18. TERRESTRIAL ECOLOGY

This chapter describes the terrestrial ecology study undertaken to address changes made to the project description, to take account of additional information made available, and to respond to specific comments made in submissions on the Arrow LNG Plant EIS (Coffey Environments, 2012).

The chapter presents the findings of the terrestrial ecology study conducted by 3D Environmental and EcoSmart Ecology which is attached as Appendix 11, Arrow Curtis Island LNG Facility Terrestrial Ecology Supplementary EIS Study and Gap Analysis (Terrestrial Ecology Supplementary EIS Study). Findings of this study pertaining to Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) listed species are also discussed in Attachment 2, Matters of National Environmental Significance Update.

Results from ecological pre-clearance surveys undertaken by Ecosure, to support the geotechnical investigation program were also used to inform this assessment.

Matters relating to shorebird species are addressed in Chapter 19, Shorebirds, which is based upon the technical study carried out by Ecosure, attached as Appendix 12, Arrow LNG Plant Interim Shorebird Technical Study (Shorebirds Supplementary EIS Study).

18.1 Studies and Assessments Completed for the EIS

This section provides an overview of the terrestrial ecology impact assessment completed for the Arrow LNG Plant EIS and the main conclusions from that assessment.

Ecosure was engaged to conduct the terrestrial ecology study which is included as Appendix 9, Terrestrial Ecology Impact Assessment to the EIS. Chapter 17, Terrestrial Ecology of the EIS presents the findings of the terrestrial ecology impact assessment. EPBC Act listed species and communities were addressed in Attachment 4, Matters of National Environmental Significance of the EIS.

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

Field surveys identified 293 native flora species and 56 introduced flora species within the study area for the Arrow LNG Plant. Of the native flora species found, none were considered threatened under Commonwealth or state legislation. A potential new taxon was identified (*Cupaniopsis sp*. indet.). This species appears to have a naturally restricted range being associated with semi-evergreen vine thicket and is closely related to a threatened flora species (*Cupaniopsis shirleyana*).

One hundred and sixty-two terrestrial fauna species were observed during field surveys within the study area for the Arrow LNG Plant, consisting of 18 mammal, 15 reptile, nine frog and 120 bird species. Of these, ten species were observed which are listed as ‘migratory’ under the EPBC Act. Of these migratory species, eastern curlew (*Numenius madagascariensis*) is also listed as ‘near threatened’ under the Nature Conservation (Wildlife) Regulation 2006. There was also one ‘vulnerable’ bird species listed under the Nature Conservation (Wildlife) Regulation, beach stone

curlew (*Esacus magnirostris*) surveyed within the study area. Within 5 km of the study area, one mammal species, the grey-headed flying fox (*Pteropus poliocephalus*) which is listed as 'vulnerable' under the EPBC Act was surveyed, along with an additional four bird species listed under the Nature Conservation (Wildlife) Regulation. One of these, squatter pigeon (*Geophaps scripta scripta*) is also listed as 'vulnerable' under the EPBC Act.

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

Curtis Island

- A 'critically endangered' vegetation community, 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' ('critically endangered') on the eastern side of Hamilton Point (Figure 17.3 of EIS). This community is listed under the EPBC Act and mapped as regional ecosystem (RE) 12.2.2.
- Limited distribution of small pockets of semi-evergreen vine thicket on headlands and beach dunes (RE 12.11.4 and RE 12.2.2 respectively) were identified (Figures 17.3 and 17.4 of EIS). These represent potential habitat for threatened flora and fauna species and are currently afforded a *Vegetation Management Act 1999* (Qld) status of 'of concern'.
- Two broad overland drainage basins occur within the central and northern portions of the Arrow Energy LNG plant site. Both of these areas support relatively intact sclerophyllous open forest that is representative of an 'endangered' RE (RE 12.3.3) (Figures 17.3 and 17.4 of EIS).
- Mangrove and saltpan habitat (RE 12.1.3 and RE 12.1.2) supports marine plants and provides known habitat for water mouse (*Xeromys myoides*), listed as 'vulnerable' under both the EPBC Act and the Nature Conservation (Wildlife) Regulation. These areas also provide potential shorebird feeding and roosting habitat.
- Field surveys recorded the Nature Conservation (Wildlife) Regulation listed species, eastern curlew, as being present within the project area on Hamilton Point. A record of beach stone-curlew from North China Bay was identified in the desktop study.
- An additional four threatened fauna species under the Nature Conservation (Wildlife) Regulation were recorded within 5 km of the site (to the north in the Environmental Management Precinct) in either field or desktop surveys. These are grey goshawk (*Accipiter novaehollandiae*), grey-headed flying-fox (*Pteropus poliocephalus*), glossy black-cockatoo (*Calyptorhynchus lathami*) and powerful owl (*Ninox strenua*).

Mainland Tunnel Launch Site and Tunnel Spoil Disposal Area

- Predominantly intact sclerophyllous open forest is present inland of the high water mark, with most of the vegetation analogous with the 'of concern' RE 11.3.4 (Figure 17.4 of EIS). Areas of this site contain essential habitat for the koala (*Phascolarctos cinereus*), which at the time of writing of the EIS was listed as 'vulnerable' in the Southeastern Queensland bioregion under the Nature Conservation (Wildlife) Regulation but has since been listed as 'vulnerable' under the EPBC Act (Section 18.3).
- The saltpan (RE 12.1.2) is a potential shorebird feeding and roosting area (Figure 17.4 of EIS). The area could support more than 15 species of migratory shorebird and therefore be considered a significant shorebird habitat under the EPBC Act Policy Statement 3.21 'Significant Impact Guidelines for 36 Migratory Shorebird Species' (DEWHA, 2009b). No areas of key shorebird foraging or roosting habitat are identified at this site in the Curtis Coast Regional Coastal Management Plan (EPA, 2003) although the mudflats on the eastern side of the mangroves adjacent to this site are identified to be key foraging habitat in the Curtis Coast

Region Coastal Management Plan. The nearest shorebird roost site is over 1 km to the southeast at Flying Fox Creek. Shorebirds are addressed in more detail in Chapter 19, Shorebirds.

Temporary Workers Accommodation Facilities

- No remnant vegetation was observed within TWAF 7 and this site is considered to be of low conservation significance, as it is a former ash pond that has been capped and sown with grass.
- At TWAF 8, a relatively consistent distribution of woodland to open forest was found to occur within the eastern two-thirds of the site, representative of remnant RE 11.3.4 ('of concern') (Figure 17.4 of EIS). Vegetation along the northern, western and southern boundaries of the site was similarly composed however generally lacked the canopy cover intercept that would satisfy the criteria for remnant status. Therefore, these areas were representative of non-remnant, high value regrowth that is characteristic of 'of concern' RE 11.3.4.
- TWAF 8 contains essential habitat for coastal sheath-tail bat (*Taphozous australis*) and koala. The site also forms part of a state wildlife corridor and provides potential habitat for a range of threatened fauna, with records of squatter pigeon, grey-headed flying-fox and square-tailed kite (*Lophoictinia isura*) nearby.

Launch Sites

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

The likely key impacts identified in the EIS as a result of the project related to vegetation clearing, habitat fragmentation, the introduction of pest flora and fauna, changes to hydrology, increased pollution, disturbance to fauna (such as through lighting, noise and vehicles) and fauna impacts as a result of trench fall.

The EIS identified areas requiring additional study to further understand the potential impacts of the project, mainly related to water mouse, shorebirds and other species of conservation significance.

The Arrow LNG Plant will implement a management hierarchy which preferentially avoids impacts, then mitigates, before offsetting any significant residual impacts. The EIS identified that the greatest residual impacts are expected to occur at the saltpan (RE 12.1.2) at the mainland tunnel launch site and tunnel spoil disposal area, at the LNG plant site within two areas of 'endangered' vegetation (regional ecosystem 12.3.3), and potential edge effects on the population of *Cupaniopsis sp*. indet. at Boatshed Point.

Table 18.1 lists the commitments Arrow Energy made in the EIS to manage the project impacts on terrestrial ecology.

Table 18.1 Terrestrial ecology EIS commitments

No.	Commitment
C17.01	Prepare construction and operations environmental management plans. These documents are to include detailed information about significant flora and fauna species and their management and ongoing conservation. Include site-specific mitigation and details of monitoring and inspection to be undertaken, in the environmental management plans consistent with advice provided by government.

Table 18.1 Terrestrial ecology EIS commitments (cont'd)

No.	Commitment
C17.02	Determine areas (if any) requiring to be offset in consultation with DERM and DSEWPC and other government stakeholders prior to commencement of construction. This is likely to include the two areas of endangered (Vegetation Management Act) remnant vegetation (RE 12.3.3; Assets 27 and 31) within the LNG plant site, and the *Cupaniopsis* sp.indet population.
C17.03	An area of semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained by the project on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of the semi-evergreen vine thicket community will be fenced off with a 20-m buffer between the semi-evergreen vine thicket community (including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi-evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. Do not develop within the fenced area of the retained semi-evergreen vine thicket community. Establish roles and responsibilities for the management of the retained semi-evergreen vine thicket community.
C17.04	A wildlife corridor of 20 m will be established on the eastern side of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the environmental management precinct.
C17.05	Route the haul road for the Hamilton Point MOF option away from the eastern margin of the headland to avoid the Critically Endangered' RE 12.2.2 (Microphyll/notophyll vine forest) on beach ridges.
C13.04	Design TWAF 8 to minimise disturbance to the Of Concern' RE 11.3.4 ('*Eucalyptus tereticornis* and/or Eucalyptus spp. tall woodland on alluvial plains') to maintain connectivity of habitat along the Targinie Creek riparian zone. Common with Chapter 13, Surface Water, Hydrology and Water Quality, and Chapter 18, Freshwater Ecology.
C13.05	Where practical, align the perimeter fence at TWAF 8 to adopt the alignment of the existing fence where it crosses Targinie Creek. Common with Chapter 13, Surface Water, Hydrology and Water Quality, and Chapter 18, Freshwater Ecology.
C13.06	Design any intra-site access road crossing of Targinie Creek at TWAF 8 to include box culverts (or similar) to enable fauna movement under the road and along the wildlife corridor. Common with Chapter 13, Surface Water, Hydrology and Water Quality, and Chapter 18, Freshwater Ecology.
C17.06	Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works.
C17.07	Develop fauna relocation protocols as part of fauna management measures including procedures if fauna is found during clearing activities, including in hollows of trees to be felled.
C17.08	Prepare a fauna management plan for the project.
C17.09	Develop weed management measures prior to initiation of construction activities in accordance with local and regional management guidelines and best practice advice prescribed in DERM's pest control factsheet series.
C17.10	Liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Notify Gladstone Regional Council of any new declared or notifiable pest species. These programs should particularly focus on the boundaries of the project site with the Environmental Management Precinct.
C17.11	Develop and implement a mosquito management plan prior to construction that includes measures to control the occurrence of stagnant pools of water on the site especially after rainfall.
C17.12	Develop and implement washdown strategies and procedures to prevent the spread of weeds.
C17.13	Include measures in the pest management plan to control invasive plant species that may colonise the mudflats and degrade remaining habitat.

Table 18.1 Terrestrial ecology EIS commitments (cont'd)

No.	Commitment
C17.14	Prior to initiation of works, clearly mark access tracks to prevent secondary tracks becoming established. Use existing access tracks where practical. Where practical, the location and design of access tracks should avoid sites of high ecological value.
C17.15	Locate construction equipment, laydown areas, turn-around areas, stockpiles and working areas within areas of existing disturbance where practical.
	Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:
C17.16	• Shield/direct the light source onto work areas where practical. Common with Chapter 19, Marine and Estuarine Ecology, and Chapter 23, Landscape and Visual.
C17.17	• Use long-wavelength lights, where practicable, including use of red, orange or yellow lights. Common with Chapter 19, Marine and Estuarine Ecology.
C17.18	• Lower the height of the light sources as far as practical. Common with Chapter 19, Marine and Estuarine Ecology.
C17.19	• Avoid planned routine maintenance flaring at night during sensitive turtle reproductive periods (where practicable). Common with Chapter 19, Marine and Estuarine Ecology.
C17.20	Design lighting around the perimeter of the LNG plant to minimise impacts on roosting shorebirds, where practical. Lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal zones, where practical.
C17.21	Design construction lighting on the causeway at the mainland tunnel entry shaft and tunnel spoil disposal area to minimise impacts on roosting shorebirds. The lowest possible luminescent globes should be used in sensitive areas, particularly around intertidal areas, where practical.
C17.22	Induct all personnel prior to entering a project site, including on measures for managing the impacts on flora and fauna likely to be present.
C17.23	Clearly mark no go zones, where required, including the semi-evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the 'Critically Endangered' RE 12.2.2 on Hamilton Point (if the Hamilton Point South MOF is selected).
C17.24	Prohibit access to the saltpans and fringing mangroves (RE 12.1.2 and 12.1.3) outside the planned area of disturbance of the mainland tunnel entry shaft and tunnel spoil disposal area.
C17.25	Conduct preclearance surveys across project areas to be cleared of vegetation. The surveys will aim to determine whether any threatened species are present at each site. Appropriate mitigation measures will be implemented if threatened species are confirmed within the area.
C17.26	Inspect the likely white-bellied sea-eagle nest on Hamilton Point for activity during breeding season prior to clearance, if this option is pursued. If active, formulate appropriate management measures, should the Hamilton Point MOF option be pursued.
C17.27	Reduce vegetation clearing where practical and only after all other options such as selective clearing and trimming of vegetation have been considered.
C17.28	Clearly mark trees for retention to avoid accidental clearing and develop clearance procedures prior to construction. The root zone should be adequately protected.
C17.29	In areas where trees are planned to be left in place, take care to minimise damage to surrounding trees when felling trees into cleared areas or in natural slots between retained trees.
C17.30	Inspect plants, soil, fill and any other such materials to be used in construction/rehabilitation works prior to entry to site. If supplied from within the fire-ant restricted area, these materials must be accompanied by a movement certificate or fire-ant declaration form. This also applies for the yellow crazy ant.
C17.31	Prohibit pets of staff and contractors from entering the project area (unless assistance animals).
C17.32	Adopt waste control measures to avoid introducing new external seed sources for exotic flora.
C17.33	Prohibit hunting and trapping unless required for pest management.
C17.34	Undertake all handling and management of fauna in compliance with permits issued by DERM.

Table 18.1 Terrestrial ecology EIS commitments (cont'd)

No.	Commitment
C17.35	Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access).
C17.36	Develop trench inspection procedures to remove trapped fauna, establish protection and refuge areas for wildlife trapped in the trench and methods to assist trapped fauna left in the trench.
C17.37	Prohibit construction and operation activities within 'field' areas that are outside of the construction area of disturbance, i.e., areas exposed to bushfire fuels, during days of total fire ban.
C17.38	Identify areas to be rehabilitated and develop procedures for restoration and maintenance.
C17.39	Rehabilitate construction access tracks not required for operations.

18.2 Study Purpose

The supplementary terrestrial ecology assessment addresses changes to the project description that have arisen as a result of the front-end engineering design (FEED) that was completed after finalisation and exhibition of the EIS, and responds to specific issues raised in the submissions on the EIS. These aspects are identified below.

18.2.1 Project Description Changes

Changes to the project description that relate to the terrestrial ecology study are primarily around amendments to the area of disturbance. The project area encompasses the area that will be disturbed or potentially disturbed by the proposed project, including all potential options (Chapter 4, Project Description: LNG Plant).

Figure 1.1 illustrates the revised project area and key project features. Main changes to the area of disturbance are at the mainland tunnel launch site and around the LNG plant site on Curtis Island, as well as the addition of the site at Red Rover Road. A summary of the amended area of disturbance in relation to regulated vegetation is presented in Section 18.5.

18.2.2 Additional Information

The EIS identified the need for further assessment on the impacts of the Arrow LNG Plant on species of conservation significance, including wet season survey. 3D Environmental and Eco Smart Ecology were commissioned to undertake an analysis of the findings of the EIS to identify any additional work scope required, followed by additional desktop study and field work.

In addition to the study findings outlined in this chapter, additional fieldwork is planned in early 2013 to satisfy the requirement for wet season survey effort. These surveys will focus upon species only present in the warmer months, as well as those that become more active around this time (e.g., frogs and reptiles). The findings of these surveys will be presented as an addendum to the SREIS to be submitted to the Coordinator-General.

18.2.3 Submissions

Several submissions on the EIS raised issues relating to terrestrial ecology. The full details of these submissions can be seen in the issue register table in Part B, together with responses to specific issues raised.

18.3 Legislative Update

Since the EIS was finalised there have been some changes to policies, guidelines and legislation that impact on the management of terrestrial ecology.

18.3.1 Species or Habitats Schedules Revision

A number of species or habitats have had their status under either the EPBC Act or the Nature Conservation (Wildlife) Regulation revised since the publication of the Arrow LNG Plant EIS. Some species under the Nature Conservation (Wildlife) Regulation have been downgraded to 'least concern' and these are discussed in Appendix 11 and are no longer considered in the assessment of impacts on Endangered, Vulnerable and Near Threatened (EVNT) species.

