the time of management to ensure that the most up to date information is considered. More detail on management practices can be found in the documents referenced.

Management measures have been discussed in Sections 4.4.1 to 4.4.8 for those declared and non-declared pest species identified within the project area and also those Class 1 and 2 species identified within the Gladstone region. GRC priorities for the management of pest animals have also been considered.

Table 6 Summary of management measures for each of the pest fauna species known to occur in or around the study area.

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
Cane Toad	<i>Rhinella marina</i>	Year round, depends only on available food and permanent water.	RSPCA, 2010	Capture and place in vented container. Cool to 4°C to render unconscious prior to placing in freezer for two days to be euthanized.	Most humane method.		Whenever caught.
Wild Dog (other than a domestic dog), including Dingo	<i>Canis familiaris</i> and <i>Canis familiaris dingo</i>	Mar-May	DPI&F, 2011a; DEEDI, 2010f	Baiting	Effective.	Fate of bait not always known. Needs to be well planned and monitored.	June - food more scarce and wild dogs are roaming over a larger area more likely to take baits.
				Trapping (soft-jaw)	Can target bait shy dogs.	Time consuming. Needs experienced trapper.	Mar-Apr - wild dogs dispersing and females coming into oestrus.
				Shooting	Species specific.	Time consuming. Not effective on its own.	Year round.
Horse	<i>Equus caballus</i>	Spring-Summer	DEH, 2004; DPI&F, 2009	Exclusion	Fencing to exclude brumbies from the Curtis Island facility.		Year round.

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
				Ground shooting	Effective in accessible and relatively flat areas. Humane and targeted when shooter experienced.	Not suitable in inaccessible or wooded terrain, time consuming and labour intensive, needs experienced shooter. Potential animal welfare concerns.	Dry season or during drought.
				Aerial shooting	Generally only used for large scale populations in remote or inaccessible areas.	Expensive, relies on experienced shooter.	Dry season or during drought.
				Muster/ use of lure mare/ disposal	Generally done from horseback or helicopter. Allows animals to be herded into a yard where they can then be transported offsite for humane disposal.	May cause substantial stress on the animal, creating injury.	
				Muster/ use of lure mare/ brumby adoption	May be opportunity to capture as above but for the horse to be adopted.	As above, stress on the animal during the capture.	

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
Feral Cat (other than a domestic cat)	<i>Felis Catus</i>	Year round	DEEDI, 2010g; DEWHA, 2008a	Trapping (soft-jaw)	Can target bait shy cats. Can use audio lures or meat/fish to attract towards traps.	Time consuming. May inadvertently capture non-target species.	Jun-Aug - food more scarce.
				Shooting	Effective if shooter experienced. Target specific.	Only mitigates damage short term.	Year round.
European Hare and European Rabbit	<i>Lepus capensis</i> and <i>Oryctolagus cuniculus</i>	Mar-May	DEEDI, 2010h; DPI&F, 2008a; DEWHA, 2008b.	Shooting	Best used to mop up small numbers post ripping (rabbits). Most effective method for hares. Humane when done correctly.	Numbers will recover quickly without complementary control methods. Labour intensive. High skill needed.	Early spring.
				Trapping (soft-jaw)	Mop up technique post ripping. Non-target animals can be released.	Not effective as a sole control method. Labour intensive and high skill.	Year round.
				Baiting			Jun-Aug - food more scarce.
				Warren ripping (rabbits only)	Long term. Can be used near urban areas.	Need to find warrens. Site access required for tractor. Unsuitable on very rocky sites. Native burrowing animals excluded from the warrens.	Dry season or during drought.

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
				Den fumigation	Useful when warren ripping unsuitable. Relatively target specific.	Labour intensive. All warren entrances need to be located. Some animal welfare concerns.	Mar-Oct.
Black Rat	<i>Rattus rattus</i>	Year round	DEWHA, 2009; Animal Control Technologies Australia, 2010; University of Illinois (date unknown),	Baiting	Strategic use of rodenticide will reduce the population. May take time for effect, therefore not necessarily humane.	May be impacts on non-target species. May result in odour issues if the rat expires in an inaccessible location.	Year round.
				Controlling food supply	Remove access to food - through appropriate storage and disposal.		Year round.
				Trapping	Will target rats within built up areas such as the construction camps. Avoids use of poisons and allows for carcass disposal.		Year round.
Feral Pig	<i>Sus scrofa</i>	Spring-Summer but can be year round	DEEDI, 2010i; DEEDI, 2010j; DEH, 2005	Trapping	Useful in populated areas, or where pig numbers low. Good to mop up after a baiting program. Can be species	Time consuming, can be expensive, must be checked regularly, some pigs trap shy.	Jun-Aug - food more scarce.

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
					specific.		
				Baiting	Most effective control available. Quick. Can be species specific.	Time consuming, can be expensive.	Jun-Aug - food more scarce.
				Shooting	Only effective in small, isolated and accessible population.		Avoid during baiting or trapping operations.
European Red Fox	<i>Vulpes vulpes</i>	Jul-Aug	DEEDI, 2010k; DEH, 2009; DEWHA, 2008c.	Baiting	Selective bait type and placement can minimise risk to non-target species.	Time consuming, relies on area being accessible.	Nov, or Jun-Jul.
				Trapping (soft-jaw)	Can be used where shooting or poisoning restricted, or where there is a high risk to native species.	Time consuming, labour intensive, generally ineffective.	

Common name	Species name	Breeding season	Relevant references	Recommended management techniques			
				Technique	Advantages	Disadvantages	Timing
				Shooting	Highly selective, popular control. Best used in conjunction with other techniques.	Depends on skill of shooter. Biased towards young inexperienced juveniles.	
				Den fumigation	Effective and targets multiple foxes.	Difficulty finding dens, only suitable when cubs present, potential non-target impacts.	Jul-Aug.

4.4.1 Cane Toad

The cane toad is a non-declared pest in Queensland as they are widespread and there is currently no effective measure for their control. The cane toad is also not declared under a GRC local law. It does, however, have a significant impact on native fauna, and is considered a significant threat to conservation values of Curtis Island:

- It is a recognised threat to the common death adder and other carnivorous species, which are known to consume the toads and die from toxic ingestion.
- Cane toad tadpoles prey on the tadpoles of native amphibian species.
- It is also thought to impact upon ecological diversity through competition for food with other carnivores and predation on small vertebrates (GHD, 2009).

