# ATTACHMENT 1

## SURAT GAS PROJECT

### Matters of National Environmental Significance

arrow energy
go further

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|---|---|---|---|
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# 1. INTRODUCTION

Arrow Energy Pty Ltd (Arrow) is seeking approval to construct, operate and decommission the Surat Gas Project, located approximately 160 km west of Brisbane in Queensland's Surat Basin. The Surat Gas Project forms an expansion to Arrow's existing operations in the Surat Basin, to cater to the growing demand for gas in the Australian market and the global liquefied natural gas (LNG) export market.

Approval is required under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). The EPBC Act provides for the protection of the environment, especially matters of national environmental significance (MNES). Under the act, actions likely to have a significant impact on MNES require assessment and approval under the EPBC Act.

MNES include:

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

## 1.1 Project Background

On 2 February 2010, Arrow referred the Surat Gas Project to the Australian Government Department of Sustainability, Environment, Water, Population and Communities (SEWPaC; previously known as the Department of Environment, Water, Heritage and the Arts (DEWHA)) in Referral No. 2010/5344. On 26 March 2010, the Australian Government declared the project a controlled action due to its potential to significantly affect listed threatened species and ecological communities (s. 18 and s. 18A) and listed migratory species (s. 20 and s. 20A).

The Australian Government determined that the appropriate level of assessment was an environmental impact statement (EIS) and accredited the EIS process under the *Environmental Protection Act 1994* (Qld) (EP Act) in accordance with the bilateral agreement between the Australian and Queensland governments.

An EIS for the project was subsequently prepared (Coffey Environments, 2012) and was published for public comment in March 2012. The EIS included an attachment specifically addressing MNES that addressed the controlled action (Attachment 3 of the EIS, Matters of National Environmental Significance). The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009a) provided the framework for the assessment of potential impacts upon MNES from the Surat Gas Project.

The attachment was prepared, as required by the final terms of reference, to describe the environmental values and assess the potential impacts of the project on MNES.

The MNES attachment and the EIS provide the information required by the Australian Government to assess potential impacts on MNES and to decide whether or not to approve the project. The government may:

- Approve the controlled action.

- Approve the controlled action with conditions.
- Not approve the controlled action.

## 1.2 Purpose of Supplementary Report to the EIS MNES Attachment

This report – an attachment to the SREIS – supersedes the MNES attachment to the EIS (Attachment 3 of the EIS, Matters of National Environmental Significance) and addresses the controlled action Referral No. 2010/5344.

The purpose of this supplementary MNES attachment is to:

- Assess the change in potential impact (between the EIS and the SREIS) to MNES as a result of the changes in project design and further information being obtained.
- Address terms of reference requirements for which information was unavailable at the time of publishing the EIS.
- Provide technical responses to address the issues raised by SEWPaC in their submission on the EIS.
- Provide technical responses to address other issues raised in submissions on the EIS relating to MNES.
- Review and confirm Arrow's project commitments.

This MNES attachment refers substantially to the additional information and revised assessments compiled from further technical studies completed for the SREIS and presented in various chapters in Part A of the SREIS.

Matters relating to aquatic ecology are addressed in the SREIS in Chapter 10, Aquatic Ecology, which is based upon the technical study carried out by AMEC (Appendix 8, Supplementary Aquatic Ecology Assessment).

Matters relating to terrestrial ecology are addressed in the SREIS in Chapter 11, Terrestrial Ecology, which is based upon the technical study conducted by 3D Environmental and EcoSmart Ecology (Appendix 9, Supplementary Terrestrial Ecology Assessment).

The project commitments included as Attachment 8 of the EIS, Commitments Summary have been reviewed to address changes to the project description and submissions to the EIS, and where necessary have been revised. New commitments developed during the studies completed for the SREIS to address the management of MNES are provided in Attachment 4, Commitments Update, and in the relevant sections of this attachment as they pertain to specific MNES. Commitments provided in Attachment 3 of the EIS, Matters of National Environmental Significance, Section 7 are still applicable unless stated otherwise.

# 2. PROJECT OVERVIEW

Arrow proposes expansion of its coal seam gas operations in the Surat Basin through the Surat Gas Project. The need for the project arises from the growing demand for gas, global demand for energy and the associated expansion of liquefied natural gas export markets.