Listing of Koala as 'Vulnerable' Under the EPBC Act

On 2 May 2012, koala populations in Queensland, New South Wales and the Australian Capital Territory were listed as vulnerable under the EPBC Act. In order to list the Queensland/New South Wales/Australian Capital Territory koala population separately, the Minister had to nominate it under Section 517(1) of the EPBC Act as a separate species to the rest of the koala population. This was based on advice from the Threatened Species Scientific Committee (TSSC) to DSEWPaC (TSSC, 2012).

All new developments within koala habitat in Queensland, New South Wales or the Australian Capital Territory will now need to consider whether the development is likely to have a significant impact upon the koala, using the existing EPBC Act significant impact criteria for vulnerable species. Referral guidelines for the koala have been released and outline criteria for assessing 'critical habitat', 'important populations' and significant impacts.

Koala is assessed in this supplementary report to the EIS (SREIS) as an EPBC Act listed species, following the EPBC Act significant impact criteria for a vulnerable species.

Listing of Lowland Rainforest of Sub-Tropical Australia as 'Critically Endangered' Under the EPBC Act

The 'Lowland Rainforest of Subtropical Australia' was added to the EPBC list as 'critically endangered' in November 2011. Listing advice for this community has been prepared although it is unlikely to be present within the project area.

18.3.2 Environmental Offsets Policy

DSEWPaC released the EPBC Act Environmental Offsets Policy in October 2012 (Australian Government, 2012a). This policy outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act and replaces the draft policy statement 'Use of environmental offsets under the EPBC Act' (2007) (DEWR, 2007).

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. The Offsets assessment guide (Australian Government, 2012), which accompanies the policy, has been developed to give effect to the requirements of the policy, utilising a balance sheet approach to measure impacts and offsets. The guide applies where the impacted protected matter is a threatened species or ecological community.

The EPBC Act Environmental Offsets Policy applies to any new referrals or variations to approval conditions from 2 October 2012. It also applies to any projects currently under assessment for which a decision has not yet been made and therefore will apply to the Arrow LNG Plant.

Any offsets under the policy, must be new and additional to what is already required – an area already set aside for conservation or that is unable to be developed is unlikely to be acceptable. Offsets are only to be proposed after all reasonable avoidance and mitigation measures have been presented. Offsets are therefore designed to compensate for the residual impact of a project, after the implementation of avoidance and mitigation measures.

The same offset can be used to satisfy both state/territory and Commonwealth environmental impact assessment processes for the one project. Offset requirements at a state level are unchanged since the Arrow LNG Plant EIS was finalised (Section 2.1 of Attachment 6 to the SREIS), and governed by the Queensland Government Environmental Offsets Policy, June 2008 (EPA, 2008a). This policy is currently under review (as of November 2012). The state government has also released the Ecological Equivalence Methodology Guideline (DERM, 2011). The guideline is intended to inform requirements for ecological offset required under the Policy for Vegetation Management Offsets and Queensland Biodiversity Offsets Policy.

Arrow Energy has developed a draft Environmental Offset Strategic Management Plan (Attachment 6), consistent with its Environmental Offset Strategy. This plan:

- Describes measures taken to avoid and minimise impacts.
- Identifies Arrow Energy's likely offset requirements.
- Presents evidence that there are opportunities to achieve the required offsets.
- Sets out Arrow Energy's preferred approach to the provision of environmental offsets.

The Environmental Offsets Strategic Management Plan presents the results of GIS analysis involving the sequential application of filters to identify suitable patches/tracts of target regional ecosystems, to facilitate identification of potential offset sites.

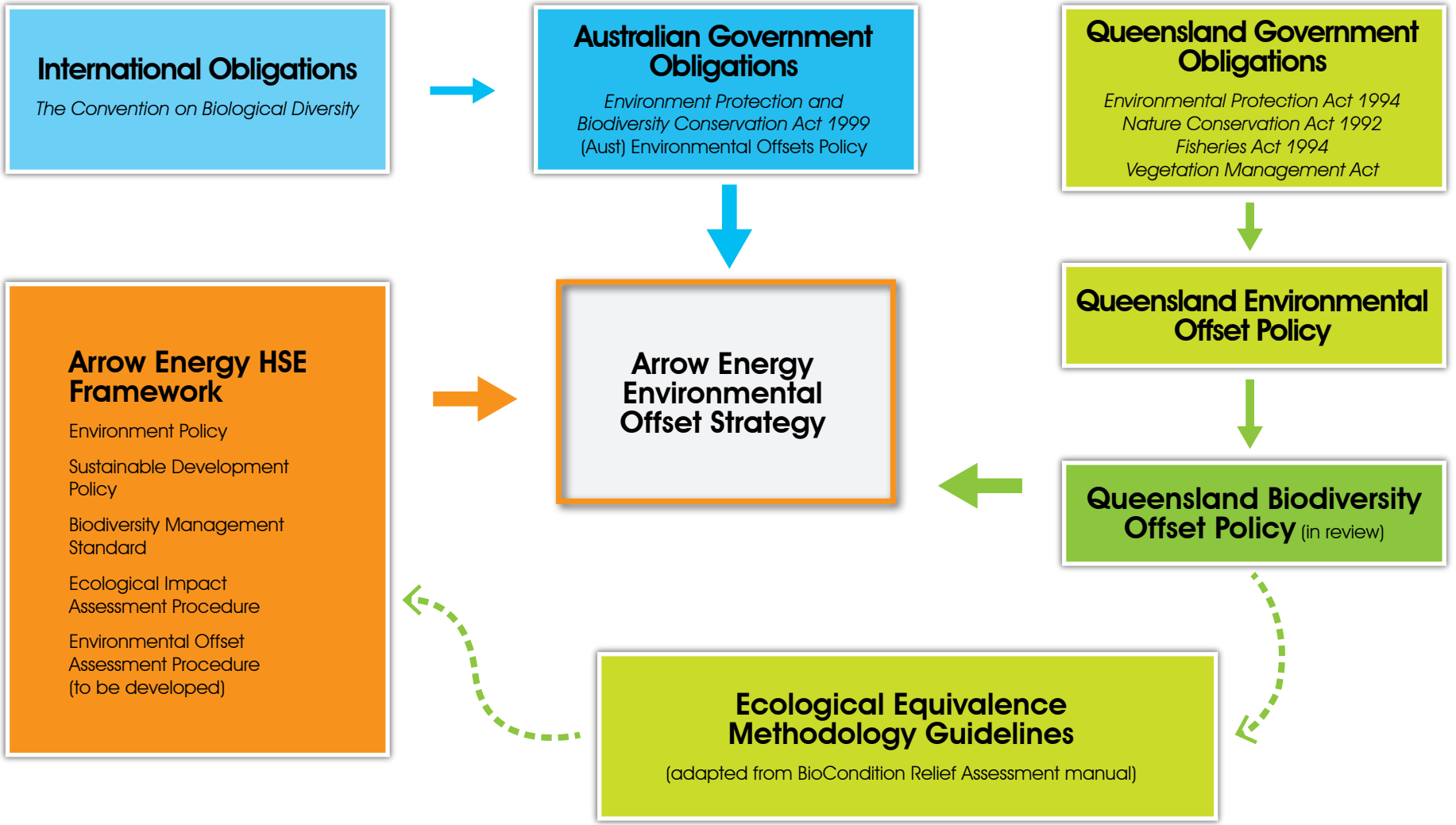
Arrow Energy's principles for offset management have been developed to align with offset principles from both Commonwealth and state policies. Offsets will:

- Meet the requirements of current government policy.
- Only be used once the hierarchy to minimise impact (avoid, minimise, mitigate) has been followed.
- Contribute to managing and protecting biodiversity.
- Be implemented strategically and economically.

The regulatory framework for environmental offsets driving this strategy and subordinate plans are shown in Figure 18.1 below.

18.4 Study Method

This section describes the terrestrial ecology study method. The work undertaken for the SREIS is largely based on a review of previous ecological work undertaken for the Arrow LNG Plant EIS (Appendix 9, Terrestrial Ecology Impact Assessment, Chapter 17, Terrestrial Ecology and Attachment 4, Matters of National Environmental Significance), cross referenced against the Terms of Reference for the Arrow LNG Plant and submissions made upon the Arrow LNG Plant EIS.



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18.4.1 Data Review of EIS

The review of previous work identified additional scope that needed to be to be addressed in the SREIS. The review predominantly verified the additional work that had already been identified by Arrow Energy prior to and following publication of the EIS. The review focused upon the scope of the desktop review for terrestrial ecology, the adequacy of sampling effort, spatial gaps in site data, seasonal gaps in site data, verification of species and communities identified and validation of the impacts on terrestrial ecology from the Arrow LNG Plant.

Areas identified for further work that were of significance to the assessment of terrestrial ecology impacts for the Arrow LNG Plant include the following:

- The 30 km buffer applied in the EIS for database searches may not be sufficient to identify coastal EVNT species potentially present within the project area.
- Launch site 1 was not subject to field survey during the EIS.
- Additional spatial data on flora is required at the mainland tunnel launch site.
- Limited floristic survey has been undertaken during the optimal seasonal window (wet season) although all EVNT species possibly present can be identified out of this period.
- Further assessment of groundwater dependent ecosystems is required.
- Limited fauna survey undertaken in warmer summer months, valuable for collecting data on migratory birds and reptiles.
- No systematic trapping using techniques such as pitfall and funnel traps, or infrared camera.
- Limited Elliot trapping in mangrove habitats for EPBC Act listed water mouse.
- Limited discussion on the impacts relating specifically to EVNT flora and fauna species, and vegetation communities.

This scope, combined with a review of project description changes and submissions issues have been used to target additional literature review and field survey requirements to further define impacts to a range of EVNT flora and fauna species, ecological communities and regional ecosystems.

18.4.2 Literature Review

A review of publically available literature was undertaken to supplement, refine and update the desktop assessment undertaken in the EIS. The review considered a full range of information sources on flora and fauna matters, but focused upon literature or databases that have been updated or added since the EIS was finalised.

Information reviewed included databases and information held by agencies, impact assessment reports from other infrastructure projects in the Gladstone region, and aerial imagery and primary literature.

The desktop studies facilitated the development of species dossiers on EVNT species (flora and fauna) likely to be present within the project area. The dossiers present a detailed analysis of the ecology of each species in question and how this relates to the activities of the Arrow LNG Plant. This includes status, species ecology, distribution and breeding, threats and occurrence in the region including any identified important populations or critical habitat.

The dossiers are structured to accord with the “Department of Environment’s significant impact guidelines 1.1 – Matters of national environmental significance”, particularly in relation to the definition of important populations and critical habitat.

Any species that appears in database searches or the referrals (EPBC No: 2009:5007 and EPBC No: 2009:5008) for the project, that were considered unlikely to be present in the project area based on range or lack of suitable habitat, were discounted and dossiers for these species were not produced. A summary of these species and the reasons for their omission from further study is presented in Appendix 11, Terrestrial Ecology Supplementary EIS Study.

18.4.3 Field Survey

The literature review assisted in identifying locations for further site survey, and the creation of a site specific list of conservation listed species and communities known from the local area, which should be the focus of field investigations. Fieldwork consisted of floristic surveys for conservation listed species and verification of vegetation community mapping, fauna habitat surveys and targeted surveys for EPBC Act and Nature Conservation (Wildlife) Regulation listed species, in particular, water mouse.

Floristic Fieldwork

Field investigation took place over a five day period between 28 August and 2 September 2012, in mild, dry conditions with moderate SSE winds. Field survey methods followed Queensland Herbarium standards as identified in Neldner *et al* (2005) and were consistent with previous field studies carried out for the EIS.

A combination of secondary, tertiary and quaternary level sampling procedures was undertaken, as well as informal site observation at a number of project infrastructure locations on Curtis Island and the mainland. Where an RE was considered to provide habitat for EVNT flora species, the search area was widened and traverses were undertaken focussing on potential habitat for the species in question. A total of 45 floristic sites were surveyed, to supplement the 75 sites described in the EIS.

No new vegetation mapping of REs was undertaken in the surveys, except for the site at Red Rover Road which was an addition to the project area since the EIS was finalised. Inconsistencies with mapping of REs undertaken in the EIS were noted, and these were targeted for further field verification. Additional liaison with Ecosure (who undertook the EIS mapping), was completed to confirm alignment with findings and updated RE mapping is presented in this SREIS.

Fauna Fieldwork (Water Mouse)

The EIS identified that water mouse was likely to be present in mangrove habitats within the vicinity of the Arrow LNG Plant sites and potentially within the project footprint. An individual was captured in 2011 approximately 4.5 km north of North China Bay on Curtis Island (Worley Parsons, 2011) and a potential abandoned mound nest was discovered approximately 2.7 km north of North China Bay in 2009 (BAAM, 2009). On the mainland, water mouse have been recorded both north and south of Fishermans Landing, and on the western banks of the Calliope River. The species was therefore identified as requiring targeted survey to establish its potential presence in relation to project infrastructure.

The Australian Government’s survey guidelines for Australia’s threatened mammals (DEWHA, 2011) recommends that water mouse survey is undertaken through a combination of three methods – habitat assessment, active searching and Elliot trapping.

Habitat Assessment

Habitat assessment within the project area was undertaken at three sites on Curtis Island (mangroves east and west of Boatshed Point and northeast of Boatshed Point (to the east of the LNG plant site)). On the mainland, assessment was undertaken at launch site 1 and adjacent to the Red Rover Road site on the Calliope River. Fringing mangroves adjacent to the mainland tunnel launch site will not be impacted by project activities, and assessment was not required at this site. Water mouse survey site locations can be found on Figure 18.2.

Key features in assessing habitats include:

- Extent of available mangrove habitat.
- Adjoining habitat (marine couch, woodland, mudflats).
- Distance from mangroves to vegetation above the high water mark (HWM).
- Availability and size of hollows.
- Prey abundance.
- Level of disturbance.

Assessment of habitat suitability allowed active searching and Elliot trapping to be focused on areas of highest water mouse potential.

Active Searching

Habitats were searched during diurnal hours for evidence of water mouse including:

- Evidence of feeding (prey middens, crab remains).
- Mounds/nest structures.
- Mud lined tree hollows.
- Tree plugs.
- Tracks through vegetation from mangroves into adjoining habitat.
- Footprints in the mud.

Active searching allows considerable portions of each mangrove area to be traversed. Any evidence of water mouse found was logged with a GPS coordinate.

Elliot Trapping

Elliot trapping was undertaken at the three sites on Curtis Island and at launch site 1 on the mainland, based on the habitat assessment undertaken. Traps were baited each night with a mixture of sardines, tuna, crab and rolled oats, and set approximately two hours before the low tide and retrieved at least two hours after low tide. Where possible, traps were left open for six hours.

Traps were set in lines of five or ten traps perpendicular from the mainland edge running through the mangroves, and separated by approximately 5 m. Where an active nesting hollow was found, five traps were placed in close proximity to the entrance.

In total, 620 trap nights were undertaken over seven nights in suitable habitat, an increase on the previous 83 trap nights undertaken during field survey for the EIS.

The suitability of each area of mangrove in relation to project infrastructure was assessed through a combination of the methods outlined above. The latter two methods can provide confirmation of the species presence, the former method only an indication of likelihood.

coffey environments	Date: 04.12.2012 MXT: 7033CC_16_GIS049_v1_1v File Name: 7033_16_F18.02_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Water mouse survey sites	Figure No: 18.2

Water mouse trapping occurred over a single night at each site. No consecutive night trapping was undertaken due to logistical constraints of widely scattered sites on the mainland and Curtis Island. It was not possible to trap at North China Bay due to access constraints, although this site has been covered by previous trapping for other projects and these results have informed this assessment. North China Bay is a highly disturbed site due to other LNG developments on Curtis Island, and the presence of this species at this site is considered unlikely.

Historically water mouse trapping in Gladstone has resulted in very low capture rates. For example trapping over a seven month period in water mouse habitat near Gladstone only resulted in two individuals being caught after thousands of trap nights. These rates indicate that trapping is not the most efficient method for determining the presence of the species, and active searching is considered to be a more successful method to determine presence of water mouse, therefore focus was placed on this method with trapping being undertaken in support of the active searching.

A combination of trapping, active searches and habitat assessment, combined with a precautionary approach when assessing the likelihood of the species presence, provides a comprehensive assessment of the likely distribution of water mouse in relation to project infrastructure for the Arrow LNG Plant.

Fauna Fieldwork (Other EVNT Species)

Survey effort to supplement the findings of the assessments undertaken for the EIS involved nocturnal spotlighting, active searching (including searching ground debris, hollows, bark inspection and aural surveys) and habitat assessment at project infrastructure locations on Curtis Island and the mainland. Surveys were undertaken to establish the suitability of habitat for EVNT species, and habitat condition. Assessing habitat features such as feed trees, ground cover and proximity to water are important to determine the likelihood of presence of particular EVNT species.