The biological effects caused by cane toads, including lethal toxic ingestion, are a key threatening process under the EPBC Act (DSEWPC, 2005).

RSPCA (2010) recommend as the most humane control method cooling the cane toads body temperature to 4°C before freezing to euthanize. Emerging control methods such as poisoning with HopStop® could also be considered for use (Eco Voice, 2011). Table 6 summarises management options for this species.

For further information refer to the DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Cane-Toad-PA21.pdf (DEEDI, 2009e).

DSEWPC Threat Abatement Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/cane-toads.html> (DEWHA, 2011a).

4.4.2 Wild Dogs

The wild dog, including purebred and hybrid dingoes and wild domestic dogs, is found throughout Queensland and has significant impacts on native fauna and livestock through predation and the spread of disease. It is recognised as one of the main pest species impacting on the ecological values of Curtis Island (GHD, 2009).

Best practice management consists of a combination of baiting (1080 baiting), trapping and shooting in combination with extensive fencing of livestock and/or natural areas (Table 6).

The following documents provide further information and describe current best practice control methods:

DEEDI Wild Dog Control Fact Sheets: http://www.dpi.qld.gov.au/4790_9154.htm (DPI&F, 2011a).

In 2002, DEEDI developed the Wild Dog Management Strategy 2002. This document is currently under review and a consultation draft, detailing up to date management

methods, is available from http://www.dpi.qld.gov.au/4790_18743.htm (DEEDI, 2010f).

4.4.3 Horses

Wild horses are found throughout central and northern Australia and, whilst not a pest management priority of GRC or DEEDI, they are a non-declared species under the LP Act and were observed in the study area (Plate 1).

Wild horses are considered to be one of the main impacts on the conservation values of Curtis Island, causing erosion and impacting upon native vegetation and pasture through grazing and trampling (GHD, 2009).



Plate 1 Wild horses observed on Curtis Island (Ecosure, 2010)

Control methods include shooting, trapping and fencing (Table 6). Control methods may be considered to be controversial, as many believe horses are iconic to the Australian landscape (DPI&F, 2009).

The following documents provide further information and describe current best practice control methods:

DSEWPC Invasive Species Fact Sheet:

<http://www.environment.gov.au/biodiversity/invasive/publications/feral-horse.html>
(DEH, 2004).

DEEDI Pest Animal Risk Assessment:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Feral-Horses-Risk-Assessment.pdf (DPI&F, 2009).

4.4.4 Feral Cat

The feral cat is an opportunistic predator of small, native fauna. It is a competitor for native predators and can also be a carrier of a parasite which affects marsupials and can cause toxoplasmosis in humans.

A combination of measures, such as baiting, trapping, fencing and exclusion from potential food sources, is the most effective form of control (Table 6).

The following documents provide further information and describe current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Feral-Cat-Ecology-PA26.pdf (DEEDI, 2010g).

DSEWPC Threat Abatement Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/cats08.html> (DEWHA, 2008a).

4.4.5 European Rabbit and European Hare

Rabbits are one of the most significant agricultural and environmental threats in Australia. They compete with native species, cause erosion and sedimentation through burrowing and impact upon native vegetation.

A significant sum is spent annually on rabbit control across Australia, combining biological, physical and mechanical methods (Table 6).

While the European hare is not a declared pest species, they are known to predate regenerating and revegetated sites. Hares can be incidentally managed as part of any rabbit control program.

The following documents provide further information and describe current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Rabbit-PA11.pdf (DEEDI, 2010h).

DEEDI Control Manual: http://www.dpi.qld.gov.au/4790_11065.htm (DPI&F, 2008a).

DSEWPC Threat Abatement Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/rabbits08.html> (DEWHA, 2008b).

4.4.6 Black Rat

The black rat is a non-declared pest in Queensland and is not declared under a GRC local law. They pose a threat to human health and are a major cause of extinction and subsequent decline in island biodiversity on offshore islands. The Commonwealth Government has developed a Threat Abatement Plan (the Plan) to manage the impacts of exotic rodents on native biodiversity on offshore islands (DEWHA, 2009). This plan provides a framework for research, reporting and management actions required to abate the threatening process.

Curtis Island is one the islands to which this Plan applies as it is considered a High Conservation Status Australian Offshore Island (Ecosure, 2009). Actions listed under the Plan include the eradication of exotic rodents on islands where high priority conservation benefits will accrue and the promotion of best practice sustained control. The prevention of invasion/reinvasion through appropriate management at

key ports is also a key action of the Plan and is relevant to quarantine operations at MOFs for this project. The DSEWPC will support landholders in the implementation of the key actions of the Plan (DEWHA, 2009)

There is no effective broad-scale control measure for black rats and baiting and trapping are the most common methods of control (Table 6).

4.4.7 Feral Pig

The feral pig is considered one of the most significant pest threats throughout Australia and is common throughout Queensland. It is also recognised as one of the main feral species on Curtis Island, as they consume turtle eggs and some plants and small animals (GHD, 2009). The impacts of feral pigs are extensive (DEEDI, 2010i) and include:

- Damage to cropping, pasture and natural areas (Plate 2) including exposure of roots and removal of vegetation and subsequent erosion and weed incursion.
- Damage to riparian and wetland environments caused by wallowing and digging behaviour.
- Predation of stock and native fauna.
- Spread of disease and weeds.



Plate 2 Evidence of feral pig damage on Curtis Island (Ecosure, 2010)

Control methods include shooting, baiting and trapping (Table 6).

The following documents provide further information and describe current best practice control methods:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Feral-Pigs-Qld-PA6.pdf (DEEDI, 2010i).

DEEDI Control Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Control-Feral-Pigs-PA7.pdf (DEEDI, 2010j).

DSEWPC Threat Abatement Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/pig.html> (DEH, 2005).

4.4.8 European Red Fox

The European red fox is an introduced pest which, like the wild dog, preys upon small native fauna and young livestock. It is a recognised threat to native fauna on Curtis Island particularly impacting on the flatback turtle (*Natator depressus*), preying on the adults, young and the eggs (GHD, 2009).

Management measures for foxes include baiting, trapping, shooting and den fumigation (Table 6).

For additional information about this pest species refer to:

DEEDI Fact Sheet:

http://www.dpi.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Fox-PA13.pdf (DEEDI, 2010k).