## 2.1 Project Description

The project development area is located approximately 160 km west of Brisbane in Queensland's Surat Basin (see Figure 2.1). Through ongoing exploration activities, Arrow has enhanced its understanding of the gas resource and subsequently, relinquished numerous parcels of land, where development activities will cease. The overall size of the project development area since the EIS was published has reduced from 8,600 $km^2$ to 6,100 $km^2$ due to the relinquishment of parcels of land within Arrow's exploration tenements. The majority of these relinquishments were made in the Goondiwindi development region.

The project development area extends from the township of Wandoan in the north towards Goondiwindi in the south, in an arc through Dalby. Townships within or in close proximity to the project development area include Wandoan, Chinchilla, Kogan, Dalby, Cecil Plains, Millmerran, Miles and Goondiwindi. Project infrastructure, including coal seam gas production wells and production facilities (including both water treatment and power generation facilities where applicable), will be located throughout the project development area but not in towns. Facilities supporting the petroleum development activities, such as depots, stores and offices, may be located in or adjacent to towns.

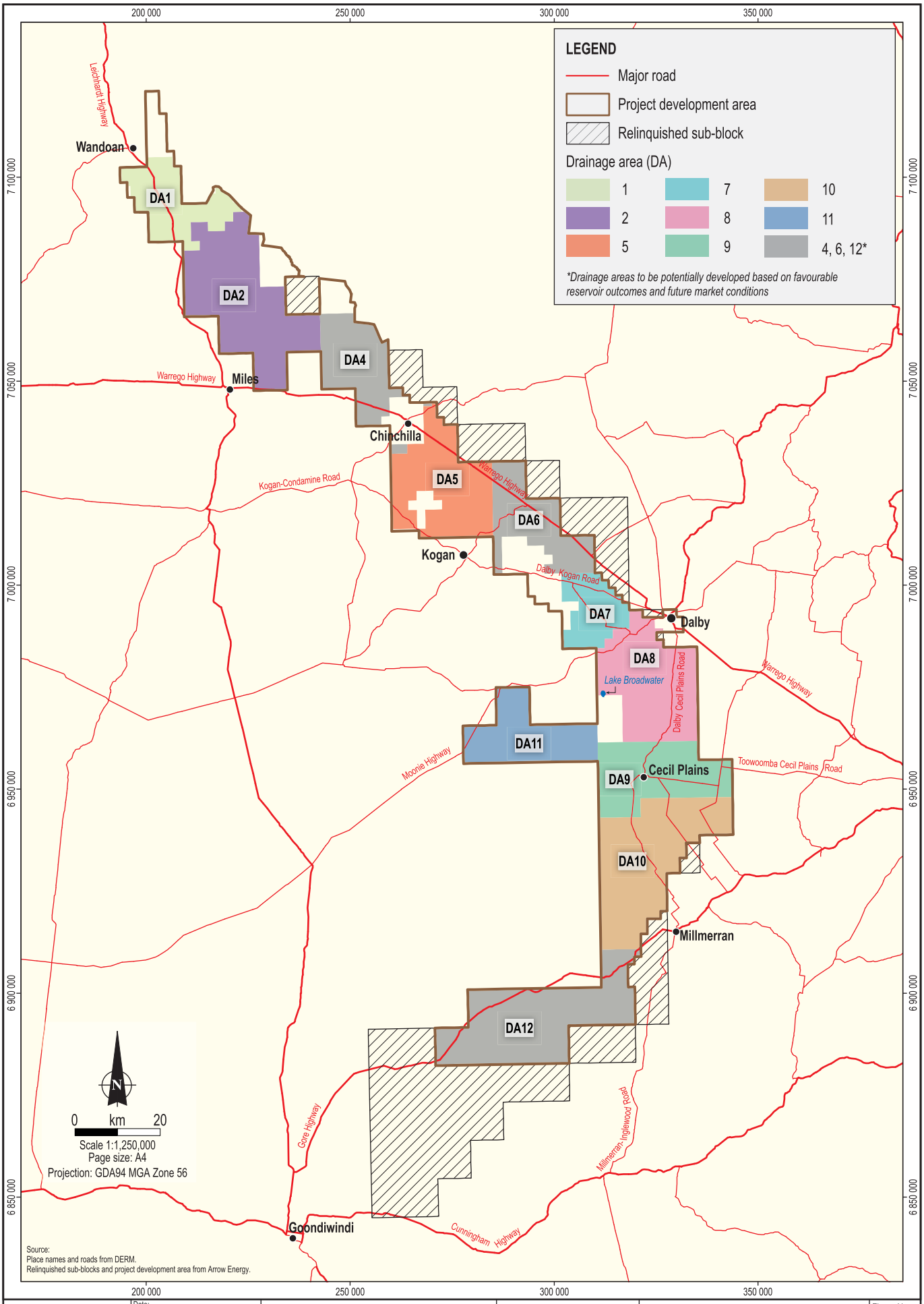
The EIS described that around 7,500 wells would be drilled across the project development area. With a smaller project development area, fewer wells will be drilled. It is currently anticipated that over the life of the project (35 years expected), about 6,500 production wells will be drilled.