Results from these vertebrate assessments, contributes to defining which species require further targeted assessment in surveys planned for early 2013 in wet season conditions, and determining sampling locations for these surveys. For many EVNT species, the desktop assessment and general survey effort already undertaken for the Arrow LNG Plant, will result in targeted surveys being unnecessary for the species in question.

18.4.4 Study Limitations and Further Work

The desktop studies and field assessments detailed in Sections 18.4.2 and 18.4.3 have largely addressed additional data required to inform floristic knowledge. Similarly, field investigation targeting water mouse and potential habitat for this species have addressed additional data required to inform fauna knowledge. The study also increases documentation on EVNT fauna species, particularly around potential impacts on these species. Targeted field survey and wet season trapping based on EPBC Act guidelines, is required early in 2013 for certain species such as brigalow scaly-foot (*Paradelma orientalis*).

TWAF 7 was not surveyed for fauna values due to access constraints. The site consists of non-remnant habitats. The flora team accessed this site and collected habitat notes and opportunistic fauna observations, which were used by the fauna team to assess habitat values.

18.4.5 Assessment Methodology

The study identified the existing environment in terms of terrestrial ecology, focusing on the findings of the review of the EIS. The results of the desktop study and additional fieldwork, were

used to review the results of the terrestrial ecology impact assessment. This specifically focused on validating the impacts and mitigation measures to which Arrow had already committed in the EIS and presenting new impacts and mitigation measures where applicable.

Mitigation measures are consistent with those presented in the EIS, and the commitment number from the EIS given thereafter in parentheses. New mitigation measures to address impacts identified in the supplementary terrestrial ecology study are also presented (commitment numbers C17.40 – C17.50).

Any assessment of impacts on listed threatened species and communities was limited to instances where the findings are inconsistent with the technical study and chapter in the EIS (e.g., a conservation listed species is found during fieldwork), and followed the methodology of the EIS (significance approach).

18.5 Environmentally Sensitive Areas and Essential Habitat Assessment

Category A and B Environmentally Sensitive Areas (ESAs) which may be impacted by project activities are described below, along with areas of essential habitat which constitute Category C ESAs.

18.5.1 Environmentally Sensitive Areas

EIS Findings

ESAs were listed in Section 17.3.2 of the Arrow LNG Plant EIS, and shown on Figure 17.2, in terms of their regional context to project infrastructure.

SREIS Study

Category A and Category B ESAs present within the project area of the Arrow LNG Plant are as presented in Table 18.2 below. The only ESAs present within the project area, relate to the Great Barrier Reef World Heritage Area, and areas of 'Endangered' RE. The total area of each ESA requiring to be cleared for the Arrow LNG Plant is also presented within Table 18.2.

Table 18.2 Environmentally sensitive areas present in the Arrow LNG Plant project area

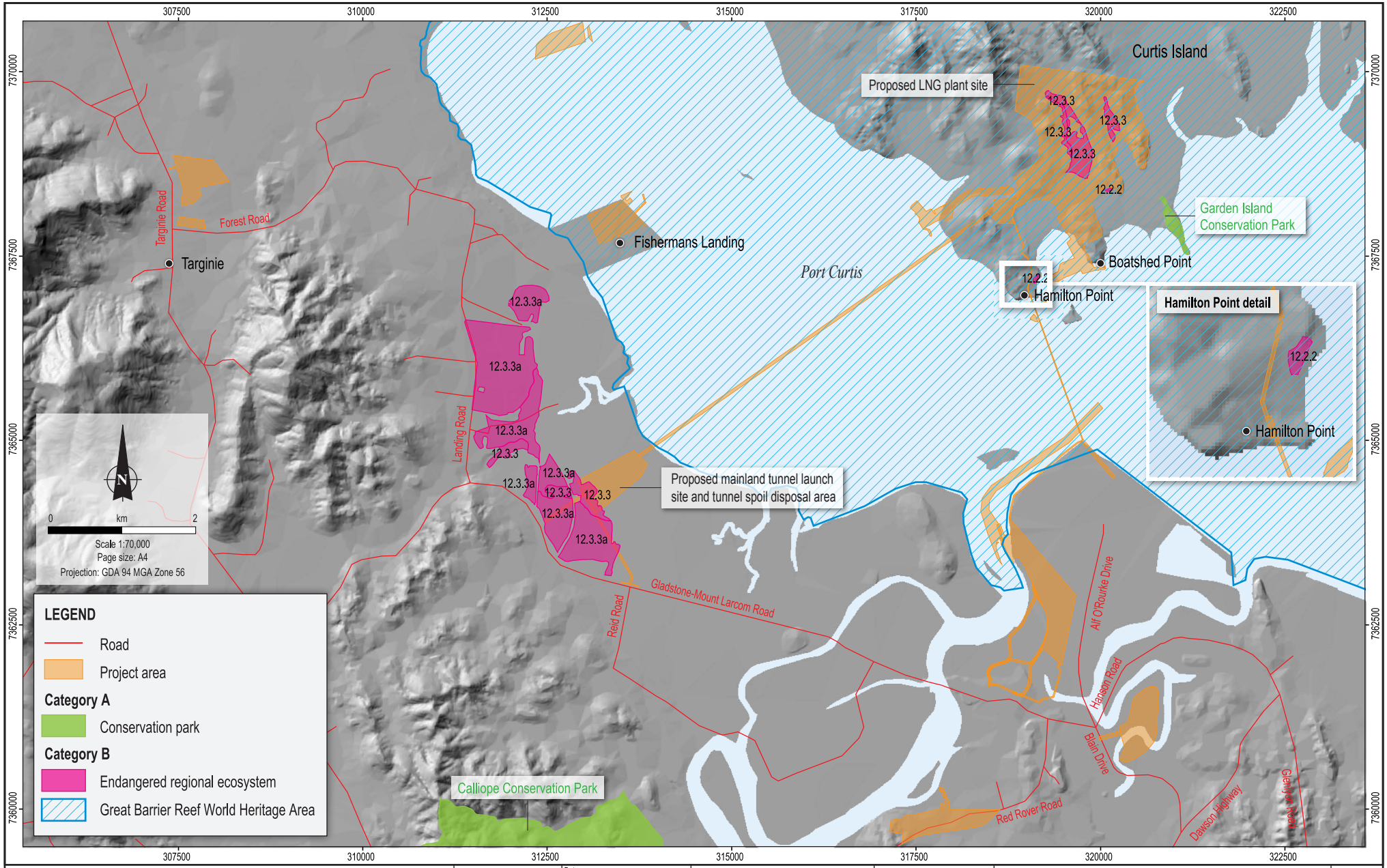
Environmentally Sensitive Area (ESA)	Area to be Cleared (ha)
The Great Barrier Reef World Heritage Area (Category B)	430.7 (including marine infrastructure)
Endangered Regional Ecosystem RE 12.3.3 (Category B)	37.73
Endangered (biodiversity status) Regional Ecosystem RE 12.2.2 (Category B)	0 (see Section 18.6.2)

All RE mapping presented in the SREIS is based on ground-truthed information from the EIS technical study and the technical study undertaken for the supplementary report.

Category A and Category B ESAs present within the project area of the Arrow LNG Plant are shown in Figure 18.3.

Impacts

The area of ESAs to be cleared does not differ from the findings of the EIS, and the impacts upon ESAs remain as assessed in Section 17.4.2 of the EIS.



Source:
Place names and roads from DME.
Project area and hillshade from Coffey Environments.
Endangered regional ecosystems from Ecosure and 3D Environmental.
Conservation parks from DERM. World Heritage Area from DEWHA.

coffey environments

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Arrow Energy

Arrow LNG Plant

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Environmentally sensitive areas in proximity to the Arrow LNG Plant project area

Figure No: 18.3

Mitigation Measures

No new mitigation measures are proposed for ESAs.

18.5.2 Essential Habitat

EIS Findings

Since the EIS was finalised and exhibited, a number of updates and corrections to essential habitat (Category C ESA) mapping presented in the EIS, for the area under the *Vegetation Management Act 1999*, have been identified.

SREIS Study

At the Red Rover Road site, habitat made up of RE 12.3.3 is mapped by DERM (now the Department of Environment and Heritage Protection (EHP)) as being essential habitat for koala. There do not appear to be any local records of this species, and this species is highly unlikely to occur at this site. No RE 12.3.3 was located on the site during the flora survey when REs were ground truthed. The site was dominated by RE 12.11.6.

At the mainland tunnel launch site, essential habitat for koala (RE 12.3.3) and little pied bat (RE 11.3.29, 12.3.3) occurs to the north and east. While no records of either of species occur within the project area, records of little pied bat occur within 1 km to the north.

Essential habitat for little pied bat extends south to overlap slightly with the footprint of the mainland tunnel launch site (overlap of 2.65 ha). The area of overlap comprises bare saltpan, and is not suitable for foraging or roosting for the species which favours dry forest and open woodland communities. There is a moderate likelihood that little pied bat could be present within woodland inland of the mainland tunnel launch site. The records of little pied bat are from 1997, and recent surveys of the area adjacent to the mainland tunnel launch site, by Tenement to Terminal Ltd (for the proposed new Gladstone Coal Terminal), did not locate the species (GHD, 2012). The species is apparently scarce in the local area (based on a large volume of ecological work for LNG and other infrastructure projects), and a small area of potential habitat will be affected. Further survey effort in early 2013 (wet season) will include a targeted bat survey to better understand the extent of any population and frequency in the project area.

There is a moderate likelihood koala could be present within woodland inland of the mainland tunnel launch site, which is mapped as essential habitat for this species. The closest record on the mainland is 15 km to the north of the project area and consultation with local wildlife carers indicates the species is extremely rare on the coast. There was no evidence of the species observed during surveys for either the EIS or SREIS, or the large volume of ecological work completed for LNG and other infrastructure projects. Further survey effort in early 2013 (wet season) targeting this species will aim to better understand the extent of any population and frequency in the project area on the mainland in woodland adjacent to the mainland tunnel launch site. It is questionable that the area of vegetation here is regularly inhabited by koalas and impacts are unlikely to affect the abundance or distribution of the species.

There is an area of essential habitat to the north of Boat Creek for rusty monitor (*Varanus semiremex*) although the species is not likely to occur within the footprint of the mainland tunnel launch site and is no longer listed as threatened under Queensland legislation. There is an area of essential habitat for wallum froglet (*Crinia tinnula*) to the southeast of the mainland tunnel launch site. The footprint of the mainland tunnel launch site and feed gas pipeline is not considered likely to support this species, due to the lack of suitable waterbodies, and the northern extent of the species range lies around Bundaberg.

At TWAF 7, areas of vegetation adjacent to, and within the site are mapped as essential habitat for Lewin's rail (*Rallus pectoralis*). The area is not the preferred freshwater and associated grassland habitat of the species and it is likely that a transient individual was recorded whilst in the area.

TWAF 8 does not contain any essential habitat. Koala essential habitat is located approximately 500 m to the east and coastal sheathtail bat approximately 200 m to the east. There do not appear to be any local records of koala, and this species is unlikely to occur at this site. The closest record on the mainland is 15 km to the north of the project area. Although there are records of coastal sheathtail bat from the area, these records occur well south of their known range and could relate to misidentified records. Coastal sheathtail bat is unlikely to frequent the area.

Essential habitat within and adjacent to the project area of the Arrow LNG Plant is shown on Figure 18.4.

Impacts

The impacts on areas of essential habitat as a result of the project are considered to be of low significance, due to a lack of local records for the species in question and sub-optimal habitat.

Mitigation Measures

No new mitigation measures are proposed for essential habitat, as it is unlikely the species in question are present in or adjacent to the project area. Should either koala or little pied bat be found to be present during further survey effort in early 2013, the requirement for mitigation measures will be investigated in management plans to be developed (Section 18.10).

18.6 Floristic Assessment

Findings of the supplementary floristic study undertaken by 3D Environmental are presented below.

18.6.1 Groundwater Dependent Ecosystems

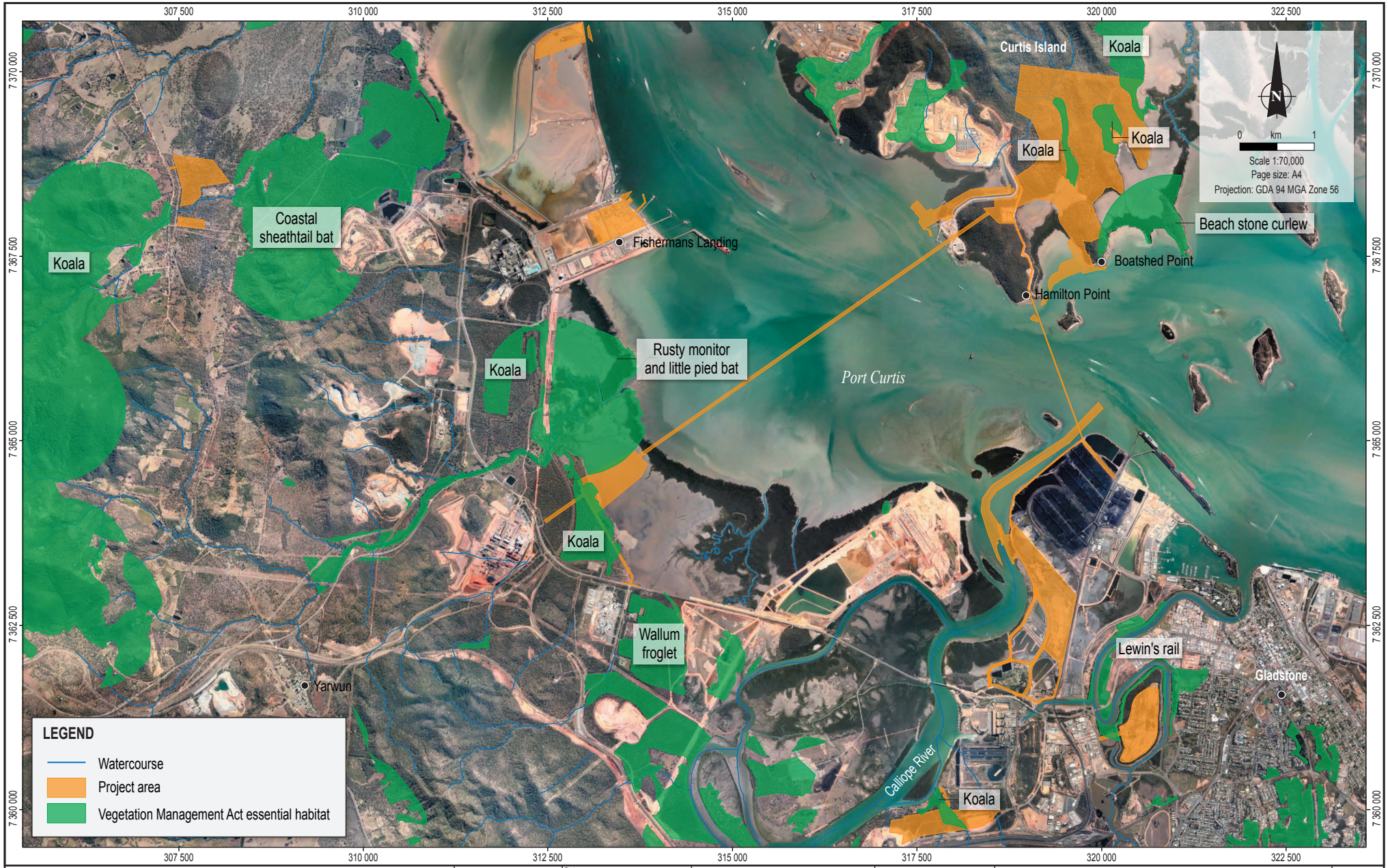
The assessment on groundwater dependent ecosystems was undertaken through further desktop study and field study.

EIS Findings

Studies in the EIS focused on groundwater resources within the project area, and concluded that the following types of groundwater dependent ecosystem might occur in the study area:

- Groundwater discharge wetlands.
- Lakes streams and estuaries.
- Phreatophytes.
- Spring fed ecosystems.

Impacts on groundwater, whether through reduced aquifer recharge, altered aquifer characteristics or altered groundwater flow, were assessed as being of low significance in the EIS (Section 14.4.1).



Source:
Place names from DME. Watercourses from Alluvium.
Essential habitat from DEHP.
Project area and species labels from Coffey Environments.
Imagery from Nearmap (captured 7 August 2012).

coffey environments

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Arrow Energy

Arrow LNG Plant

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Essential habitat within the Arrow LNG Plant project area

Figure No: **18.4**

SREIS Study

Four groundwater dependent ecosystem types as classified by Geoscience Australia potentially occur within the project area. These include:

- Terrestrial vegetation.
- River base flow systems.
- Wetlands.
- Estuarine and near-shore marine ecosystems.

Well-developed flood plain woodlands associated with alluvial plains are present on Curtis Island, at TWAF 8 and at the mainland tunnel launch site. These habitats will likely have root systems that at least seasonally intercept shallow groundwater aquifers and maintain the integrity of these habitats during prolonged drought.