DSWEPC Invasive Species Fact Sheet:

<http://www.environment.gov.au/biodiversity/invasive/publications/european-red-fox.html> (Department of the Environment and Heritage (DEH), 2009).

DSEWPC Threat Abatement Plan:

<http://www.environment.gov.au/biodiversity/threatened/publications/tap/foxes08.html> (DEWHA, 2008c).

4.5 Biting Insect Species

4.5.1 Yellow Crazy Ants

Yellow crazy ants (*Anoplolepis gracilipes*) are an introduced exotic species. They are considered environmental pests and have significant impacts on native flora and fauna and the horticultural industry, including:

- The mutual protection of sap-sucking insects such as scale and mealy bugs, which themselves have a detrimental impact on native vegetation.
- Causing the injury and death of native fauna through the release of formic acid, which irritates the eyes and skin. This may also affect humans (DEEDI, 2010l).

The yellow crazy ant is a Class 1 declared species in Queensland and is also considered one of the world's 100 worst invasive species (DSEWPC, 2011b).

The current distribution of this species does not include the Gladstone region. However, as it is commonly transported in sea cargo, the Australian Quarantine Inspection Services (AQIS) frequently identify and eradicate this ant in port areas. Therefore there is risk it will be found in the Port of Gladstone, and/or the port facilities and quarantine areas for this project (DEEEDI, 2010).

The following measures should be implemented throughout the construction, rehabilitation, operational and decommissioning phases of the project to prevent yellow crazy ant infestations:

- Yellow crazy ant identification and reporting procedures should form part of the EMP and induction.
- Plants, soil, fill and any other such materials to be used in construction/rehabilitation works should be inspected prior to entry to the site.
- Inspections for Yellow Crazy Ant should be undertaken at those AQIS quarantine areas associated with the MOFs for this project.

If yellow crazy ants are identified or suspected on the project site, the Environmental Manager should notify Biosecurity Queensland immediately.

For further information about Yellow Crazy Ants, including identification information and pictures, refer to: http://www.dpi.qld.gov.au/4790_8654.htm (DEEDI, 2010).

4.5.2 Fire Ants

Fire ants (*Solenopsis invicta*) pose a significant national economic, environmental and social threat and are a notifiable pest under the *Plant Protection Act 1989*.

Recorded fire ant infestations are currently contained within southeast Queensland, particularly the Brisbane, Logan and Ipswich local authority areas. An infestation was recorded in the southern mainland section of the study area (near Fishermans Landing) and was included in the Yarwun Fire Ant Restricted Area until November 2010, when it was declared free of infestation (DPI&F 2011b).

The following measures should be implemented throughout the construction, rehabilitation, operational and decommissioning phases of the project to prevent fire ant infestations:

- Fire Ant identification and reporting procedures should form part of the CEMP and induction
- Plants, soil, fill and any other such materials to be used in construction/rehabilitation works should be inspected prior to entry to site and, if supplied from within the 'Fire ant restricted area', must be accompanied by a movement certificate or 'Fire ant declaration' form.

If fire ants are identified or suspected on the project site, the project's Environmental Manager should notify Biosecurity Queensland immediately.

For further information about fire ants, including identification information and

pictures, refer to: http://www.dpi.qld.gov.au/4790_4538.htm (DEEDI, 2011g).

4.5.3 Mosquitoes and Biting Midges

Mosquitoes and biting midges are native insects, and are therefore not declared pest species under Queensland legislation. They contribute to the biodiversity of natural areas and are an important food source for other aquatic and avian species (DERM, 2011).

Some mosquito species may be a vector for human disease. Local governments are authorised, under the *Health Act 1996*, to implement mosquito control programs to reduce the incidence of vector-borne diseases. The Queensland Parks and Wildlife Service (QPWS) may also implement mosquito control programs in QPWS managed areas. Midges do not transmit human diseases however they do cause a nuisance through biting and are recognised vectors for arboviruses in livestock overseas (DERM, 2011).

The most common mosquito-borne diseases occurring in Queensland include Dengue Fever, Ross River Fever and Barmah Forest Virus. Other, rare, mosquito borne diseases known to have occurred in Queensland include Murray Valley and Japanese Encephalitis and malaria.

Mosquitoes breed in salt, brackish or fresh water so will likely be present throughout the project site. Biting midges will likely be restricted to those areas immediately adjacent to intertidal areas and shallow watercourses, such as the mainland tunnel entry shaft and tunnel spoil disposal area, Hamilton Point and Boatshed Point.

The following measures should be implemented throughout the construction, rehabilitation, operational and decommissioning phases of the project to prevent mosquito outbreaks and the incidence of mosquito-borne infections and nuisance biting:

- Ensure vessels and equipment that hold water are inspected regularly for ponding water and emptied to limit mosquito breeding opportunities.
- Ponding water should be minimised through the filling of shallow depressions caused by construction works or machinery. Where filling is not possible, ponded water should be pumped to appropriate drainage areas or treated with an approved chemical, by an appropriately licensed and certified contractor.
- The identification of mosquito breeding sites and appropriate reporting procedures should be included in the EMP and induction procedures for staff and contractors.
- Personal protective measures and reporting procedures for suspected mosquito-borne infections should be included in induction procedures for staff and contractors.
- Worker accommodation and other buildings should be appropriately constructed to minimise the presence of mosquitoes. Best practice measures include the construction of high-set buildings, up-wind of known biting insect

breeding sites and the installation of insect screens and/or air conditioning (DERM, 2011).

- Provide appropriate personal protective equipment to staff and contractors including tropical strength insect repellent.
- Staff and contractors should be required to wear long sleeved, loose clothing wherever practicable.
- Wherever practicable, minimise work undertaken outside at those times of the day when biting insects are most active (sunrise and sunset).
- Water-holding plants should not be used in revegetation works
- Communicate regularly with GRC regarding their biting insect management programs or if an outbreak is suspected (GRC Environmental Health - (07) 4976 6996).

If mosquito-borne infection is suspected, contact Queensland Health.

4.6 General Mitigation and Monitoring Actions

The project has the potential to facilitate dispersal and establishment of pest plants and animals in areas where they currently do not occur, as well as the expansion of existing infestations. In addition to the species specific management measures detailed above, the following general recommendations will apply to the management of pest flora and fauna throughout the construction, rehabilitation, operational decommissioning phases of the project and consider the recommendations of the '*Petroleum Industry Minimising Pest Spread Advisory Guideline*' (2008).