Wells will be drilled from both single-well pads (as described in the EIS) and multi-well pads. The single-well pads will typically be vertical production wells, while the multi-well pads will be comprised of up to 12 wells per pad (most commonly comprising nine wells per pad), approximately 8 m apart. A likely configuration of the multi-well pads will be one central vertical production well, with the remainder of the wells being deviated production wells.

The multi-well pads consolidate a group of wells at one surface location, reducing the total number of well pad sites, reducing the individual pad area required per well, and increasing the distance between any two well pad sites. Overall, the total disturbance area resulting from well pads will be reduced.

A single well site may be up to approximately 100 m x 100 m (i.e., 1 ha) including an area for sediment and erosion control devices, while a multi-well pad containing up to 12 wells may be 200 m x 100 m (i.e., 2 ha) inclusive of allowance for sediment and erosion control. Well sites will be assessed on an individual basis to reduce footprint as far as practicable.

Field development planning has advanced since preparation of the EIS. The overall project development area has been separated into eleven drainage areas (Figure 2.1), identified simply by sequential numbering. The drainage area numbers correspond to the gas reserves that will feed each central gas processing facility (CGPF). The supplementary report to the EIS discusses the sequence of the project's development in terms of these drainage areas (as opposed to the five development regions that were described in the EIS).

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| coffey environments | Date: 21.06.2013<br>MXD: 7040AE_12_GIS054_v1_1<br>File Name: 7040_12_ATT1_F02.01_GIS_VS | Arrow Energy<br>Surat Gas Project | arrow energy go further | Surat Gas Project Development Area | Figure No: 2.1 |

Eight of these drainage areas are initially expected to be developed for the Surat Gas Project (drainage areas 1, 2, 5, 7, 8, 9, 10 and 11). Each drainage basin will incorporate wells, a water gathering network, a gas gathering network and a CGPF. The number of CGPFs has reduced from the 12 described in the EIS to eight. A further three drainage areas may be developed with favourable reservoir outcomes and future market conditions.

Arrow has identified four sites to locate central gas processing facilities, two of which will have water treatment facilities located adjacent to them. The approximate footprint for a CGPF is 350 m x 250 m. The number of water treatment facilities has been reduced from six described in the EIS to two, co-located with the CGPFs in drainage area 2 and drainage area 9. The total footprint at each water treatment facility could be up to 2 $km^2$ (200 ha), as originally stated in the EIS.

Sites with a water treatment facility located adjacent to a CGPF were referred to as integrated processing facilities in the EIS. These sites are now referred to as a CGPF and water treatment facility.

A further site, temporary workers accommodation facility (TWAF) F, has been identified by Arrow to accommodate workers.

The exact locations of infrastructure within the four identified CGPF sites and one TWAF site have not been determined. However, properties within these areas have been identified for development. Final siting of infrastructure and the specific orientation and layout of each facility will depend on site-specific land and environmental features, such as remnant vegetation, topography, soil and the proximity of sensitive receptors. Facilities will be designed and constructed to minimise footprint and environmental impact.

Field compression facilities described in the EIS have been retained in the revised project description, as a contingency option. Should field compression facilities be required, the location would be considered in accordance with Arrow's commitment to avoid major infrastructure on intensively farmed land. Field compression facilities would likely be located between production wells and the CGPFs. The maximum number of field compression facilities (six) and approximate footprint (100 m by 50 m) has not changed from the EIS.

The updated Coal Seam Gas Water and Salt Management Strategy (Attachment 5) states that coal seam gas water will be discharged from each water treatment facility to a nearby watercourse as required and within prescribed limits. Discharge to watercourses is a management option that addresses the variability of other coal seam gas water management options (i.e., distribution to existing and new water users for beneficial use and injection to a suitable aquifer). Surface water aspects such as watercourse type, morphology, and aquatic ecosystems at the two identified water treatment facility sites will dictate the management options that can be utilised.

Additional infrastructure will also include:

- Low-pressure gas gathering lines to transport gas from the production wells to production facilities.
- Medium-pressure gas pipelines to transport gas between field compression facilities and central gas processing or integrated processing facilities.
- High-pressure gas pipelines to transport gas from central gas processing and integrated processing facilities to the sales gas pipeline.
- Water gathering lines (located in a common trench with the gas gathering lines) to transport coal seam gas water from production wells to treatment and storage facilities.