At TWAF 8 the watercourse is an ephemeral system, carrying water only during wetter periods. On Curtis Island predominantly dry drainage systems that only flow during and immediately after periods of heavy rainfall exist. Groundwater would have little impact on base stream flow, although groundwater may sustain riparian vegetation during extended drought periods.

No wetland habitats, other than riparian or estuarine wetlands are present within the project area.

The narrow fringe of melaleuca shrubland on the interface of terrestrial and estuarine habitats at the mainland tunnel launch site is an example of estuarine or near shore habitat that may be regulated by shallow groundwater discharge.

Impacts

On Curtis Island, all vegetation that is potentially sustained by shallow groundwater tables will be cleared and hence any water table drawdown will have no impact on remaining vegetation.

At the mainland tunnel launch site, trenching and excavation associated with tunnel construction may have a localised impact on groundwater levels on the margins of the trench. The ‘dry’ shaft installation techniques will limit the extent of any impact associated with dewatering to the immediate area. Due to the localised nature of impact, it is not expected that this will have any significant impact on deep rooted vegetation and groundwater levels will stabilise once the walls of the excavated void are sealed.

The narrow fringe of melaleuca dominant woodland on the littoral margins of the mainland tunnel launch site may be subject to localised impacts of groundwater drawdown. However, this habitat is already senescent and is a component of an RE that is extensive in the region (RE 12.1.2) and of no particular conservation significance. The significance of impact to groundwater dependent ecosystems is negligible.

At the Red Rover Road site and TWAF 8, vegetation clearing associated with construction activities will not result in drawdown of shallow water tables. No impact is expected to retained vegetation resulting from groundwater drawdown.

No extraction of groundwater is planned by the project.

Mitigation Measures

No additional mitigation measures are proposed for groundwater dependent ecosystems. Details relating to the monitoring of groundwater are presented in Section 14.7.2 of the Arrow LNG Plant EIS. In addition, Arrow committed to reducing vegetation clearance where practical (C17.27 in Table 17.10 of the EIS).

18.6.2 Vegetation Communities (Commonwealth)

The assessment on vegetation communities (Commonwealth) was undertaken through further desktop study and field study.

EIS Findings

The EIS concluded that no EPBC Act listed threatened ecological communities were present within the project area. An area of 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' ('critically endangered'), was located as a small pocket of microphyll/notophyll vine forest on the eastern side of Hamilton Point, outside the project area (Section 17.3.3 of the EIS).

SREIS Study

A search of the EPBC database buffered to 50 km indicated six potential EPBC Act listed ecological communities as being potentially present within the project area. Further desktop review and field survey did not suggest the presence of any of these habitats within the project area, with the exception of 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' ('critically endangered').

The presence of this community was confirmed on the eastern side of Hamilton Point in field surveys. A broad beach ridge was also identified to the northeast of Boatshed Point. There are two small patches of critically endangered littoral vine thicket (RE 12.2.2 'microphyll/notophyll vine forest on beach ridges') at the eastern end of the beach ridge, and being associated with a littoral landform, these are consistent with the EPBC Act listed community. The community is shown in Plate 18.1, and the location of the beach ridge, along with the associated patches of littoral vine thicket is shown on Figure 18.5.

Impacts

Since the finalisation and exhibition of the EIS, the haul road option on Hamilton Point has been discontinued. A horizontal directional drill (HDD) pad and easement for a high voltage line to the Arrow Energy LNG plant from the mainland runs up the eastern margin of Hamilton Point adjacent to existing services lines for Gladstone Area Water Board (GAWB). The GAWB service lines are immediately adjacent to the EPBC Act listed community, and the Arrow Energy high voltage line is located on the western side of the GAWB service lines, approximately 25 m away from the area of coastal vine thicket.

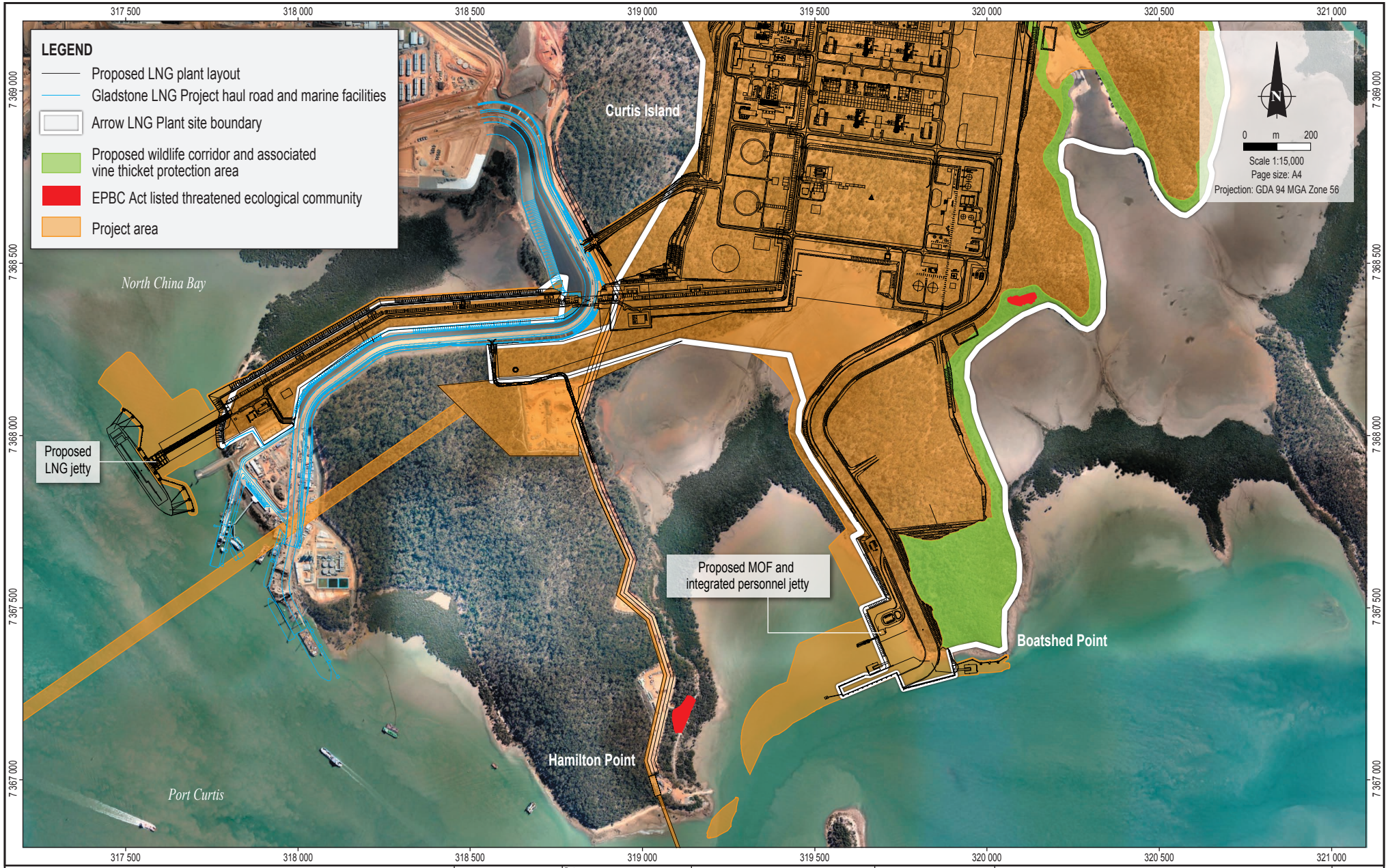
The patches of critically endangered littoral vine thicket (RE 12.2.2) northeast of Boatshed Point, and the community on Hamilton Point will not be cleared. The site layout has been revised to avoid these areas. These patches are within the wildlife corridor which Arrow Energy has committed to establish. The corridor will be established on the eastern side of Boatshed Point to maintain connectivity between the semi-evergreen vine thicket community and the environmental management precinct (C17.04).

Part of RE 12.2.11 on the beach ridge northeast of Hamilton Point is not encompassed within the wildlife corridor. The beach ridge may be affected by construction activities, specifically construction of the haul road. However, the areas of vine thicket on the beach ridge are located within the wildlife corridor and will not be cleared.

Although infrastructure avoids these areas, the community to the northeast of Boatshed Point and the community on Hamilton Point could be vulnerable to increased edge effects such as weed ingress, trampling from increased personnel movement and potentially increased fire frequency.

Plate 18.1

'Littoral rainforest and coastal vine thickets of eastern Australia' ('critically endangered') community northeast of Boatshed Point



Source:
EPBC Act listed threatened ecological communities from Ecosure and 3D Environmental.
Project area and proposed wildlife corridor from Coffey Environments.
Imagery from Nearmap (captured 7 August 2012).

coffey environments

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MXD: 7033CC_16_GIS051_v1_1
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Arrow Energy

Arrow LNG Plant

arrow energy go further

Littoral rainforest and coastal vine thickets of eastern Australia (critically endangered) communities on Curtis Island

Figure No: **18.5**

The impact on Commonwealth EPBC Act listed vegetation communities is therefore assessed as being moderate. The area to the northeast of Boatshed Point is a newly identified community from ground truthing in floristic survey since finalisation of the EIS and the impacts on this area are newly assessed. The proposed activities will not directly impact the habitat although have potential to cause degradation, particularly through facilitated weed invasion. These habitats represent an extremely small proportion of this ecological community's national extent (<0.01 %) and thus any impact is considered to be of low magnitude, although the sensitivity of this community is very high.

Mitigation measures

Commitments in relation to weed control (C17.09, C17.10 and C17.12, and vegetation clearing (C17.27 and C17.28) in the EIS remain unchanged. Commitment C17.23 from the EIS has been amended to take into account the newly surveyed community on the northeast of Boatshed Point and now reads:

- Clearly mark no-go zones, where required, including the semi-evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point, and the "Critically Endangered" EPBC Act listed vine thicket communities on the eastern margin of Hamilton Point, and northeast of Boatshed Point. Signage will be erected around the margins of the communities to indicate restricted access.

Environmental management plans for the project will need to take the EPBC Act listed community northeast of Boatshed Point into account so that procedures for protection (weed control, fire management etc) and monitoring (habitat condition) are established prior to construction. New commitments to address this issue are as follows:

- Protect the EPBC Act listed community northeast of Boatshed Point and employ low impact methods of weed control within and adjacent to EPBC Act listed communities (C17.40).
- Establish a management buffer of suitable width and of contiguous natural vegetation, around the EPBC Act listed community northeast of Boatshed Point to minimise the potential for edge effects and limit the potential for weed invasion. The buffer will be defined in the Wildlife Corridor Management Plan to be developed prior to construction (C17.41).
- Implement fire control measures to prevent wildfire incursion into the EPBC Act listed communities. This may include construction of firebreaks or asset protection burning outside of the community and its associated buffer (C17.42).
- Detail the need to protect EPBC Act listed communities and explain mitigation measures that are to be implemented in workforce inductions (C17.43).

18.6.3 Vegetation Communities (State)

The assessment on vegetation communities (state) was undertaken through further desktop study and field study.

EIS Findings

REs mapped by DERM (now EHP) were validated in the field using transect data and geological mapping. Where required, the boundaries of REs were remapped using hand held GPS and the assistance of aerial photography. The EIS identified nine RE types that will be cleared for project infrastructure either on Curtis Island or at mainland sites. The proportion of clearance against the extent of the RE within the bioregion was less than 0.2% in all cases, except RE 12.11.4

'*Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics' ('of concern' Vegetation Management Act status), which was 0.4% (Table 17.6 of the EIS).

Of the nine mapped REs, one had a vegetation management status of 'endangered', three 'of concern' and five 'least concern'. The endangered RE 12.3.3 '*Eucalyptus tereticornis* woodland to open forest on alluvial plains' ('endangered' Vegetation Management Act status) was present on alluvial plains of Curtis Island, and approximately 26 ha were proposed to be cleared.

SREIS Study

Some inconsistencies with the RE mapping in the EIS were identified during supplementary fieldwork. In some cases these were as a result of the difficulty of separating similar REs on the basis of presence/absence of two ecologically similar species whose regional distribution overlaps considerably, and issues with being on the cusp of different bioregions. In other cases, these were as a result of additional fieldwork sites increasing the coverage density of a particular area and improved understanding of the vegetation composition of these areas.

Inconsistencies were identified as follows:

- Woodlands on the hillslopes of Curtis Island were mapped entirely as RE 12.11.14 ('of concern'). The fieldwork identified that the majority of the rocky hillslopes were dominated almost entirely by ironbark (*Eucalyptus crebra*) and more consistent with RE 12.11.7 '*Eucalyptus crebra* woodland on metamorphics +/- interbedded volcanics' ('least concern' Vegetation Management Act status). RE 12.11.14 is present solely on lower colluvial footslopes.
- Northeast of Boatshed Point a broad beach ridge was identified (see Section 18.6.2), with the feature being a Holocene littoral landform. Vegetation in this area is consistent with RE 12.2.11 'Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest on beach ridges in northern half of bioregion' ('least concern' Vegetation Management Act status), rather than the RE 12.11.4 as mapped in the EIS. The two small patches of vine thicket at the eastern end of this landform are consistent with RE 12.2.2 'microphyll/notophyll vine forest on beach ridges' ('of concern' Vegetation Management Act status).
- Adjacent to the area of RE 12.3.3 on the alluvial plains at the LNG plant site, an area of RE 12.3.7 '*Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest' ('least concern' Vegetation Management Act status) mapped in the EIS, was considered to be more consistent with RE 12.3.3 '*Eucalyptus tereticornis* woodland to open forest on alluvial plains' ('endangered' Vegetation Management Act status) due to the lack of presence of *Casuarina cunninghamiana*.
- Woodland inland of the mainland tunnel launch site mapped as RE 11.3.4 in the EIS '*Eucalyptus tereticornis* and/or Eucalyptus spp. tall woodland on alluvial plains' ('of concern' Vegetation Management Act status) was considered to be more consistent with RE 12.3.3, both west and east of the rail corridor at this site.

Impacts

RE mapping from the EIS has been updated to address the inconsistencies identified. Regulated vegetation proposed to be cleared within the Arrow LNG Plant project area is shown in Table 18.3. Note that this table shows the base case and alternative cases for clearance, as described within Appendix 11, Terrestrial Ecology Supplementary EIS Study. The base case clearance also takes into account areas that have already been cleared for other infrastructure (services lines for GAWB on Hamilton Point, areas around North China Bay).

Table 18.3 Regulated vegetation to be cleared within the Arrow LNG Plant project area

Regional Ecosystem	Area Cleared Within Project Area (ha)						Total Arrow LNG Plant Clearance (base case) (ha)	Total Arrow LNG Plant Clearance (alternative case) (ha)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion (%) (based on base or alternative case, whichever greatest)
	MTLS	TWAF 8	RRR	LS1	CI	TWAF 7			
RE 11.3.4 *Eucalyptus tereticornis* and/or *Eucalyptus* sp. tall woodland on alluvial plains (OC)	-	23.91	-	-	-	-	-	23.91	0.01
RE 12.1.2 Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains (LC)	32.5	-	-	4.5	17.49	0.52	55.01	54.49	0.19
RE 12.1.3 Mangrove shrubland to low closed forest on marine clay plains and estuaries (LC)	-	-	0.61	2.01	2.48	0.21	4.7	5.1	0.01
RE 12.11.14 *Eucalyptus crebra*, *Eucalyptus tereticornis* woodland on metamorphics ± interbedded volcanics (OC)	-	-	-	-	74.74	-	74.74	74.74	0.25
RE 12.11.4 Semi-evergreen vine thicket on metamorphics ± interbedded volcanics (OC)	-	-	-	-	0.66	-	0.66	0.66	0.02
RE 12.11.6 *Corymbia citriodora*, *Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics (LC)	-	-	22.71	-	68.14	-	68.14	90.85	0.04
RE 12.11.7 *Eucalyptus crebra* woodland on metamorphics +/- interbedded volcanics (LC)	-	-	-	-	59.45	-	59.45	59.45	0.19

Table 18.3 Regulated vegetation to be cleared within the Arrow LNG Plant project area (cont'd)

Regional Ecosystem	Area Cleared Within Project Area (ha)						Total Arrow LNG Plant Clearance (base case) (ha)	Total Arrow LNG Plant Clearance (alternative case) (ha)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion (%) (based on base or alternative case, whichever greatest)
	MTLS	TWAF 8	RRR	LS1	CI	TWAF 7			
RE 12.2.11 Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest on beach ridges in northern half of bioregion (LC)	-	-	-	-	0.47	-	0.47	0.47	<0.01
RE 12.3.3 *Eucalyptus tereticornis* woodland to open forest on alluvial plains (E)	7.87	-	-	-	29.86	-	37.73	37.73	0.09
RE 12.3.6 *Melaleuca quinquenervia*, *Eucalyptus tereticornis*, *Lophostemon suaveolens* woodland on coastal alluvial plains (LC)	-	-	-	-	2.62	-	2.62	2.62	0.02
RE 12.3.7 *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest (LC)	-	-	0.59	-	-	-	-	0.59	<0.01

MTLS = mainland tunnel launch site, RRR = Red Rover Road site, LS1 = launch site 1, CI = Curtis Island. Clearance as a proportion of the bioregion following Accad (2008).