4.6.1 Induction

Appropriate induction procedures should be developed for the training of staff, contractors and visitors in the identification and management of pest species, guided by the '*Petroleum Industry Minimising Pest Spread Advisory Guideline*' (DPI&F, 2008b). The section relevant to training has been included as Appendix D.

- Induction procedures should incorporate current information, including:
 - Identification of declared and other pests and infestation areas.
 - Potential risk associated with the movement of vehicles and machinery and the importation of plants and fill.
 - Corrective and management actions.
 - Legislative requirements, i.e., monitoring, control and reporting.
- Relevant staff and contractors should attain established proficiencies in the identification of pests and infestation sites, in the assessment of risk of pest incursion and in the inspection of vehicles and equipment.
- Relevant resources should support induction training and be readily available (and maintain currency) throughout the duration of the project.
- The Health Management Plan will be required to consider the potential

human health impacts from pest flora and fauna.

4.6.2 Pest Flora and Fauna Prevention and Control

Vehicle and Machinery Washdown

- Contracts with suppliers of equipment and services will include vehicle washdown conditions prior to presenting to site.
- Arrow's Weed and Pathogen Management Procedure should include appropriate vehicle washdown requirements to address pest management requirements.
- Existing vehicle and equipment washdown facilities should be utilised. The DPI&F maintains a list of facilities in Central Queensland (DPI&F, 2010b).
- Where existing washdown facilities prove inadequate, appropriate vehicle and equipment washdown facilities should be established on entry to, and exit from areas within the project site. This includes areas identified as containing pest species or possessing significant ecological or agricultural values which may be impacted on by the introduction of pest species. These facilities should be provided at each construction area and at MOFs.
- When constructing vehicle washdown facilities the following factors should be considered:
 - Intended use, i.e., vehicle size and type.
 - Purpose, i.e., weed management only, weed and pest animal management in addition to material and chemical (e.g., oil, paint) management.
 - Demand, i.e., volume of vehicles, high traffic periods.
 - Location, i.e., proximity of site to sensitive areas, safest entry/exit point, highest use areas, power supply.
 - Construction resources, i.e., cost, availability.
 - Water availability, i.e., volume required, flow rates, pressure, water conservation issues.
 - Environmental management, i.e., drainage, sedimentation and sludge ponds, bunding, treatment and disposal of washdown water.

Vehicle washdown facilities should incorporate vacuum and air compressor equipment to clean seed and dry organic matter from inaccessible vehicle areas and vehicle cabins.

A number of guidelines have been developed by the Queensland Government as part of the Queensland Weed Seed Spread Project, for the provision of vehicle washdown facilities and cleandown and inspection procedures. These include the Queensland Guideline for the Construction of Vehicle and Machinery Washdown Facilities (Department of Natural Resources, 2000a) and the Queensland Checklist for Cleandown Procedures (Department of Natural Resources, 2000b). These documents should be considered when siting, constructing and using vehicle washdown facilities

for this project.

Inspection Procedures

- All inspections of vehicles, machinery, personnel and materials should undertaken by suitably trained and proficient personnel.
- Vehicles and machinery entering sensitive areas or project areas adjacent to sensitive areas should be inspected for pest material prior to entry, in addition to washdown measures.
- Vehicles and machinery exiting project areas where infestations are known, should be inspected for pest materials, in addition to washdown measures.
- Clothing should be inspected for pest material on entry to sensitive sites and on exit from known infestation sites and appropriate facilities provided to remove pest material, e.g., boot wash, clothes brushes or hand-held vacuum, shower.
- Materials and material transport vehicles suspected of exposure to parthenium or giant rat's tail grass (or other species prescribed by DEEDI, 2010m) should be inspected prior to entry to site and all materials should be accompanied by a Weed Hygiene Declaration (Appendix C of the Petroleum Industry Minimising Pest Spread Advisory Guideline {2008}). Weed Hygiene Declarations are available from DEEDI (2010m).

The Queensland Checklist for Inspection Procedures (Department of Natural Resources, 2000c) should be considered.

Planning

- Avoid, wherever practicable, the siting of project operations in high risk pest areas.
- Minimise vegetation and soil disturbance and the area to be cleared, wherever practicable, to reduce opportunistic infestation and the disturbance/transfer of pest material.
- Consider potential for soil disturbance when determining pest flora control methods. Chemical control or slashing may be preferable to heavy mechanical control in situations where erosion and sedimentation are an issue (i.e., during wet season, in areas adjacent to waterways).
- Utilise existing road and track networks wherever practicable.

Treatment and Control

- Ensure all procedures for the treatment and control of pests are current, in accordance with best practice and compliant with relevant legislative guidelines.
- Treatment and control activities should only be undertaken by suitably trained and proficient/certified personnel or contractors, except where a notifiable pest is identified. Biosecurity Queensland coordinates the control of notifiable pests.
- Chemicals used in the control of pest species should be handled, applied and stored in accordance with any label requirements, permit conditions or

material safety data sheets.

- Declared weed species should be treated/removed from construction areas, prior to the commencement of clearing activities. This is to limit the spread of weeds which may be mulched along with cleared vegetation. All weed species have the potential to reshoot within mulched material. Lantana provides good mulch, provided that it is finely chipped. Priority species to remove/treat before clearance, due to the likelihood of spread, include mother of millions, hymenachne, prickly pear, parthenium and giant rat's tail grass.
- Non-residual agents (such as Roundup Biactive) should be utilised in the treatment of weed species, wherever practicable, to ensure mulch stockpiled from cleared vegetation is free of chemical agents, prior to use.
- Stockpiled weeds awaiting removal should be covered or enclosed on covered receptacles to prevent foraging by fauna or wind dispersal of seed.
- Appropriate waste control measures should be established to minimise the transfer of plant waste and external seed sources and new, external food sources for pest fauna.
- All putrescible waste must be stored in covered receptacles.
- The storage of putrescible waste should be limited to a maximum one week in the project area.
- Dogs or other companion animals of construction staff and contractors (excluding assistance animals) should be banned from the project area.