- Gas-powered electricity generation equipment co-located with production facilities, or electricity transmission infrastructure that will draw electricity from the Queensland electricity grid via third-party substations.

Arrow has established a site selection framework to guide the identification of sites for production wells, pipelines and production facilities. The framework will also be used to select sites for associated infrastructure, such as access roads and construction camps. Environmental and social constraints to development identified through the EIS process, coupled with the application of appropriate environmental management controls, will ensure that protection of environmental values (resources) is considered in project planning. This approach will maximise the opportunity to select appropriate site locations that minimise potential environmental and social impacts.

Arrow intends to pursue opportunities in the selection of equipment (including reverse osmosis units, gas-powered engines, electrical generators and compressors) and the design of facilities that facilitate the cost-effective and efficient scaling of facilities to meet field conditions. This flexibility will enable Arrow to better match infrastructure to coal seam gas production. It will also enable Arrow to investigate the merits of using template design principles for facility development, which may in turn generate further efficiencies as the gas reserves are better understood, design is finalised, or field development progresses.

## 2.2 SEWPaC Submission on the Surat Gas Project EIS

In June 2012, SEWPaC, which administers the EPBC Act, made a submission on the MNES attachment to the EIS to Arrow. Issues raised in the submission related to:

- Accessibility of information within the EIS.
- Assessment of significance of residual impacts.
- Cumulative and indirect impacts.
- Impacts on listed species.
- Mitigation measures and management plans.
- Offset requirements.
- Species survey methods.

The comments provided by SEWPaC are provided in Appendix A of this attachment, along with cross references to the corresponding section of the EIS, the SREIS, and/or this attachment where each comment is addressed. Details of the responses to the department's submission on the EIS are provided in Part B, Chapter 21 of the SREIS.

## 2.3 Issues Relating to MNES Raised in Public Submissions

A small number of submissions relating to MNES were received during the public comment period on the EIS. These submissions related to:

- Management of the Great Barrier Reef.
- Wetlands of National Significance.

The issues raised in submissions from members of the public relating to MNES are provided in Appendix B of this attachment, with cross references to the corresponding section of the EIS, the SREIS, and/or this attachment where each issue is addressed. Details of the responses to public submissions on the EIS are provided in Part B, Chapter 19 of the SREIS. Part B also presents information about the public exhibition period and the process for lodgement of submissions on the EIS, and statistics on the number and variety of submissions received during the EIS review period.

# 3. LEGISLATIVE UPDATE

The SREIS Chapter 2, Project Approvals provides an update to the principal approvals required by Arrow to construct and operate and maintain the project that were detailed in the EIS (Chapter 2 of the EIS, Project Approvals). Updates to legislation since the EIS was published and which are applicable to MNES are summarised below. Additional legislation and policies relevant to the project are described in Attachment 7, Legislation and Policy.

The EPBC Act establishes an Australian Government administered environmental assessment and approval system. This system operates in addition to but separate from state and territory systems. The EPBC Act determines that impacts upon matters of national environmental significance are the primary trigger for Australian Government involvement in environmental protection.

In accordance with the requirements of the EPBC Act, the project was referred to DEWHA now known as SEWPaC.

## 3.1 Update to EPBC Act Environmental Offsets Strategy

SEWPaC has released the EPBC Act Environmental Offsets Policy and associated Offsets Assessment Guide (SEWPaC, 2012). The policy relates to protection of all matters protected under the EPBC Act through application of project specific biodiversity offsets. Implications of this policy on the offsets likely to be required for the Surat Gas Project are discussed in Section 12 of this attachment.

## 3.2 Species or Habitats Schedules Revision

Revisions have been made to the schedules of the EPBC Act for a number of species or communities since the project was declared a controlled action on 26 March 2010 (due to its potential to significantly affect listed threatened species and ecological communities (s. 18 and s. 18A) and listed migratory species (s. 20 and s. 20A)).

### Koala (*Phascolarctos cinereus*)

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 was required to nominate it under Section 517(1) of the EPBC Act as a separate species to other koala populations. This approach was based on advice from the Threatened Species Scientific Committee (TSSC) to SEWPaC (TSSC, SEWPaC 2012).

All new developments past the listing date that are 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 as well as outline criteria for assessing ‘critical habitat’, ‘important populations’ and significant impacts. The MNES assessment for the Surat Gas Project is not affected by the listing as it came after the Australian Government Environment Minister decided the project was a controlled action.