Regional Ecosystem (Status under VMA) – E = Endangered, OC = Of Concern, LC = Least Concern.

Base case clearance comprises the Arrow Energy LNG plant site on Curtis Island, the mainland tunnel launch site, launch site 1 and TWAF 7. Alternative case is as per the base case, with TWAF 7 removed, and replaced by TWAF 8 and Red Rover Road.

The inconsistencies between the REs mapped in the EIS and in the SREIS are described above, and are relatively minor in terms of the proportions of REs being impacted. The largest difference from the EIS is the reclassification of RE 11.3.4 at the mainland tunnel launch site to RE12.3.3.

Based on revised vegetation mapping and reconfiguration of the project site layout, it is calculated that 37.73 ha of RE 12.3.3 will be impacted by the project (both cases) compared to 25.69 ha that was assessed in the EIS. A subsequent reduction in the extent of RE 11.3.4 to be impacted from 40.1 ha to 23.91 ha is also calculated (alternative case).

At a bioregion level, clearance is minor, typically less than 0.1% of the extent of the RE within the bioregion. The exceptions to this are RE 12.1.2 (base case) and RE 12.11.7 (both cases) which are less than 0.2% of the extent of the RE within the bioregion, and RE 12.11.14 which totals 0.25% of the extent of this RE within the bioregion (both cases).

Areas of RE 12.1.2 to be cleared at Arrow project sites are predominantly areas of bare claypan which result from micro-topographic variation dependent on salinity and elevation. Actual saltpan vegetation to be cleared at the mainland tunnel launch site comprises elevated alluvial rises which occupy a relatively small proportion of the marine plain. The estimated area of vegetated alluvial rises is 0.3 ha of the total area of disturbance of 35 ha of RE 12.1.2 at this site.

REs in relation to project infrastructure are shown on Figure 18.6 (Curtis Island) and Figure 18.7 (mainland).

Mitigation Measures

No new mitigation measures are proposed and the commitments identified in the EIS remain unchanged.

18.6.4 Endangered, Vulnerable or Near Threatened Species (Flora)

The assessment on EVNT flora species was undertaken through further desktop study and field study.

EIS Findings

The EIS concluded that no species that have a conservation status under the EPBC Act or the Nature Conservation (Wildlife) Regulation were likely to be present within the project area.

Specimens of an unidentified species of Cupaniopsis, thought to be closely related to the threatened flora species *Cupaniopsis shirleyana*, were identified within the study area during early field surveys. The recorded specimens were identified by the Queensland Herbarium as *C. shirleyana*, which at the time was listed as vulnerable under both the EPBC Act and Nature Conservation (Wildlife) Regulation. These specimens were recorded within an area of semi-evergreen vine thicket located on the southern extent of Boatshed Point. Initial assessment by the Queensland Herbarium in August 2010 indicated that the sampled species, was potentially a new taxon, and it was treated as such in the EIS.

Source:
Place names from DME. Watercourses from Alluvium.
Ecological assets (values based on regional ecosystem ground truth data) from Ecosure and 3D Environmental.
Project area from Coffey Environments.
Imagery from Nearmap (captured 7 August 2012).

coffey environments

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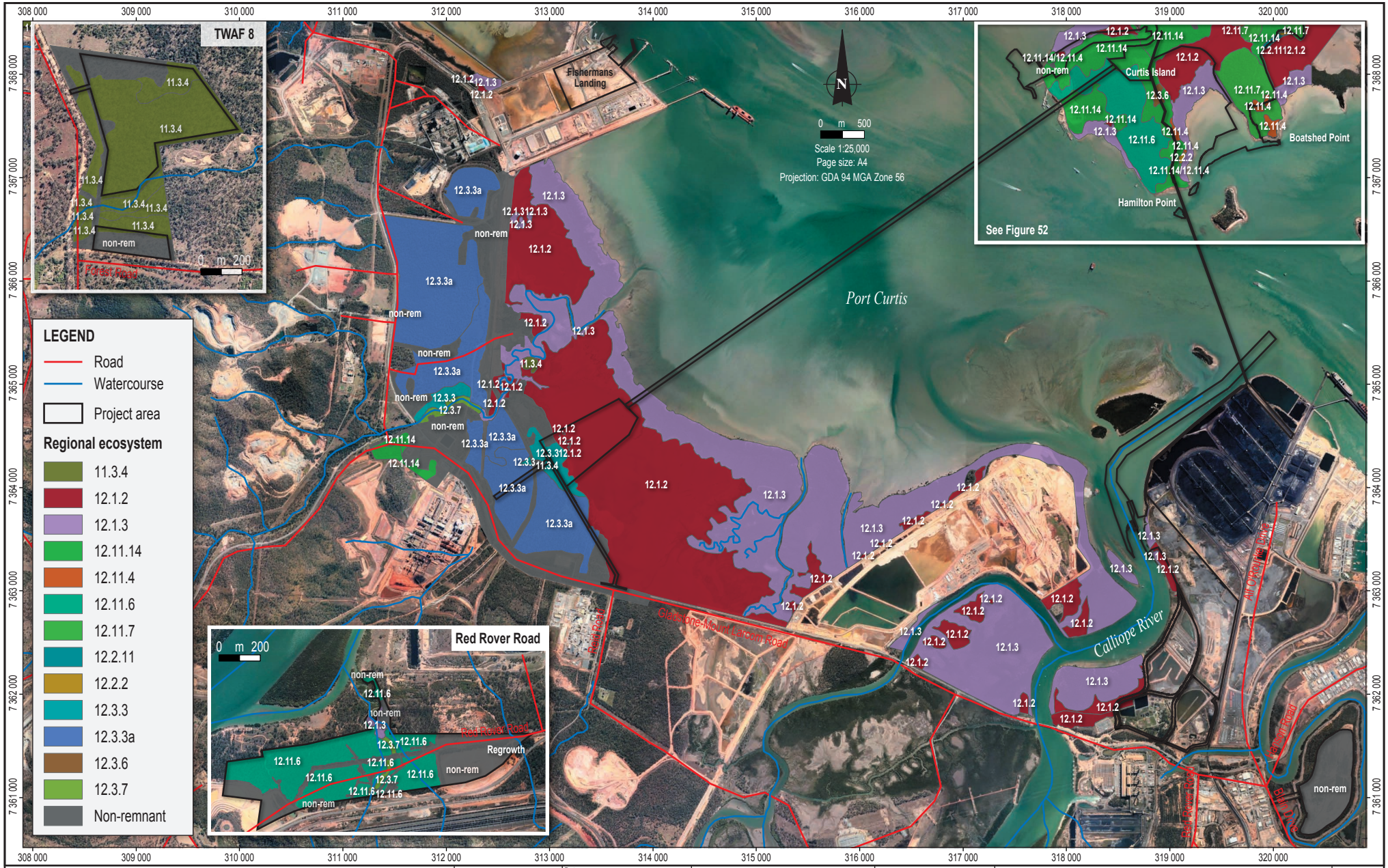
Arrow Energy

Arrow LNG Plant

arrow energy go further

Field validated regional ecosystem communities (Curtis Island)

Figure No: **18.6**



Source:
Place names and roads from DME. Watercourses from Alluvium.
Ecological assets (values based on regional ecosystem ground truth data) from Ecosure and 3D Environmental.
Project area from Coffey Environments.
Imagery from Nearmap (captured 7 August 2012).

coffey environments

Date: 12.12.2012
MXD: 7033CB_16_GIS053_v0_3
File Name: 7033_16_F18.07_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Field validated regional ecosystem communities (mainland)

Figure No: **18.7**

SREIS Study

A review of database searches undertaken for the EIS has concluded that all potentially occurring species that have a conservation status under the EPBC Act or the Nature Conservation (Wildlife) Regulation, were adequately accounted. No species were assessed as being likely to be present in the project area.

An extract of the latest Queensland herbarium floristic records from a 100 km buffer around the study area indicate that *C. shirleyana* is no longer recognised in the project area or surrounds. The specimen submitted from Boatshed Point during the EIS has also formally been recognised as an undescribed species (*Cupaniopsis sp*.). A previous extract from a similar area in late 2011 identified several specimens of *C. shirleyana*, although these have all been reclassified as the same undescribed species in the latest extract. Hence, *C. shirleyana* has no further relevance to the project and the specimens on Boatshed Point are to be treated as an undescribed species of Cupaniopsis.

Site assessments validated the findings of the desktop review, and no EVNT species were found. The value of habitats for EVNT species was generally low, often due to the presence of an extensive range of exotic weed species. Where habitat was suitable (e.g., vine thicket areas) extensive supplementary searches were undertaken, but failed to locate any EVNT species.

Searches of littoral margins for the restricted endemic *Epaltes sp. nov* failed to locate the species. *Epaltes sp. nov*, is a newly discovered species (A. Bean, Queensland Herbarium, pers. com Feb 2012) known from one location in southeast Queensland, approximately 11 km north of the mainland tunnel launch site, and two locations on the central Queensland coast.

The record to the north of the mainland tunnel launch site was collected on the interface between eucalypt woodland and estuarine habitats during floristic surveys undertaken by 3D Environmental associated with another study.

In undertaking pre-clearance work for the geotechnical investigations supporting the design of Arrow Energy's LNG plant, no 'Endangered', 'Vulnerable' or 'Near Threatened' flora species were recorded at either the investigation sites or suggested routes of the access tracks on Curtis Island. Three species of plants recognised as Type A – Restricted Plants (species of commercial interest) under the *Nature Conservation Act* were recorded as present. These species are:

- Grass trees (*Xanthorrhoea johnsonni*).
- Weeping cabbage palm (*Livistona decora*).
- Orchids (Orchidacae spp.).

Impacts

Impacts upon EVNT flora species are unchanged from those assessed in the EIS, as the supplementary study validated the assessment that no EVNT species were likely to be present in the project area.

The update to the status of the previously unidentified species of Cupaniopsis, does not change how impacts to this species by the Arrow LNG Plant are assessed and confirms that the species is likely to be a previously unrecognised taxon. Although the species has no formal status at this stage, it is likely to be of regional significance, despite not yet appearing on any official listing.

Mitigation Measures

No new mitigation measures are proposed and the commitments identified in the EIS remain unchanged.

18.7 Fauna Assessment (Endangered, Vulnerable or Near Threatened Species)

Findings of the supplementary fauna study undertaken by Eco Smart Ecology are presented below. The assessment on EVNT fauna species was undertaken through further desktop study and field study.

EIS Findings

Database searches identified 54 species with a conservation status under the EPBC Act or Nature Conservation (Wildlife) Regulation as potentially occurring in the study area. Further analysis of this list based on habitat preferences and range, refined this list to ten species that had a high likelihood of being present in the study area.

Field surveys recorded 162 terrestrial fauna species within the study area. Three EVNT species (eastern curlew, beach stone curlew and squatter pigeon) were recorded within the study area either on Arrow LNG Plant surveys or other studies undertaken in the area.

Further analysis of EPBC Act listed species was made in Attachment 4 (Matters of National Environmental Significance) of the EIS. The analysis concluded that significant impacts on these species were not likely as a result of the Arrow LNG Plant, with the possible exception of water mouse. The MNES assessment identified that further fieldwork and desktop study was required to validate these conclusions.

SREIS Study

In undertaking pre-clearance work for the geotechnical investigations supporting the design of Arrow Energy's LNG plant, no EVNT fauna species or evidence of species were found at either the investigation sites or suggested routes of the access tracks on Curtis Island. Individuals of five migratory species listed under the EPBC Act were observed during the surveys; these species are:

- Rufous fantail (*Rhipidura rufifrons)*.
- White-bellied sea-eagle (*Haliaeetus leucogaster)*.
- Spectacled monarch (*Monarcha trivirgatus)*.
- Rainbow bee-eater (*Merops ornatus)*.
- Eastern osprey (*Pandion cristatus)*.

The project area is unlikely to support an important population or an ecologically significant proportion of the population of these species.

Field surveys identified 102 vertebrate species, including 29 species recorded for the first time taking the total number of species for the study area to 191. The majority of these species are not listed as EVNT species.

Two EVNT taxa were recorded during the surveys within or adjacent to the project area – glossy black-cockatoo and water mouse. Black-necked stork (*Ephippiorhynchus asiaticus*) was recorded in the local area near Southend on Curtis Island. Glossy black-cockatoo were seen flying over launch site 1 but did not land at the site.

Database searches identified a large number of species that were potentially present within the vicinity of the Arrow LNG Plant based on the expanded 50 km search area. Further refinement of the search results based on known range, likelihood of occurrence and habitat preferences identified that a large number of these species were unlikely to be present with the Arrow LNG Plant project area (Table 11 of Appendix 11, Terrestrial Ecology Supplementary EIS Study).

Of these discounted species, many were identified as potentially occurring within the Arrow LNG Plant study area in the EIS and associated MNES attachment. The Terrestrial Ecology Supplementary EIS Study (Appendix 11) sets out the detailed rationale behind their omission from detailed assessment in this study. Species include yellow chat (Dawson) (*Epthianura crocea macgregori*), yakka skink (*Egernia rugosa*) and collared delma (*Delma torquata*). Predominantly the omission was based around further detail of the species range in the area, and understanding of habitat suitability (or rather lack of) in the Arrow LNG Plant project area.

Species of conservation significance (not including shorebird species discussed in Chapter 19, Shorebirds) identified as possibly occurring within the Arrow LNG Plant project area are presented in Table 18.4 and each species has a detailed dossier presented in Appendix 11, Terrestrial Ecology Supplementary EIS Study.

Table 18.4 EVNT species potentially occurring in the Arrow LNG Plant project area

Species	Status (EPBC Act)	Status (NC Act)	Likelihood of Occurrence and Notes
Brigalow Scaly-foot *Paradelma orientalis*	V	V	Low – potential habitat occurs on Curtis Island (dry sclerophyll forest with native ground cover) although unlikely that resident populations are present based on closest records (away from Boyne Island) and lack of findings in survey work on Curtis Island.
Black-necked Stork *Ephippiorhynchus asiaticus*	-	NT	Known – occurs on a variety of wetland types around the Port Curtis area, although the species does not appear to be frequent around Port Curtis or favour any particular areas.
Grey Goshawk *Accipiter novaehollandiae*	-	NT	Expected – a number of records on Curtis Island in the vicinity of Ship Hill north of the project area. Favours eucalypt forests which are widespread on Curtis Island, and it is likely that a pair or more roves widely over this area including the Arrow Energy LNG plant.
Square-tailed kite *Lophoictinia isura*	-	NT	Expected – recorded a number of times on Curtis Island and the mainland, the species favours a variety of forest types and it is likely that the species presence relates to birds moving through large home ranges or transient individuals as no nests found.
Squatter pigeon *Geophaps scripta scripta*	V	V	Expected (mainland only) – the species is regularly recorded on the mainland including in the vicinity of TWAF 8, favouring open woodlands and low grassy habitats. It is widely distributed with no particular sites or habitat favoured or important populations identified.
Glossy black-cockatoo *Calyptorhynchus lathami*	-	V	Low – likely that a resident, partly nomadic population of glossy black-cockatoos is present in the Gladstone area but the species will be closely linked to Allocasuarina species which have not been identified on the Arrow LNG Plant site on Curtis Island but are widespread to the east of the site.
Powerful owl *Ninox strenua*	-	V	Expected – other surveys identified at least three pairs widely spread on the mainland around Gladstone, and one, possibly two pairs on Curtis Island. It is likely that the species will occur within tall eucalypt forest of the LNG plant site on Curtis Island.

Table 18.4 EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Status (EPBC Act)	Status (NC Act)	Likelihood of Occurrence and Notes
Little pied bat *Chalonolobus pictatus*	-	NT	Moderate – not recorded on Curtis Island and only known from two records on the mainland near Fishermans Landing.
Grey-headed flying-fox *Pteropus poliocephalus*	V	-	Moderate – large temporary camp known from Calliope area, records of grey-headed flying foxes from both Curtis Island and in proximity to mainland sites but likely to relate to transitory individuals.
Koala *Phascolarctos cinerus*	V	V	Moderate (mainland only) – there have been no recorded sightings on Curtis Island for over 30 years and the closest record on the mainland is 15 km to the north of the project area. However, habitat in the vicinity of the mainland tunnel launch site is mapped as essential habitat for the koala.
Northern quoll *Dasyurus hallucatus*	E	-	Unlikely – no records occur within proximity to the project area and the habitat for the species is marginal.
Water mouse *Xeromys myoides*	V	V	Known – this species was not captured in targeted trapping, although active searches located an active nest hollow in mangroves to the east of Boatshed Point, and an abandoned hollow and footprints in mangroves to the west of Boatshed Point. Habitat at mainland sites was assessed as sub-optimal.