4.6.3 Monitoring

- Scheduled monitoring should be carried out, either as part of daily or weekly inspections by the Environment and Workplace Health and Safety Officer (or equivalent) and/or in accordance with approvals/permits. This should incidentally identify pest activity (i.e., dens, burrows) and fence breaches, as well as those points identified below.
- Stockpiled mulch and soil should be monitored to ensure any pest infestation is identified.
- Any disturbed areas should be monitored to prevent the establishment of pest species.
- Records of all training, planning, treatment and control actions should be maintained for the duration of the project and for a two year period following the date of the record.
- Surveys by an ecologist should also be conducted. These should encompass the best times to monitor pest flora (see Table 5 in Section 4.2) and will ideally occur both immediately before and after pest fauna management.
- Example monitoring checklists are included in Appendices B and F of the *Petroleum Industry Minimising Pest Spread Advisory Guideline* (2008).

4.7 Reporting

Pest management activities and issues should form part of any required environmental reporting carried out in accordance with approvals, licences and/or permits. This will be in addition to any internal reporting and that required by Biosecurity Queensland (DEEDI) in the event a notifiable species, which requires immediate action, is identified and/or eradicated.

Arrow Energy should also work in partnership with GRC to ensure:

- The pest management priorities of the local authority are considered when implementing pest management programs.
- GRC is informed of any new, or the eradication of, declared or notifiable species within the study area.
- Pest management activities are carried out efficiently and effectively to achieve more effective outcomes, e.g., planned control activities could be carried out jointly/concurrently to achieve better results on a broader scale.

Arrow Energy should also consider the key pest species, identified as threatening processes, in the '*Curtis Island Environmental Management Precinct Ecology, Environment and Heritage Study*' (2009).

4.7.1 Contacts

The following agencies can provide assistance when managing pests and when reporting the presence of declared or notifiable species:

Biosecurity Queensland	Ph: 132 523
Exotic Plant Pest Hotline (DEEDI)	Ph: 1800 084 881
Gladstone Regional Council Rural Lands Protection	Ph: (07) 4976 6950

5 Conclusion

Ecosure (2011) has identified that pest flora and fauna are likely to have an impact on the terrestrial ecological values of the study area. The terrestrial ecology impact assessment for this project (Ecosure, 2011) quantifies the significance of impacts (including pest flora and fauna) on terrestrial ecological values, both prior to and post mitigation.

Literature review and field surveys undertaken (Ecosure, 2011) found a number of declared pest species both within and adjacent to the study area. The impacts that these pests may have on ecological values include displacing native wildlife, introducing diseases, degrading habitat and predation. Pests may also impact livestock and primary production, both in and around the study area. Project infrastructure and equipment may be directly damaged by pest flora and fauna. There is a financial cost associated with pest control but there is also a legislative and moral requirement to manage declared pests.

Pest flora and fauna control programs need to draw on a suite of management techniques to maximise effectiveness. These techniques will depend upon the specific conditions experienced at the time and the location of the pest infestation. Control programs should draw on the most up to date management advice provided by the relevant government agencies.

It is also important to work with surrounding land managers and Gladstone Regional Council to wherever possible achieve a consolidated approach.

Application of the mitigation measures discussed in this report will reduce the impact of pest species both within and around the study area.

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Appendix A - Pest Flora Species List

FAMILY	Botanical Name	Status	Location – Regional Ecosystem and Assessment Site (see Appendix 3)																		Sub-HAT Vegetation	Road Reserve
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14					
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075			
AMARANTHACEAE	<i>Amaranthus hybridus</i>	*							+													
AMARANTHACEAE	<i>Gomphrena celosioides</i>	*							+(d,t)													
APOCYNACEAE	<i>Asclepias curassavica</i>	*							1-2		1											
APOCYNACEAE	<i>Cryptostegia grandiflora</i>	*(Class 2)							+	+				+(t)				+				
APOCYNACEAE	<i>Gomphocarpus physocarpus</i>	*						1(t)	1-2					1(t)		2						
ARECACEAE	<i>Syagrus romanzoffianum</i>	*							+													
ASTERACEAE	<i>Acanthospermum hispidulum</i>	*																			+(t)	
ASTERACEAE	<i>Ageratum conyzoides</i>	*	+(t)		+(t)				+	+	+					1						
ASTERACEAE	<i>Ageratum houstonianum</i>	*																			1(t)	
ASTERACEAE	<i>Bidens pilosa</i> var. <i>pilosa</i>	*			1(t)		1-2		1				+		1							
ASTERACEAE	<i>Calyptocarpus vialis</i>	*							3-4									+	1-3			
ASTERACEAE	<i>Cirsium vulgare</i>	*																			1(t)	
ASTERACEAE	<i>Conyza</i> sp.	*			+									+	+(t)							
ASTERACEAE	<i>Gnaphalium pensylvanicum</i>	*												+(t)	+							
ASTERACEAE	<i>Sigesbeckia orientalis</i>	*								+(t)				2		2-4						

FAMILY	Botanical Name	Status	Location – Regional Ecosystem and Assessment Site (see Appendix 3)																		Sub-HAT Vegetation	Road Reserve
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14					
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075			
ASTERACEAE	<i>Sonchus oleraceus</i>	*							+(t)													
ASTERACEAE	<i>Tagetes minima</i>	*												1-3(t)								
CACTACEAE	<i>Opuntia stricta</i>	(Class 2)															+(t)	+	1			
CAESALPINIACEAE	<i>Senna occidentalis</i>	*			+(t)																	
CAESALPINIACEAE	<i>Senna surratrenis</i>	*																	1(t)			
CUCURBITACEAE	<i>Cucumis melo ssp. agrestis</i>	*																				
EUPHORBIACEAE	<i>Chamaesyce hirsuta</i>	*		1(t)				1	1					1			1					
FABACEAE	<i>Aeschynomene indica</i>	*							+(t)													
FABACEAE	<i>Crotalaria pallida</i>	*												2(t)								
FABACEAE	<i>Macroptilium atropurpureum</i>	*																			'+(t)	
FABACEAE	<i>Macroptilium lathyroides</i>	*																			'+(t)	
FABACEAE	<i>Stylosanthes scabra</i>	*			1				+													
LAMIACEAE	<i>Leonotis nepetifolia</i>	*																			'+(t)	
MALVACEAE	<i>Malvastrum americanum</i>	*							1					1			+					
MALVACEAE	<i>Malvastrum coramandelianum</i>	*					1							2		1						
MALVACEAE	<i>Sida acuta</i>	*						+						1(t)								
MALVACEAE	<i>Sida rhombifolia</i>	*		1	1				4	1-2				2		1		+				
NYMPHACEAE	<i>Nymphaea caerulea ssp.</i>	*						1(d,t)														