Of the species listed above, no habitat critical to the survival of the species, for any of the species, was identified. No important populations were identified in the vicinity of the project area, with the exception of water mouse. Under the significant impact guidelines for this species (DEWHA, 2009d) an important population is one that shows evidence of recent activity, and recent water mouse activity was noted to the east and west of Boatshed Point.

Typical water mouse habitat includes abundant mangroves adjacent to supralittoral vegetation above the high-tide mark. Nesting occurs within the supralittoral zone and individuals forage within the adjacent mangroves. In locations where there is little supralittoral vegetation, or where supralittoral vegetation and mangroves are separated by large distances of open mudflats, the species may nest in tree hollows. The supralittoral zones on Curtis Island were generally not extensive.

Within the project area, all mangroves surveyed were assessed as being suitable for water mouse. On Curtis Island, no individual water mouse were observed although their presence was indicated by evidence of nesting and feeding. An active nesting hollow (Plate 18.2) and evidence of feeding were located on the eastern side of Boatshed Point, and an abandoned nesting hollow and footprints were observed to the west of Boatshed Point. These signs indicate that water mouse are present and living within these areas. Mangroves in the area to the east of Boatshed Point are unaffected by the project, and clearance of mangroves to the west is minimal compared to areas that will be retained further west towards Hamilton Point.

On Curtis Island, mangrove areas to the east of Boatshed Point are extensive and extend predominantly unbroken to Endfield Creek near Southend. Mangroves between Hamilton Point and Boatshed Point are smaller in extent, with no connectivity to other mangrove areas (Plate 18.3).

Plate 18.2

Active water mouse nesting hollow in mangroves east of Boatshed Point

Plate 18.3

Mangroves west of Boatshed Point

Mangroves at North China Bay remain largely intact. The current development on Hamilton Point around North China Bay, associated with the GLNG project, has already affected shoreline habitats, removing natural cover and increasing lighting. These activities are likely to have created a significant barrier to movement in a southerly direction from North China Bay. The proposed activities by Arrow Energy will further modify this area, although it is unlikely movements will be further reduced.

Mainland sites were less suitable due to increased disturbance and smaller habitat extent. Launch site 1 lacked suitable supralittoral habitat due to the presence of an access road immediately adjacent to the mangroves (Plate 18.4).

Assessment of the habitat at the Red Rover Road site indicated it was unlikely water mouse was present in this area with the habitat restricted in extent, and the site heavily disturbed.

In the area around the mainland tunnel launch site, surveys for the proposed new Gladstone coal terminal (GHD, 2012), trapped two individuals in fringing mangroves approximately 1 km to the southeast of the mainland tunnel launch site. Mangrove and intertidal vegetation surrounding the study area were considered to have high habitat potential for water mouse. However, the mainland tunnel launch site does not require the removal of fringing mangroves or areas of intertidal vegetation. Areas of RE 12.1.2 to be cleared at Arrow Energy project sites are predominantly areas of bare claypan which result from micro-topographic variation dependent on salinity and elevation. Actual saltpan vegetation to be cleared at the mainland tunnel launch site comprises elevated alluvial rises which occupy a relatively small proportion of the marine plain. The estimated area of vegetated alluvial rises is 0.3 ha of the total area of disturbance of 35 ha of RE 12.1.2 at this site.

Species records of EVNT species in relation to project infrastructure are shown on Figure 18.8 (Curtis Island) and Figure 18.9 (mainland).

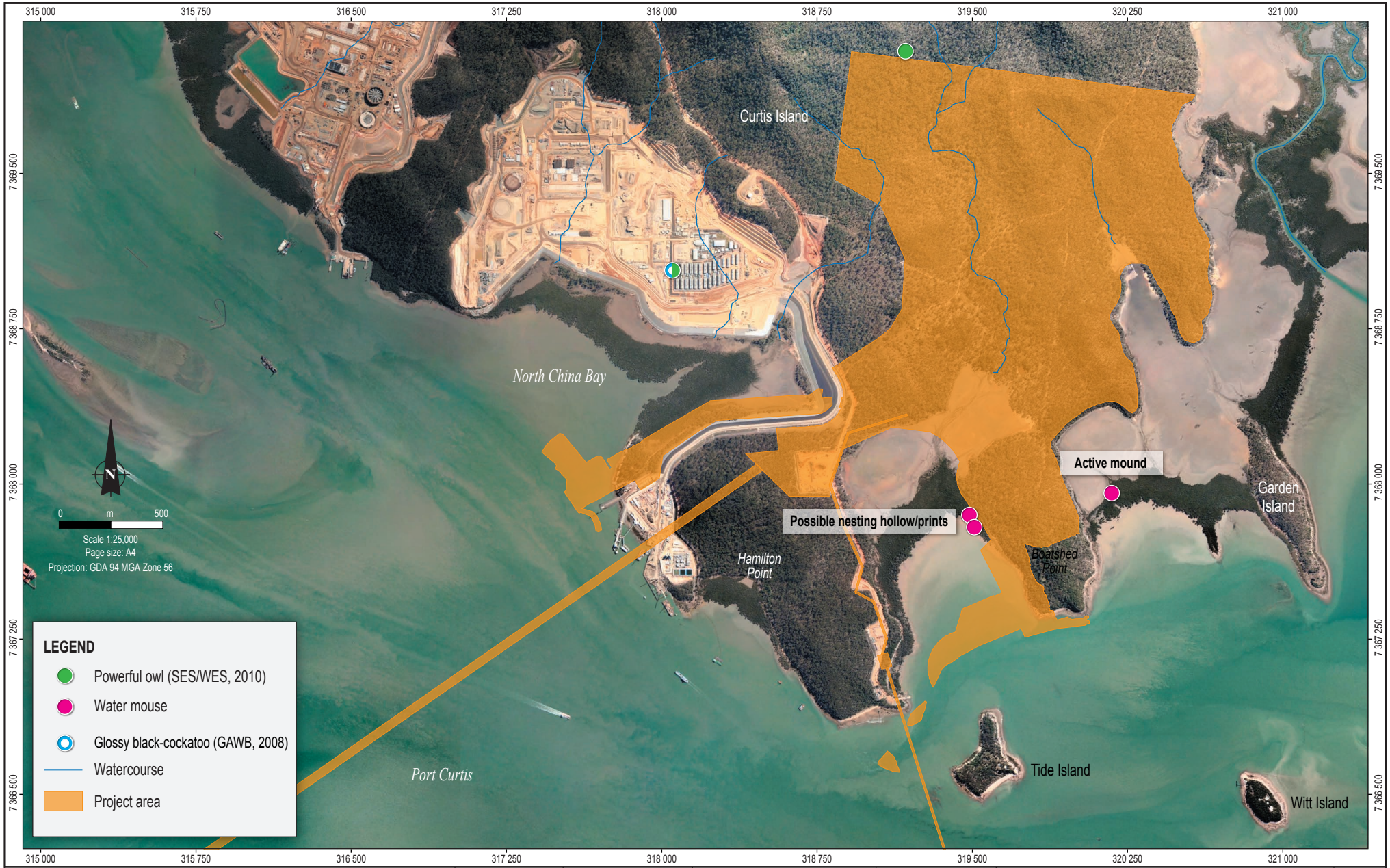
EPBC Act listed species are also discussed in further detail in the update to the MNES attachment (Attachment 2, Matters of National Environmental Significance Update.)

Impacts and mitigation measures

Impacts on EVNT fauna species from the Arrow LNG Plant are summarised in Table 18.5. For each EVNT fauna species, an assessment of the likelihood of habitat offset requirements is given on the basis of the findings of the EIS and SREIS. Wet season surveys undertaken in early 2013 will provide additional data to support these findings.

Plate 18.4

Mangroves at launch site 1 showing high tide against rock revetment of access road



Source:
Watercourses from Alluvium. Project area from Coffey Environments.
EVNT species from 3D Environmental/EcoSmart Ecology; SES/WES relates to surveys undertaken by Sandpiper Ecological Surveys (SES) and Wildsearch Environmental Services (WES) (2010) for powerful owl on the mainland around Gladstone.
Imagery from Nearmap (captured 7 August 2012).

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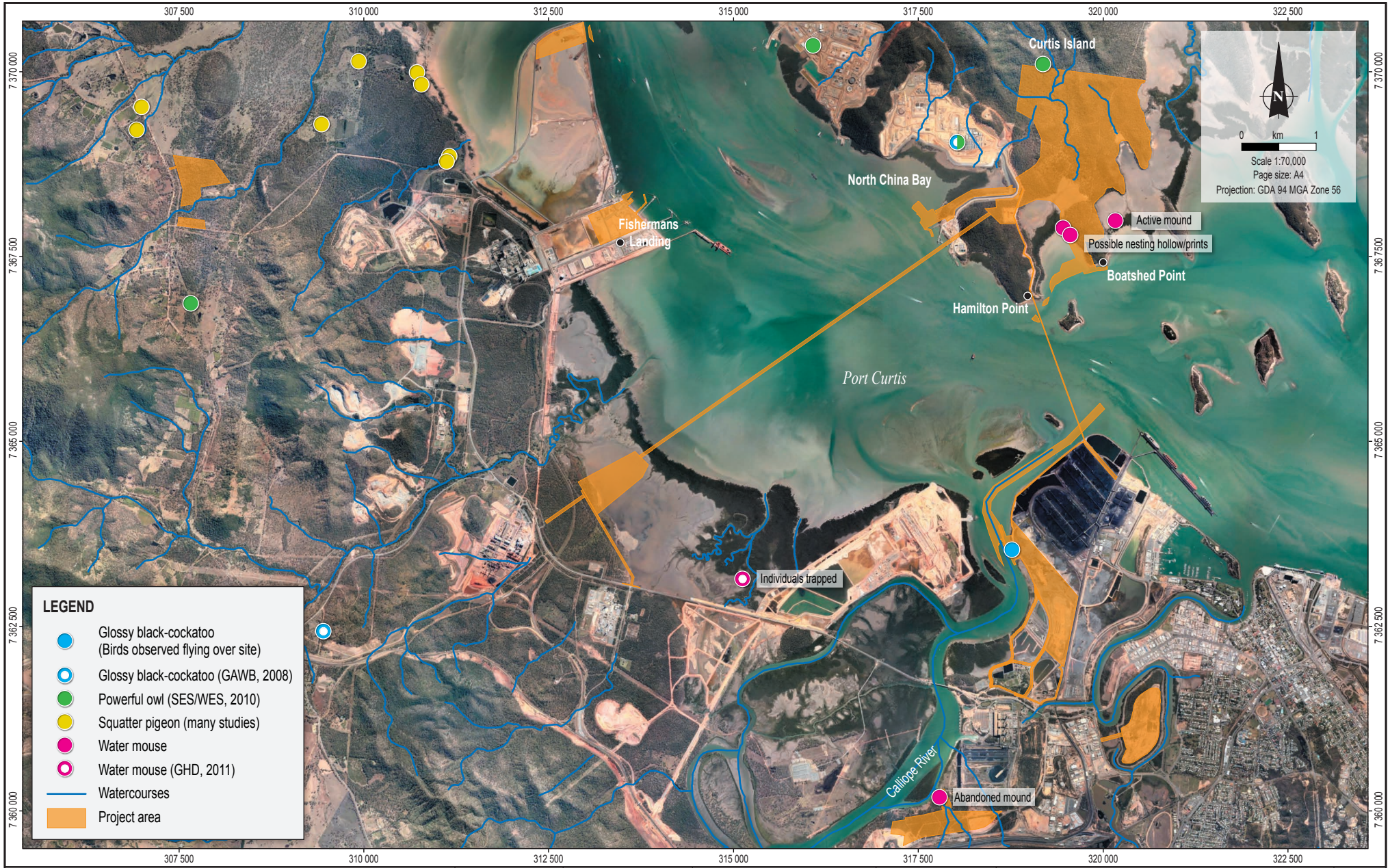
Arrow Energy

Arrow LNG Plant

arrow energy go further

Records of EVNT species in relation to Arrow LNG Plant project area (Curtis Island)

Figure No: 18.8



Source:
Place names from DME. Watercourses from Alluvium.
EVNT species from 3D Environmental/EcoSmart Ecology; SES/WES relates to surveys undertaken by Sandpiper Ecological Surveys (SES) and Wildsearch Environmental Services (WES) (2010) for powerful owl on the mainland around Gladstone.
Project area from Coffey Environments.
Imagery from Nearmap (captured 7 August 2012).

coffey environments

Date: 12.12.2012
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File Name: 7033_07_F18.09_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Records of EVNT species in relation to Arrow LNG Plant project area (mainland)

Figure No: 18.9

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work

Brigalow scaly-foot
Paradelma orientalis
 	
Moderate sensitivity the species can tolerate some level of habitat degradation, but is unlikely to persist in heavily disturbed land or fragmented habitats. Listed under both state and federal legislation as vulnerable.
	Habitat loss through direct clearing (240 ha of possible habitat) is minor in relation to surrounding available suitable habitat on Curtis Island. No probable habitat was identified, and actual loss of habitat is dependent on the existence of resident populations and the growing body of evidence suggests that a resident population is unlikely.
	Edge effects (e.g., weed infestation).
	Trench capture.
		• Clearly delineate clearing boundaries prior to clearing commencing to avoid unnecessary vegetation loss (C17.44).
		• Where practical, stock-pile cleared vegetation in 'wind-rows' around the edge of retained vegetation. In addition to providing shelter, this will also provide some physical barrier reducing edge impact severity and the risk of weed spread (C17.45).
		• Trench activities will include the following protocols:
		  • Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works (C17.06).
		  • Minimise the duration trenches are open, ensure daily trench inspections are undertaken by suitably qualified spotter/catchers and ensure that the length of open trench does not exceed that which can be inspected by the available spotter/catchers in any one daily period (C17.46).
		  • Develop measures to prevent fauna entrapment and implement prior to construction where practical (e.g., the use of pipe caps if piping stored at ground level, string pipes with gaps for wildlife access) (C17.35).
		  • Develop trench management procedures to prevent access of fauna into trenches. These procedures will include measures such as trench breakers and covers. In addition, inspection procedures will be established in order to remove trapped fauna, create protection and refuge areas for wildlife trapped in the trench and develop methods to assist trapped fauna left in the trench (C17.36A).
			Low significance
			Impacts prior to mitigation are considered unlikely (growing evidence suggests that resident populations are unlikely and the species does not occur outside of Boyne Island in the local area). Loss of vegetation is irreversible, but of low magnitude in context of surrounding values.
			Further survey effort is recommended in early 2013 (wet season) to better understand the potential presence of the species within the project area. Surveys are expected to further support the evidence that the species is unlikely to be present on Curtis Island. Extensive fieldwork undertaken for other LNG project s on Curtis Island did not locate this species.
			Based on current evidence the proposed activities will not impact brigalow scaly-foot populations or habitats and therefore the requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Black-necked stork *Ephippiorhynchus asiaticus* (Plate 18.5) **Moderate sensitivity** the species can tolerate some anthropogenic activity, but is sensitive to the loss of wetlands or actions which affect prey abundance. Listed under state legislation as near threatened.	Habitat loss from project activities in the context of surrounding habitats will be negligible. Unlikely disturbance levels will be significantly more than existing levels from movement of vessels and personnel around Port Curtis and its margins.	None considered necessary.	**Low significance** The proposed activities will affect only a very minor portion of possible black-necked stork habitat as affected areas of wetland consist only of rocky shoreline, mudflat or mangrove and no freshwater wetland habitat will be affected, The species is highly mobile and therefore development will not create barriers to movement or dispersal. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.
Grey goshawk *Accipiter novaehollandiae* **Moderate sensitivity** The species can be observed in modified landscapes, including areas affected by logging or partial clearing. Generally absent for areas of broadscale clearing or urban landscapes. Listed under state legislation as near threatened.	Habitat loss through direct clearing will result in approximately 243 ha of possible habitat being lost, although in the context of surrounding available habitats is minor and no critical habitat has been identified for this species within the project area.	None considered necessary.	**Low significance** Clearing, in the context of surrounding available habitats, is minor. Furthermore, there is no evidence of breeding within or in close proximity to the proposed actions. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Square-tailed kite *Lophoictinia isura* **Moderate sensitivity** The species can be observed in modified landscapes, including areas affected by logging or partial clearing. Generally absent for areas of broadscale clearing or urban landscapes. Listed under state legislation as near threatened.	Habitat loss through direct clearing is minor in the context of surrounding available habitats and no critical habitat has been identified for this species within the project area. It is unlikely this species uses the Arrow LNG Plant project area with any regularity.	None considered necessary.	**Low significance** Clearing, in the context of surrounding available habitats, is minor. Furthermore, there is no evidence of breeding within or in close proximity to the proposed actions. The species has a broad home range and wide ranging geographic distribution. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.
Squatter pigeon *Geophaps scripta scripta* **Moderate sensitivity** Often observed in modified landscapes including along tracks, roads and in open paddocks. The species has significantly declined from southern portion of range where widespread clearing has occurred. Listed under both state and federal legislation as vulnerable.	Habitat loss through direct clearing (32 ha of probable habitat at TWAF 8 in the alternative case) is minor in relation to surrounding abundant suitable habitat (in the vicinity of TWAF 8), and it is unlikely impacts on the species will be significant. Edge effects (e.g., weed infestation). Increased abundance of predatory species such as feral cats and foxes at TWAF 8, increasing mortality and reducing reproductive success.	• Where practical, stock-pile cleared vegetation in 'wind-rows' around the edge of retained vegetation. In addition to providing shelter, this will also provide some physical barrier reducing edge impact severity and the risk of weed spread (C17.45). • Develop weed management measures prior to initiation of construction activities in accordance with local and regional management guidelines and best practice advice prescribed in DERM's pest control factsheet series (C17.09). • Liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Notify Gladstone Regional Council of any new declared or notifiable pest species. These programs should particularly focus on the boundaries of the project site with the Environmental Management Precinct (C17.10). • Develop and implement washdown strategies and procedures to prevent the spread of weeds (C17.12).	**Low significance** The squatter pigeon is highly mobile and it is likely that individuals move over a broad area on the mainland, although it is likely to be absent from Curtis Island. Clearing on the mainland will affect only a minor portion of sub-optimal habitat. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Glossy black-cockatoo *Calyptorhynchus lathami* (Plate 18.6) **High sensitivity** Birds can be observed near urban landscapes, and even occasionally in larger parks and gardens. However, they are susceptible to the loss of large hollow-bearing trees and foraging resources. The species has a low fecundity making it slow to recover from population declines. Listed as vulnerable under state legislation.	Based on available evidence, the lack of feeding resources available for the species means it is unlikely to use the study area with any consistency. Although glossy black-cockatoos were seen during surveys they were seen to be flying over the project area and were not observed to use the area. The probability that this species will be impacted is therefore low. Similar forest habitats are abundant within the local area, both on Curtis Island and the mainland. While clearing may reduce the extent of suitable habitat, in the context of surrounding areas this loss will be not be significant.	None considered necessary.	**Moderate significance** Foraging resources (Allocasuarina spp) are limited in any of the habitats to be impacted within the project area and the species is unlikely to be impacted. The high sensitivity of the species means the residual significance of impacts is moderate. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.
Powerful owl *Ninox strenua* **High sensitivity** While mobile, this species requires large tracks of contiguous vegetation with abundant hollows for nesting and to support prey. Listed under state legislation as vulnerable.	Habitat loss through direct clearing is minor in relation to surrounding abundant suitable habitat. The LNG plant site is unlikely to form part of the range of a pair of this species and the ability to alter ranges depends on the presence of competing pairs and abundance of prey in adjoining areas. Project lighting has the potential to further reduce habitat by reducing the suitability of woodland immediately adjacent to the LNG plant site, although this will generally be limited to the area immediately adjacent to the facility. Noise has the potential to affect the suitability of surrounding habitats through reducing prey availability, although this will generally be limited to the area immediately adjacent to the facility.	Consider measures to minimise light emitted from the LNG plant during the detailed design of the LNG plant including: • Assess the necessity and choice of lighting in the plant area: – Use low-pressure sodium (LPS) lights as a first-choice light source and high-pressure sodium (HPS) lights where LPS is not practical. – Replace short-wavelength light with long-wavelength light and exclude short-wavelength light with the use of filters. – Avoid using halogen, metal halide or fluorescent lights (white lights) where possible, and only use white lights in contained areas where colour rendition is required.	**Moderate significance** The extent of impacts on powerful owl is difficult to determine accurately without knowledge of home range and habitat use. The frequency of records in the southwest of Curtis Island, compared to the cumulative loss of habitat for LNG facilities, suggest that at least one pair of powerful owl may be significantly impacted. While previous works are likely to have been adequate, targeted techniques (i.e., call playback) during the early 2013 baseline survey will improve survey rigour. The requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Powerful owl (cont'd) *Ninox strenua*		– Minimise the number and wattage of lights, and recess lighting into structures where possible. • Use timers and motion-activated light switches. • Use reflective materials to delineate equipment or pathways and use embedded lighting for roads. • Position doors and windows on the sides of buildings facing away from marine turtle nesting beaches and install and use window coverings to reduce light emissions. • Maintain elevated horizons (such as topographic features, vegetation or barriers) to screen rookery beaches from light sources (C17.47). • Regularly maintain all machinery and equipment and check for excessive noise generation (C22.04). • Develop requirements for ecological watching briefs/wildlife spotter-catchers as well as procedures for addressing ecological issues as they arise during construction, operation and rehabilitation works (C17.06).	
Little pied bat *Chalinolobus pictatus* **Moderate sensitivity** While most regularly located in large tracts of vegetation, the species also occurs in narrow connected remnants such as along waterways. Listed as near threatened under state legislation.	Loss of potential habitat will be minor, and it is unclear whether resident populations occur as there is a lack of records despite considerable survey effort.	Consider measures to minimise light emitted from the LNG plant during the detailed design of the LNG plant including: • Assess the necessity and choice of lighting in the plant area: – Use low-pressure sodium (LPS) lights as a first-choice light source and high-pressure sodium (HPS) lights where LPS is not practical. – Replace short-wavelength light with long-wavelength light and exclude short-wavelength light with the use of filters.	**Low significance** While clearing of suitable habitat for infrastructure is irreversible, the species is apparently scarce in the local area and a small area of potential habitat will be affected. Further survey effort in early 2013 will include a targeted bat survey to better understand the extent of any population and frequency in the project area. The requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Little pied bat (cont'd) *Chalinolobus pictatus*		– Avoid using halogen, metal halide or fluorescent lights (white lights) where possible, and only use white lights in contained areas where colour rendition is required. – Minimise the number and wattage of lights, and recess lighting into structures where possible. • Use timers and motion-activated light switches. • Use reflective materials to delineate equipment or pathways and use embedded lighting for roads. • Position doors and windows on the sides of buildings facing away from marine turtle nesting beaches and install and use window coverings to reduce light emissions. • Maintain elevated horizons (such as topographic features, vegetation or barriers) to screen rookery beaches from light sources (C17.47).	
Grey-headed flying-fox *Pteropus poliocephalus* **Moderate sensitivity** While highly tolerate to disturbance (often seen in urban settings), this species has declined significantly in the northern portion of its range, suggesting that in this location it should be considered to have a moderate sensitivity to disturbance.	No flying-fox camps are known to occur within the project area footprint. The species is highly mobile, but may be affected by loss of foraging resources from the project area. In total, it is estimated that approximately 127 ha of suitable foraging habitat will be cleared. As clearing is to facilitate the construction of infrastructure, the loss of this vegetation is likely to be prolonged, and irreversible. However, similar habitat occurs throughout much of Curtis Island and in large expanses of forest that occur on the mainland, so substantial foraging habitat remains within the local area.	• Clearly delineate clearing boundaries prior to clearing commencing to avoid unnecessary vegetation loss (C17.44).	**Low significance** Due to the comparative abundance of similar resources within the local area, the loss of foraging trees associated with the development are not expected to significantly affect the local population. No survey work other than general pre-clearance surveys required for this species, and the requirement for habitat offset is unlikely.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Koala *Phascolarctos cinerus* (Plate 18.7) **High sensitivity** While this species can occur in landscapes subject to some modification, anecdotal evidence suggests it has declined in the local area.	The loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure. Death or injury of individuals during clearing. Increased risk of vehicle strike on existing roads due to increased traffic frequency.	• Clearly delineate clearing boundaries prior to clearing commencing to avoid unnecessary vegetation loss (C17.44). • If koalas are found during wet season surveys to be undertaken in early 2013 or pre-clearance surveys, develop and implement appropriate mitigations in the species management plan which could include fauna spotter/catchers, limiting vehicle speed limits and habitat rehabilitation (C17.48).	**Moderate significance** Habitat loss for infrastructure is irreversible and contains some areas of mapped essential habitat for the species. Current evidence suggests the species is rare in the local area, and absent from Curtis Island. The high sensitivity of the species means that the residual significance of impacts is moderate. Further survey effort in early 2013 will aim to better understand the extent of any population and frequency in the project area on the mainland in woodland adjacent to the mainland tunnel launch site. Clearing of mapped essential habitat (approximately 48 ha at TWAF 8 and mainland tunnel launch site) may require offsets. It is unlikely that lost vegetation is regularly inhabited by koalas and impacts are unlikely to affect the abundance or distribution of the species. The requirement for habitat offset will be revisited after the early 2013 surveys but is unlikely.
Water mouse *Xeromys myoides* **High sensitivity** While the species can sometimes tolerate edge impacts, it is restricted to particular habitat types and sensitive to the loss of prey items. It is listed under both state and federal legislation as vulnerable.	Water mouse presence was confirmed in the project area with an abandoned hollow and footprints in mangroves to the west of Boatshed Point. Evidence of recent activity qualifies a water mouse population as being of importance. Although project activities generally avoid mangrove areas, small areas of mangrove will be cleared at launch site 1 (2 ha in both cases), North China Bay (1.7 ha in both cases) and west of Boatshed Point (0.8 ha in both cases). The habitat at launch site 1 is already heavily modified and isolated, habitat in North China Bay is highly disturbed by construction activities for other LNG proponents, and has already been	• Design infrastructure to reduce impacts on shoreline habitat, where possible, and reduce the risk of unnecessary clearing by demarcating disturbance areas (C17.49). • Reduce lighting wherever possible, in locations where movement between water mouse foraging and nesting habitats (e.g., between mangroves and the supralittoral zone) occurs (C17.50). Consider measures to minimise light emitted from the LNG plant during the detailed design of the LNG plant including: • Assess the necessity and choice of lighting in the plant area:	**Moderate significance** The limited clearing within the mangroves and adjoining habitat is unlikely to significantly impact water mouse. Loss of habitat is minimal compared to areas of retained habitat, and no nesting structures were recorded in surveyed areas to be cleared. Modification of shoreline habitat between areas of habitat has the potential to affect movement, and therefore increase isolation of local populations. If permanent, the loss of connectivity for the western Boatshed Point sub-population could reduce the population viability, although large extents of mangroves will be retained in this area.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Water mouse (cont'd) *Xeromys myoides*	partially cleared. The habitat west of Boatshed Point is isolated from other mangrove areas, and the area lost is small in relation to the large areas of retained mangrove at this site. Construction of infrastructure has the potential to create movement barriers. Passage of the population west of Boatshed Point south to and from North China Bay is doubtful due to construction activities of other LNG proponents at this site. Construction of infrastructure on the western side of Boatshed Point for the Arrow LNG Plant (the MOF) is likely to create a movement barrier for water mouse moving either to the east or west and other areas of mangrove habitat. As movement from the west and north is already inhibited by construction for other LNG plants around North China Bay and the west coast of Curtis Island, the barrier of movement to and from the east for the western Boatshed Point sub-population is the most significant project related impact. The Curtis Island water mouse population is likely to be formed by a chain of sub-populations in the bays between headlands on south Curtis Island, with some movement between these sub-populations likely, although the rate of movement is unknown. Fragmentation of the population to the west of Boatshed Point is already taking place to the west, and the effect of further fragmentation to the east is unknown, without knowledge of the genetic diversity of these sub-populations, movement between the sub-populations and the size of the sub-populations.	– Use low-pressure sodium (LPS) lights as a first-choice light source and high-pressure sodium (HPS) lights where LPS is not practical. – Replace short-wavelength light with long-wavelength light and exclude short-wavelength light with the use of filters. – Avoid using halogen, metal halide or fluorescent lights (white lights) where possible, and only use white lights in contained areas where colour rendition is required. – Minimise the number and wattage of lights, and recess lighting into structures where possible. • Use timers and motion-activated light switches. • Use reflective materials to delineate equipment or pathways and use embedded lighting for roads. • Position doors and windows on the sides of buildings facing away from marine turtle nesting beaches and install and use window coverings to reduce light emissions. • Maintain elevated horizons (such as topographic features, vegetation or barriers) to screen rookery beaches from light sources (C17.47). • Liaise with Biosecurity Queensland and Gladstone Regional Council on project biosecurity and pest management programs. Notify Gladstone Regional Council of any new declared or notifiable pest species. These programs should particularly focus on the boundaries of the project site with the Environmental Management Precinct (C17.10). • Test and treat all discharges to Port Curtis to meet water quality criteria, as required, prior to discharge (C16.04).	The Arrow LNG Plant will contribute to the isolation of one small patch of known habitat to the west of Boatshed Point. In the context of overall cumulative impact, the potential loss of this local population is not likely to be significant in the context of the wider population on Curtis Island and around Port Curtis. In the long term, a decommissioning and rehabilitation plan will be developed for the Arrow LNG Plant. This plan will consider options for removal of the MOF at Boatshed Point, which would facilitate passage to and from the bay to the west of Boatshed Point. No further survey work other than general pre-clearance surveys required for this species. Offsets for the species under the EPBC Act are not considered necessary, as no areas of critical habitat will be cleared for the project. Offsets are considered after impacts have been avoided or mitigated to the extent practicable. Arrow Energy are avoiding the removal of mangrove habitat where possible, such as at the mainland tunnel launch site. It is not possible to satisfactorily offset against impacts from fragmentation, although any offset of mangrove and saltpan vegetation habitat that Arrow Energy will undertake under state vegetation offsets legislation is likely to have benefits for security of potential water mouse habitats elsewhere. A water mouse management plan will be developed detailing procedures during construction and operation of the Arrow LNG Plant. Timelines and responsibility for completing the work will be included, and the plan developed and approved by a suitably qualified ecologist with a working knowledge of the species.

Table 18.5 Potential impacts on EVNT species potentially occurring in the Arrow LNG Plant project area (cont'd)

Species	Project Related Impacts	Proposed Mitigation Measures	Residual Impacts and Recommendation for Further Work
Water mouse (cont'd) *Xeromys myoides*	Any movement taking place to the east from this sub-population needs to take place across sub-optimal rocky habitat, but nevertheless the construction of the MOF will likely inhibit movement further than is naturally the case at this site. Light impacts could affect water mouse by increasing predation, altering foraging and disposal patterns, reducing prey abundance and leading to abandonment of nesting hollows. Increased predator abundance (particularly pest fauna) may occur as a result of project activities. Changes in natural hydrology, modified water levels and salinity in tidal waterways may affect water mouse and their prey.	• Develop appropriate spill prevention and response plans to cover project activities and the types and quantities of fuel, oil and chemicals held at each site (C13.12).	

Note: Commitment number C17.47 was developed for the technical study assessing the impact on turtles from light from the Arrow LNG Plant (Appendix 9 Marine Ecology (Turtles) Technical Study – Curtis Island Baseline Light Monitoring 2012). Aspects of the commitment are also of benefit to minimising impacts of lighting on terrestrial ecology.

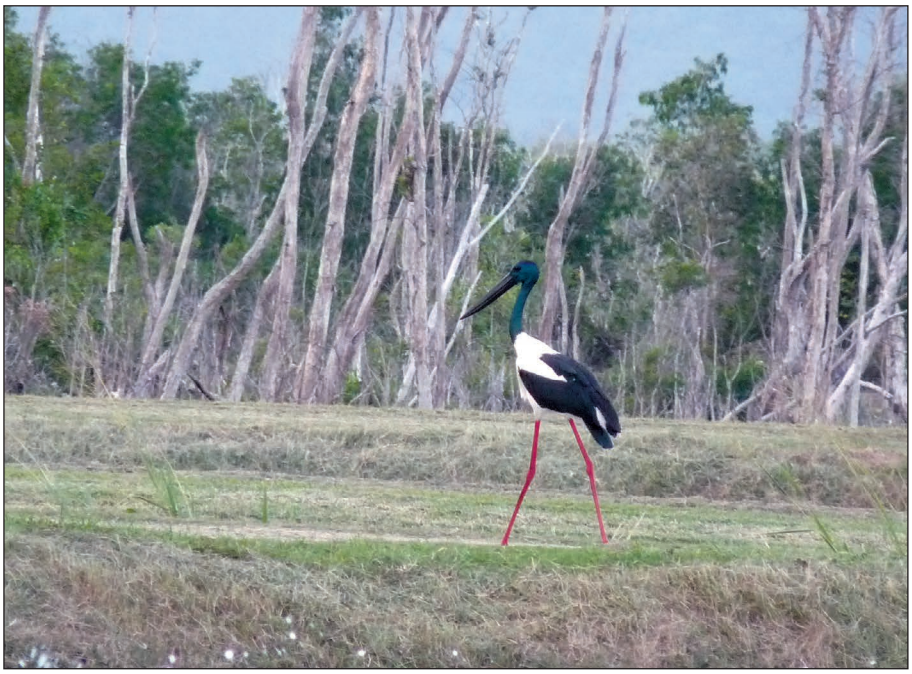

Plate 18.5
Black-necked Stork
(library image)

Plate 18.6
Glossy-black cockatoo
(library image)

Plate 18.7
Koala
(library image)

The main impacts on EVNT fauna species relate to powerful owl and water mouse.