FAMILY	Botanical Name	Status	Location – Regional Ecosystem and Assessment Site (see Appendix 3)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
	<i>zanzibarensis</i>																				
PASSIFLORACEAE	<i>Passiflora foetida</i>	*	+	1	+				+(t)						+						
PASSIFLORACEAE	<i>Passiflora suberosa</i>	*					1	3	3	1-3	3-4	2	3	3	2	2-3	1	1	2		
PHYTOLACCAEAE	<i>Rivinia humills</i>	*					1					5									
POACEAE	<i>Brachiaria subquadiripara</i>	*					1									2					
POACEAE	<i>Chloris inflata</i>	*							2												
POACEAE	<i>Cynodon dactylon</i>	*						+(t)	3(d,t)		+										
POACEAE	<i>Dactyloctenium aegypticum</i>	*															1(t)				
POACEAE	<i>Digitaria eriantha</i>	*							+												
POACEAE	<i>Digitaria violascens</i>	*																			'+(t)
POACEAE	<i>Hyparrhenia rufa</i>	*	6	3	2	6															
POACEAE	<i>Megathrysus maximus</i> var. <i>pubiglumis</i>	*	1(t)		1	1-3(t)		3-4			1-2										
POACEAE	<i>Melinis minutiflora</i>	*		+(t)																	
POACEAE	<i>Melinis repens</i>	*		+			1	2						2		2-3	1-2		2-3		
POACEAE	<i>Sorghum alnum</i>	*							1(t)												
POACEAE	<i>Urochloa mosambicensis</i>	*																			'+(t)
RUTACEAE	<i>Citrus x bahiensis</i>	*										+(t)									
SCROPHULARIACEAE	<i>Scoparia dulcis</i>	*			+(t)																
SOLANACEAE	<i>Capsicum frutescens</i>	*							+(t)												
SOLANACEAE	<i>Solanum nigrum</i>	*			+				+	1				1		+					

FAMILY	Botanical Name	Status	Location – Regional Ecosystem and Assessment Site (see Appendix 3)																		
			11.3.4				12.2.2		12.3.3		12.3.7	12.11.4		12.11.6			12.11.14			Sub-HAT Vegetation	Road Reserve
			S055	S056	S057	S058	S081	S108	S063	S078	S100	S069	S084	S085	S089	S092	S062	S070	S075		
SOLANACEAE	<i>Solanum seaforthianum</i>	*						1				+	3	2							
TILIACEAE	<i>Triumfetta rhomboidea</i>	*							1			1-2			3	1	1(t)				
VERBENACEAE	<i>Lantana camara</i> var. <i>camara</i>	*(Class 3)	1-2	1	1		1	2-3	+(t)	1-2		+	1-2								
VERBENACEAE	<i>Stachytarpheta jamaicensis</i>	*	1(t)		+																

1. “Status” indicates the Queensland conservation status of each taxon under the *Nature Conservation (Wildlife) Regulation 2006*. The codes are Least Concern (LC) and Naturalised Exotic (*). Threatened taxa are described as Endangered (E), Vulnerable (V) or Near Threatened (NT). No species which are afforded a conservation status under the *Environmental Conservation and Biodiversity Conservation Act 1999* were identified in the Study Area.
2. Relative abundance” was based on the Hurst & Allen modification of the Braun-Blanquet technique cover-abundance scale (Hurst and Allen 2007, Mueller-Dombois & Ellenberg 1974, Whittaker 1975) as follows:
 - + = one or two individuals only
 - 1 = sparse, <5%;
 - 2 = any number, <5%;
 - 3 = 5 – 24%;
 - 4 = 25 – 49%;
 - 5 = 50 – 74%;
 - 6 = 75 – 100%.
3. The annotation that has been used after some of the relative abundance scores are as follows:
 - d = dam
 - d/l = drainage line
 - e = edge of vegetation community
 - t = traverse

Appendix B - Vegetation Assessment Sites

Study Area	Assessment Type	Waypoint	Zone	Easting	Northing	Assessment Site	DERM Mapped Regional Ecosystem	Field-validated Regional Ecosystem	Remnant Status	Vegetation Management Status
Mainland	secondary	418	56 K	311887	7366459	S055	11.3.29	11.3.4	REMNANT	Of Concern
Mainland	secondary	419	56 K	311770	7365956	S056	11.3.29	11.3.4	REMNANT	Of Concern
Mainland	secondary	420	56 K	312628	7364087	S057	11.3.29	11.3.4	REMNANT	Of Concern
Mainland	secondary	423	56 K	313020	7363716	S058	11.3.29/12.3.3	11.3.4	REMNANT	Of Concern
Curtis Island	secondary	176	56 K	319109	7367202	S081	12.11.4	12.2.2	LV (CEEC)	Of Concern
Curtis Island	secondary	94	56 K	319658	7368718	S063	12.3.7/12.3.11 (70/30)	12.3.3	REMNANT	Endangered
Curtis Island	secondary	137	56 K	320123	7369383	S078	12.3.11/12.11.6/12.11.14 (60/30/10)	12.3.3	REMNANT	Endangered
Curtis Island	secondary	123	56 K	319838	7367704	S069	12.11.4	12.11.4	REMNANT	Of Concern
Curtis Island	secondary	223	56 K	318423	7370447	S084	12.11.4	12.11.4		Of Concern – High Value Regrowth
Curtis Island	secondary	228	56 K	317970	7371291	S085	12.11.6	12.11.6		Least Concern – Regrowth Vegetation
Curtis Island	secondary	238	56 K	317152	7371788	S089	12.11.6/12.11.14 (85/15)	12.11.6		Least Concern – Regrowth Vegetation
Curtis Island	secondary	249	56 K	318042	7370004	S092	12.3.7/12.3.11 (60/40)	12.11.6		Least Concern – Regrowth Vegetation
Curtis Island	secondary	342	56 K	316363	7372855	S100	12.3.3/12.3.7 (70/30)	12.3.7 (w/l broader 12.3.3)		Least Concern – Regrowth Vegetation (subdominant Endangered – Regrowth Vegetation)

Appendix C - Pest Fauna Species List

Date	GPS Coordinates				Group	Number Recorded	Name		Status	Comment
	X	Y	Zone	Datum			Common	Scientific		
4/02/2010	297992	7357501	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
12/07/2010	298085	7358604	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
13/07/2010	299360	7360056	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
13/07/2010	297060	7363739	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
16/07/2010	307902	7371706	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
16/07/2010	306810	7371658	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
17/07/2010	297932	7362575	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
17/07/2010	311760	7365999	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
22/07/2010	320126	7369452	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Lots of groups under logs
23/07/2010	319025	7369776	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
24/07/2010	318315	7370326	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Under log
12/07/2010	299360	7360056	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
13/07/2010	298085	7358604	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
14/07/2010	301619	7368602	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Seen on driving transect
14/07/2010	301619	7368602	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Seen in dam. Driving transect
15/07/2010	306717	7371730	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Seen on driving transect from corner of Chermih Rd and Calliope River Targinie Rd to end of Chermih Rd
19/07/2010	319731	7369261	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Seen on driving transect to North China Bay landing

Date	GPS Coordinates				Group	Number Recorded	Name		Status	Comment
	X	Y	Zone	Datum			Common	Scientific		
21/07/2010	319518	7368815	56K	GDA94	Mammal	1	Horse	<i>Equus caballus</i>	Exotic	Several seen around Farmhouse in disturbed grassland on driving transect to North China Bay landing, eastern side of LNG facility
23/07/2010	319340	7368869	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Seen on driving transect
4/02/2010	298500	7363400	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	In farmland south of road
26/02/2010	311553	7368520	56K	GDA94	Mammal	1	European hare	<i>Lepus capensis</i>	Exotic	Foraging in woodlands
26/02/2010	311553	7368520	56K	GDA94	Mammal	1	Dog	<i>Canis familiaris</i>	Exotic	Foraging in woodlands
19/05/2010	320355	7369304	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	Foraging in open-forest
12/07/2010	298085	7358604	56K	GDA94	Amphibian	1	Cane toad	<i>Rhinella marina</i>	Exotic	
14/07/2010	296528	7365264	56K	GDA94	Mammal	1	European hare	<i>Lepus capensis</i>	Exotic	
16/07/2010	308562	7371939	56K	GDA94	Mammal	1	Dog	<i>Canis familiaris</i>	Exotic	
16/07/2010	312498	7363515	56K	GDA94	Mammal	1	Dog	<i>Canis familiaris</i>	Exotic	
17/07/2010	311186	7364386	56K	GDA94	Mammal	1	Dog	<i>Canis familiaris</i>	Exotic	
20/07/2010	315706	7372771	56K	GDA94	Mammal	1	European red fox	<i>Vulpes vulpes</i>	Exotic	
21/07/2010	320787	7371869	56K	GDA94	Mammal	1	European red fox	<i>Vulpes vulpes</i>	Exotic	
23/07/2010	322309	7373326	56K	GDA94	Mammal	1	Dog	<i>Canis familiaris</i>	Exotic	
21/07/2010	313942	7372789	56K	GDA94	Mammal		Black rat	<i>Rattus rattus</i>	Exotic	
19/02/2011	318568	7367658	56K	GDA94	Amphibian		Cane toad	<i>Rhinella marina</i>	Exotic	

Appendix D - Training Guideline (from DPI&F, 2008b)

Individual companies should endeavour to provide training, if not to all employees then to key field based staff, in the identification of declared pests and pests in their various operational areas.

This training would cover issues such as:

- Identification of:
 - Declared pests
 - Common Pests
 - Infestation areas
- Procedures for assessing the risk of movement of declared and other significant pests by plant, machinery, vehicles, soils and other material from and to operational areas.
- Corrective actions which may be taken to minimise risk of spread.
- Control and management of identified pest outbreaks.
- Legislative requirements.

Key staff and contractors to attain proficiency in the identification of common and declared pests (including those declared under a local law) and known infestation locations.

Information can be sourced from the following:

- Local Government management plans
- Local Government officers
- Biosecurity Queensland , DPI&F Land Protection Officers
- Consultation with local stakeholders
- Biosecurity Queensland , DPI&F website (www.dpi.qld.gov.au)

Resources that can be used or may be developed include:

- Area/regional specific weed deck booklet (<http://www.weeds.org.au/weeddeck.htm>; <http://www.sainty.com.au/>)
- Pest fact sheets. Biosecurity Queensland website. Weed section (www.dpi.qld.gov.au)
- Information sheets from Local Government and natural resource management groups
- Maps of known infestation areas from Local Government, Biosecurity Queensland website (www.dpi.qld.gov.au), Land Protection officers and Weeds of National Significance Coordinators (www.weeds.org.au).

Key staff and contractors to attain proficiency in assessing the risk of movement of pests to and from operational areas including:

- Processes and procedures used in assessing risk (e.g. risk matrix see Appendix G):
 - Where has the vehicle, machine or material come from and travelled through?
 - Has the vehicle been off formed roads?
 - Is there written confirmation that the vehicle, machinery or material is of a low risk of being contaminated (e.g. Weed Hygiene Declaration Form completed – Appendix C)?
- Where is the vehicle, machinery or material destined?
- Is the destination an area of high concern for pest management (e.g. remote, rarely visited, sensitive)?

Key staff and contractors to attain proficiency in preventative measures to minimise weed spread:

- Clean down and inspection procedures
- Dealing with the storage or stockpiling of products in areas infested by pests
- Managing the movement of vehicles, machinery, materials and equipment
- Keeping required records.

Key staff and contractors to attain proficiency in control and management practices:

- Knowledge of appropriate control techniques for specific pests (refer to Biosecurity Queensland website (www.dpi.qld.gov.au))
- Knowledge of managing infested areas.

Key staff and contractors to have knowledge and understanding of relevant legislative requirements including:

- *Land Protection (Pest and Stock Route Management) Act 2002*
- Environmental Authority under the *Environmental Protection Act* (e.g. Code of Environmental Compliance for Petroleum Exploration and Production).