The Arrow Energy LNG plant site is likely to be part of the home range of one pair of powerful owl (Plate 18.8). Large areas of habitat to the north of the LNG plant will be retained in the Environmental Management Precinct, although this area may already be home to competing pairs. Any displacement from the Arrow Energy LNG plant site may adversely affect this powerful owl pair.

Project activities generally avoid mangrove habitats and direct impacts on these habitats (mainland tunnel launch site) which may hold water mouse. Indirect impacts such as changes in natural hydrology and mobilisation of acid sulfate soils may occur. Arrow Energy will comply with applicable water quality guidelines and develop and implement stormwater and acid sulfate soils management plans (sections12.5 and 13.5 of EIS).

Habitat at launch site 1 is considered to be suboptimal for water mouse. The mangroves are bordered by a rock revetment wall and haul road at this site which has removed suitable supralittoral habitat for this species (used as a high tide refuge). There is limited connectivity to other mangrove habitat, and extensive areas of mangrove on the west of the Calliope River are separated from this area by the broad river channel. Two hectares of mangrove will be removed at this site in both cases.

On Curtis Island, clearance in North China Bay of 1.7 ha (both cases) of mangrove will take place in the context of an already extensively disturbed site. Shoreline habitats are already altered with reduced natural cover, increased lighting, and increased personnel and vehicle movements.

To the west of Boatshed Point, a corridor of 0.8 ha of mangrove will be cleared (both cases) to construct a haul road along the western shore of Boatshed Point. The small area of mangrove to be cleared is at the southeastern edge of a more extensive area of mangrove in this embayment. Any water mouse present are expected to be displaced into the retained area of mangrove away from disturbed areas. Signs of water mouse presence were noted in fieldwork and it is likely that a population occurs in this area.

Small areas of mangrove will be cleared at Red Rover Road (0.6 ha in alternative case) and TWAF 7 (0.2 ha in base case) but this clearance is not of mangrove habitat assessed as being suitable for water mouse.

Fragmentation of existing habitats has been identified as a potential impact upon water mouse, and fragmentation of this already isolated potential population to the west of Boatshed Point is likely to be exacerbated by project activities. Construction of the MOF on Boatshed Point may reduce passage to the east and extensive areas of mangrove in this area. Construction of the LNG jetties by Arrow Energy and other LNG proponents on Hamilton Point have already reduced passage west to areas of mangrove in North China Bay and to the north on Curtis Island.

The population west of Boatshed Point is already disconnected from more extensive areas of mangrove by rocky headlands to the west and east. Although some movement across these headlands is possible, installation of infrastructure at Boatshed Point will prohibit any movement for the life of the infrastructure.

Although the further fragmentation may reduce the population viability west of Boatshed Point, the potential isolation of this local population is not likely to be significant in the context of the wider population on Curtis Island and around Port Curtis.

Plate 18.8
Powerful Owl
(library image)

18.8 Cumulative Impacts

Table 18.6 presents areas of clearance of regulated vegetation within the bioregion, as a result of current and approved projects within the Gladstone region. Arrow Energy's contribution to the clearance is the base case or alternative case, whichever is greatest for that particular RE type.

Table 18.6 shows that, of the overall area of regional ecosystems in the Southeastern Queensland bioregion, the proportion to be cleared as a result of identified projects is generally low, being less than 0.5% in most cases.

RE 12.11.14, will be reduced by approximately 0.5% at a bioregion level, and the 'Endangered' RE 12.3.3, will be reduced by approximately 0.5% at a bioregion level. The clearance of mangrove vegetation (RE 12.1.3) is low, less than 0.04% of that available within the bioregion.

Impacts within these ecosystems as a result of cumulative losses are likely to remain as assessed in Section 32.3.7 of the EIS. Overall, the cumulative impact of the Arrow LNG Plant on habitat loss is considered low. In the case of LNG projects, development will take place within the Curtis Island Industry Precinct, which covers less than 3% of Curtis Island and lies adjacent to an Environmental Management Precinct. The Curtis Island National Park lies further to the north. These undeveloped areas provide alternative habitat opportunities. Similarly, on the mainland, most industrial development is proposed along the coastal strip and typically away from heavily forested areas.

Arrow Energy will provide environmental offsets for unavoidable impacts arising from the development of the Arrow LNG Plant. Similar conditions have been placed upon other LNG projects on Curtis Island. Areas requiring offsets will be further defined in consultation with regulatory agencies prior to the commencement of construction.

Table 18.6 Cumulative clearance of regulated vegetation

Regional Ecosystem	Total Arrow LNG Plant Clearance (ha)	Total Area Proposed to be Cleared by all Projects including Arrow LNG Plant (ha)	Area of Regional Ecosystem Within the Bioregion (ha)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion – Arrow only (%)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion – All Projects (%)
RE 11.3.4 *Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains	23.91	464.41	186,656	0.01	0.25
RE 12.1.2 Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains	55.01	116.71	28,532	0.19	0.41
RE 12.1.3 Mangrove shrubland to low closed forest on marine clay plains and estuaries	5.1	19.78	50,481	0.01	0.04
RE 12.2.11 Corymbia spp., Eucalyptus spp., Acacia spp. open forest to low closed forest on beach ridges in northern half of bioregion	0.47	0.47	20,654	<0.01	<0.01
RE 12.11.14 *Eucalyptus crebra*, *Eucaplyptus tereticornis* woodland on metamorphics ± interbedded volcanics	74.74	151.24	30,127	0.25	0.50
RE 12.11.4 Semi-evergreen vine thicket on metamorphics ± interbedded volcanics	0.66	0.66	3,081	0.02	0.02

Table 18.6 Cumulative clearance of regulated vegetation (cont'd)

Regional Ecosystem	Total Arrow LNG Plant Clearance (ha)	Total Area Proposed to be Cleared by all Projects including Arrow LNG Plant (ha)	Area of Regional Ecosystem Within the Bioregion (ha)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion – Arrow only (%)	Area of Regional Ecosystem to be Cleared as a Proportion of that Available Within the Bioregion – All Projects (%)
RE 12.11.6 *Corymbia citriodora*, *Eucalyptus crebra* open forest on metamorphics ± interbedded volcanics	90.85	502.75	241,676	0.04	0.21
RE 12.11.7 *Eucalyptus crebra* woodland on metamorphics +/- interbedded volcanics	59.45	83.35	31,332	0.19	0.27
RE 12.3.3 *Eucalyptus tereticornis* woodland to open forest on alluvial plains	37.73	214.63	42,963	0.09	0.50
RE 12.3.6 *Melaleuca quinquenervia*, *Eucalyptus tereticornis*, *Lophostemon suaveolens* woodland on coastal alluvial plains	2.62	2.62	14,032	0.02	0.02
RE 12.3.7 *Eucalyptus tereticornis*, *Melaleuca viminalis*, *Casuarina cunninghamiana* fringing forest	0.59	3.49	53,259	<0.01	0.01

18.9 Offsets

Arrow Energy has developed a Draft Environmental Offset Strategic Management Plan (Attachment 6 to the SREIS), consistent with its Environmental Offset Strategy. This plan:

- Describes measures taken to avoid and minimise impacts.
- Identifies Arrow Energy's likely offset requirements.
- Presents evidence that there are opportunities to achieve the required offsets.
- Sets out Arrow Energy's preferred approach to the provision of environmental offsets.

The Draft Environmental Offsets Strategic Management Plan presents the results of GIS analysis involving the sequential application of filters to identify suitable patches/tracts of target regional ecosystems, to facilitate identification of potential offset sites.

Arrow Energy's principles for offset management planning have been developed to align with offset principles from the regulatory framework and to guide offset planning:

- Offsets will meet the requirements of current government policy.
- Offsets will only be used once the hierarchy to minimise impact (avoid, minimise, mitigate) has been followed.
- Offsets will contribute to managing and protecting biodiversity.
- Offsets will be implemented strategically and economically.

18.10 Conclusion

The findings of the supplementary terrestrial ecology study support the assessment made in the EIS that no significant flora species listed under state or federal legislation are likely to occur within the project area. The update to the status of the previously unidentified species of Cupaniopsis, does not change how impacts to this species by the Arrow LNG Plant are assessed and confirms that the species is likely to be a previously unrecognised taxon. Although the species has no formal status at this stage, it is likely to be of regional significance, despite not yet appearing on any official listing.

There are two areas of EPBC Act listed vegetation communities 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' ('critically endangered') immediately adjacent to project infrastructure, and measures to limit impacts on these communities will be addressed in environmental management plans to be developed, to ensure procedures for protection (weed control, fire management etc) and monitoring (habitat condition) are established prior to construction.

A number of minor inconsistencies in vegetation mapping at a state level have been identified. The result is relatively minor adjustments in the proportions of REs being mapped, the largest of which was an increase in the area to be cleared of RE 12.3.3. The significance of impacts on the RE has not changed from that assessed in the EIS.

Further information on the impacts on EVNT fauna species has been provided in the supplementary study, particularly for water mouse. Other EVNT species were either considered unlikely to be present within the project area, or not significantly impacted by the Arrow LNG Plant. Further fieldwork, planned for the wet season in early 2013, is expected to validate these findings and inform the development of detailed environmental management plans prior to construction.

Water mouse presence was confirmed around Boatshed Point, with an active nest hollow in mangroves to the east and an abandoned nest hollow in mangroves to the west. The limited clearing within the mangroves and adjoining habitat is unlikely to significantly impact water mouse. The modification of shoreline habitat between areas of habitat will likely affect the movement of water mouse to the east, and increase the isolation of the sub-population to the west of Boatshed Point. The Arrow LNG Plant will only contribute to the isolation of one small patch of known habitat for water mouse to the west of Boatshed Point. In the context of overall cumulative impact, the potential isolation of this local population is not significant.

Further survey effort in early 2013 (wet season) will be undertaken to better understand the extent of any population and frequency in the project area of a number of species, particularly little pied bat, koala and brigalow scaly foot.

18.11 Commitments Update

As identified in Table 18.7, Commitments C17.05 and C17.26 (included in the EIS) are now redundant and have been removed as the Hamilton Point MOF and haul road option is no longer being assessed in the SREIS. Ten new commitments have been added in response to the additional survey and assessment of impacts on the EPBC Act listed communities present adjacent to the project area, and on EVNT fauna species.

Commitment C17.02A relates to offsets and has also been revised to include marine offsets. Commitment C17.47 was developed for the technical study assessing the impact on turtles from light from the Arrow LNG Plant (Appendix 9, Marine Ecology (Turtles) Technical Study – Curtis Island Baseline Light Monitoring 2012). Aspects of the commitment are also of benefit to minimising impacts of lighting on terrestrial ecology values.

The new and revised commitments relevant to terrestrial ecology are set out in Table 18.7. Other measures are unchanged and are included in Attachment 7, Commitments Update.

Table 18.7 Commitments update: terrestrial ecology

No.	Commitment	Comment
C17.02A	~~Determine areas (if any) requiring to be offset in consultation with DERM and DSEWPC and other government stakeholders prior to commencement of construction. This is likely to include the two areas of endangered(Vegetation Management Act) remnant vegetation (RE 12.3.3; Assets 27 and 31) within the LNG plant site, and the *Cupaniopsis* sp.indet population.~~ Develop an Environmental Offsets Operational Management Plan that addresses terrestrial and marine offset requirements in consultation with relevant government stakeholders prior to commencement of construction. The plan will provide details on offset options and opportunities, and details on how the offset meets relevant policies and how it will be managed over the life of the offset.	Changed to include marine offsets and government stakeholders and to align with confirmed approach.
C17.03A	An area of semi-evergreen vine thicket community (containing the *Cupaniopsis* vegetation community) will be retained by the project on Boatshed Point. This area will be demarcated prior to the commencement of construction and workers and machinery will be prohibited from accessing the area. The boundary of the semi-evergreen vine thicket community to be retained will be fenced off with a 20-m buffer between the semi-evergreen vine thicket community (including the *Cupaniopsis* vegetation community) and the fence and area of disturbance. The retained vine thicket area is designed to protect a viable semi-evergreen vine thicket vegetation community and a viable population of *Cupaniopsis* sp. indet. on Boatshed Point. Do not develop within the fenced area of the retained semi-evergreen vine thicket community. Establish roles and responsibilities for the management of the retained semi-evergreen vine thicket community.	Amended for clarity.

Table 18.7 Commitments update: terrestrial ecology (cont'd)

No.	Commitment	Comment
~~C17.05~~	~~Route the haul road for the Hamilton Point MOF option away from the eastern margin of the headland to avoid the Critically Endangered' RE 12.2.2 (Microphyll/notophyll vine forest) on beach ridges.~~	Removed as Hamilton Point MOF option discontinued.
	Implement measures to reduce the impacts of light from the LNG plant and ancillary facilities including:	No change
C17.16A	• Shield/direct the light source onto work areas where practical, and avoid light spill on to habitat areas (such as mangroves and Clinton ash ponds) where practical.	Changed to expand on intent of commitment.
C17.23	Clearly mark no go zones, where required, including the semi-evergreen vine thicket (*Cupaniopsis*) fenced area on Boatshed Point and the critically endangered ~~RE 12.2.2 on~~ EPBC Act listed vine thicket communities on the eastern margin of Hamilton Point ~~(if the Hamilton Point South MOF is selected),~~ and northeast of Boatshed Point. Signage will be erected around the margins of the communities to indicate restricted access.	Updated to provide specific guidance.
~~C17.26~~	~~Inspect the likely white-bellied sea-eagle nest on Hamilton Point for activity during breeding season prior to clearance, if this option is pursued. If active, formulate appropriate management measures, should the Hamilton Point MOF option be pursued.~~	Removed as Hamilton Point MOF option discontinued.
C17.36A	Develop trench management procedures to prevent access of fauna into trenches. These procedures will include measures such as trench breakers and covers. In addition, inspection procedures will be established in order to remove trapped fauna, ~~establish~~ create protection and refuge areas for wildlife trapped in the trench and develop methods to assist trapped fauna left in the trench.	Updated to include refined management procedures.
C17.40	Protect the EPBC Act listed community northeast of Boatshed Point and employ low impact methods of weed control within and adjacent to EPBC Act listed communities.	New commitment
C17.41	Establish a management buffer of suitable width and of contiguous natural vegetation, around the EPBC Act listed community northeast of Boatshed Point to minimise the potential for edge effects and limit the potential for weed invasion. The buffer will be defined in the Wildlife Corridor Management Plan to be developed prior to construction.	New commitment
C17.42	Implement fire control measures to prevent wildfire incursion into the EPBC Act listed communities. This may include construction of firebreaks or asset protection burning outside of the community and its associated buffer.	New commitment
C17.43	Detail the need to protect EPBC Act listed communities and explain mitigation measures that are to be implemented in workforce inductions.	New commitment
C17.44	Clearly delineate clearing boundaries prior to clearing commencing to avoid unnecessary vegetation loss.	New commitment
C17.45	Where practical, stock-pile cleared vegetation in 'wind-rows' around the edge of retained vegetation. In addition to providing shelter, this will also provide some physical barrier reducing edge impact severity and the risk of weed spread.	New commitment
C17.46	Minimise the duration trenches are open, ensure daily trench inspections are undertaken by suitably qualified spotter/catchers and ensure that the length of open trench does not exceed that which can be inspected by the available spotter/catchers in any one daily period.	New commitment

Table 18.7 Commitments update: terrestrial ecology (cont'd)

No.	Commitment	Comment
C17.47	Consider measures to minimise light emitted from the LNG plant during the detailed design of the LNG plant including: • Assess the necessity and choice of lighting in the plant area: – Use low-pressure sodium (LPS) lights as a first-choice light source and high-pressure sodium (HPS) lights where LPS is not practical. – Replace short-wavelength light with long-wavelength light and exclude short-wavelength light with the use of filters. – Avoid using halogen, metal halide or fluorescent lights (white lights) where possible, and only use white lights in contained areas where colour rendition is required. – Minimise the number and wattage of lights, and recess lighting into structures where possible. • Use timers and motion-activated light switches. • Use reflective materials to delineate equipment or pathways and use embedded lighting for roads. • Position doors and windows on the sides of buildings facing away from marine turtle nesting beaches and install and use window coverings to reduce light emissions. • Maintain elevated horizons (such as topographic features, vegetation or barriers) to screen rookery beaches from light sources.	New commitment
C17.48	If koalas are found during wet season surveys to be undertaken in early 2013 or pre-clearance surveys, develop and implement appropriate mitigations in the species management plan which could include fauna spotter/catchers, limiting vehicle speed limits and habitat rehabilitation.	New commitment
C17.49	Design infrastructure to reduce impacts on shoreline habitat, where possible, and reduce the risk of unnecessary clearing by demarcating disturbance areas prior to the disturbance commencing.	New commitment
C17.50	Reduce lighting wherever possible, in locations where movement between water mouse foraging and nesting habitats (e.g., between mangroves and the supralittoral zone) occurs.	New commitment

Arrow Energy will develop a number of management plans pertaining to ecological issues prior to construction, namely:

- Species management plan.
- Wildlife corridor management plan.

An outline of these plans is provided in Attachment 5, Other Management Plans. Pre-clearance survey procedures will also be developed.