Appendix E - Terms of Reference Cross-reference Table

Terms of Reference		Ecosure Pest Management Plan	
Section	EIS Requirement	Technical Study Name	Technical Specialist Report Section
3.3.2.1 Description of Environmental Values Terrestrial Flora With regard to the project areas, this section should include:	The occurrence of pest plants (weeds), particularly declared plants under the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> should be shown on a map at an appropriate scale.	Ecosure Pest Management Plan	Figure 2
	The use of Biosecurity Queensland's Annual Pest Distribution Survey data and predictive pest maps available on the DEEDI website should be utilised in conjunction with Queensland Herbarium naturalised flora data to source the occurrence of pest plants in the project area.	Ecosure Pest Management Plan	Figure 2 Table 1
3.3.2.2 Potential Impacts and Mitigation Measures Terrestrial Flora With regard to the project areas, this section should include:	A discussion on the potential for the introduction and/or spread of weeds or plant disease, including: (i). Identification of the origin of construction materials, machinery and equipment. (ii). Vehicle inspection regime, which addresses the need for vehicle and machinery wash-down and any other hygiene protocols, including the requirement that all vehicles and equipment must be cleaned before starting the job and that these wash down areas contain water/soil away from creeks and gullies. (iii). staff/operator education programs. (iv). determination of the potential for the introduction of, or facilitation of, exotic, non-indigenous and noxious plants.	Ecosure Pest Management Plan	Vehicle Washdown – 4.6.2 Education – 4.6.1 Fact Sheets and Procedures – 1.9; 4.6.1 Species Specific Information – 4.2 Location and Abundance – Appendix A Site Specific Pest Flora – Table 2
	A draft weed management plan in an EM Plan format. This plan should be developed and finalised in consultation with Biosecurity Officers from DEEDI land and local government environmental officers, to cover construction, rehabilitation and operation periods	Ecosure Pest Management Plan	See discussion in text as to why the EM Plan format has not been used at this stage (Section 1.9)

Terms of Reference		Ecosure Pest Management Plan	
Section	EIS Requirement	Technical Study Name	Technical Specialist Report Section
	Weed management strategies are required for managing weed species already present at the project site and ensuring no new declared plants are introduced to the area. Reference should be made to the local government authority's pest management plan when determining control strategies. The strategies for managing weeds should be discussed in the main body of the EIS and provided in a working form in a Pest Management Plan as part of the overall EM plan for the project.	Ecosure Pest Management Plan	4.2 4.6
	A biosecurity management plan for biosecurity mitigation measures where the project accesses primary production areas (plant communities of commercial significance).	Ecosure Pest Management Plan	1.6.1
3.3.3.1 Description of Environmental Values Terrestrial Fauna With regard to the project areas, this section should include:	The existence of feral or exotic animals, including maps of major pest infestations.	Ecosure Pest Management Plan	Figure 3
	The use of Biosecurity Queensland's Annual Pest Distribution Survey data and predictive pest maps available on the DEEDI website, together with local government area pest management plans, should be utilised to source the occurrence of pest animals in the project area.	Ecosure Pest Management Plan	Figure 3 Table 2
3.3.3.2 Potential Impacts and Mitigation Measures Terrestrial Fauna With regard to terrestrial and riparian fauna, the assessment of potential impacts should consider:	Methods for minimising the introduction of feral animals, and other exotic fauna such as declared pest ant species (fire ants and yellow crazy ants).	Ecosure Pest Management Plan	4.4 4.5 4.6
	A review of control measures to prevent increases in local populations and spread of biting insect species of pest and health significance associated with construction and operational activities and disposal of construction and operational wastes.	Ecosure Pest Management Plan	4.5 4.6.2
	A pest animal management plan in an EM Plan format. This plan should be developed and finalised in consultation with Biosecurity Officers from DEEDI and local government environmental officers, to cover construction, rehabilitation and operation periods.	Ecosure Pest Management Plan	See discussion in text as to why the EM Plan format has not been used at this stage (Sections 1.9)
	A biosecurity management plan for biosecurity mitigation measures where the project accesses primary production areas.	Ecosure Pest Management Plan	1.6.1
3.3.4 Potential Impacts and	Strategies for protecting rare or threatened species and any obligations, legislation or policies imposed by the Queensland and	Arrow LNG Plant Freshwater Aquatic Ecology Baseline Impact Assessment –	Refer Aquateco report

Terms of Reference		Ecosure Pest Management Plan	
Section	EIS Requirement	Technical Study Name	Technical Specialist Report Section
Mitigation Measures Freshwater Aquatic Flora and Fauna	Australian governments.	Aquateco Consulting Pty Ltd	
This section should discuss all foreseen direct and indirect effects on aquatic flora and fauna, including:	The discussion should include: description of the potential for and mitigation measures to prevent the introduction, transfer or facilitation of exotic, non-indigenous and noxious plants and water borne insect pests.	Arrow LNG Plant Freshwater Aquatic Ecology Baseline Impact Assessment – Aquateco Consulting Pty Ltd	Refer Aquateco report
3.3.5 Potential Impacts and Mitigation Measures Marine Flora and Fauna	Fish species, mammals, reptiles and crustaceans occurring in marine waters, including pest species.	Marine and Estuarine Ecology Report (Coffey Environments)	Refer: Coffey Environments report
Marine flora and fauna occurring in the areas affected by the proposal should be described noting the patterns and distribution in Port Curtis. The description of the fauna and flora present in the areas should include:	Vectors for an introduction of a marine pest, possible impacts of a marine pest incursion and proposed mitigation measures should be discussed together with on-going monitoring for marine pests in the port and proposed response arrangements if a marine pest incursion occurs.	Marine and Estuarine Ecology Report - Coffey Environments	Refer: Coffey Environments report

Revision History

Revision number	Revision date	Details	Prepared by	Reviewed by	Approved by
01	15.04.11	Draft 1	Christy Englezakis	Beth Kramer	Phil Shaw Director
02	12.05.11	Draft 2	Christy Englezakis	Beth Kramer	Phil Shaw Director
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04.1	16.07.11	Final Revision 1	Beth Kramer		Phil Shaw Director

Distribution List

Copy number	Date	Type	Issued to	Name
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2	16.08.11	electronic	Ecosure	Admin

The terrestrial ecology pest management plan was prepared by Christy Englezakis (Senior Environmental Scientist) and Beth Kramer (Principal Environmental Scientist).



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