The koala does not constitute one of the controlling provisions for the project, and is not discussed further within this attachment. However, potential impacts to the terrestrial faunal values of this species and its potential habitat within the project area are addressed in the EIS (Appendix K,

Terrestrial Ecology Impact Assessment) and the SREIS (Appendix 9, Supplementary Terrestrial Ecology Assessment).

### King blue grass (*Dicanthium queenslandicum*)

On 30 January 2013, an amendment was made to the status of king blue grass (*Dicanthium queenslandicum*) under the EPBC Act, upgrading the species to endangered (previously vulnerable). The amendment to the listing for king blue grass came into effect after the project was declared a controlled action. The SREIS considers this species with the status it had at the time the controlled action was decided i.e., as vulnerable. Potential impacts on king blue grass are assessed in accordance with the EPBC Act significant impact criteria for vulnerable species.

### Brigalow scaly-foot (*Paradelma orientalis*)

On 29 April 2013, an amendment to the EPBC Act was made to delist a number of species listed as threatened. Of these species, brigalow scaly-foot (*Paradelma orientalis*) is of relevance to the project as the species was listed as vulnerable in the EPBC Act referral for the Surat Gas Project.

Brigalow scaly-foot is now delisted and is not considered threatened under Australian Government legislation. Although no assessment is required under the EPBC Act, the species is retained in the MNES attachment for the SREIS, and its revised status will be addressed when EA applications are made for the project prior to construction.

### Wardell's wattle (*Acacia wardellii*)

On 23 May 2013, an amendment was made to delist Wardell's wattle (*Acacia wardellii)* listed as vulnerable under the EPBC Act. Wardell's wattle is now delisted and is not considered threatened under Australian Government legislation. Although no assessment is required under the EPBC Act, the species is retained in the MNES attachment for the SREIS, and its revised status will be addressed when EA applications are made for the project prior to construction.

### Australian painted snipe (*Rostratula australis*)

On 30 April 2013, an amendment was made to upgrade Australian painted snipe (*Rostratula australis*) previously listed as vulnerable under the EPBC Act to endangered. The amendment to the listing for Australian painted snipe came into effect after the project was declared a controlled action. The SREIS considers this species with the status it had at the time the controlled action was decided i.e., as vulnerable. Potential impacts on the Australian painted snipe are assessed in accordance with the EPBC Act significant impact criteria for vulnerable species.

## 3.3 Environment Protection and Biodiversity Conservation Act 1999 Proposed Amendment

A bill seeking amendment to the EPBC Act is being introduced into Federal Parliament to include water resources as a matter of national environmental significance for coal seam gas and large coal mining developments. The amendment is sought to provide for the comprehensive assessment of impacts on water resources to ensure their protection.

The amendment must be debated and passed by both Houses of Parliament, and receive royal assent, before it becomes law. If passed and enacted, the amendment will require coal seam gas and large coal mining projects to assess impacts on water resources in accordance with the requirements of the EPBC Act. The Minister for Sustainability, Environment, Water, Population and Communities will decide whether to retrospectively apply the amendment to existing projects prior to seeking royal assent of the amendment.

This amendment is not yet in force (with no decision on retrospective application) does not currently apply to the Surat Gas Project, and has not been considered in this MNES attachment. However, the Surat Gas Project EIS and SREIS do include rigorous assessments of the potential impacts to water from project activities (Appendix 4, Supplementary Groundwater Assessment and Appendix 8, Supplementary Aquatic Ecology Assessment).

## 3.4 Independent Expert Scientific Committee

The Australian Government has established an Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) through amendment to the EPBC Act. The IESC provides advice to the federal minister on research priorities to improve the understanding of potential impacts of coal seam gas and large mining developments on water resources. The committee can be requested by federal, state and territory governments to provide advice on water-related aspects of environmental impact assessments.

The Surat Gas Project EIS was referred to the IESC on 14 January 2013 by SEWPaC. The committee's advice to the department dated 20 February 2013 was published on its website in March 2013. The federal minister will consider the IESC's advice in preparing the assessment report for the Surat Gas Project EIS. The SREIS is also expected to be referred to the IESC for their advice and Arrow will respond to the advice of the IESC as appropriate.

# 4. ASSESSMENT METHOD

This section describes the method used in this assessment of impacts from the project on MNES. The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009a) provides the framework for the assessment of potential impacts upon MNES from the Surat Gas Project. Under these guidelines, 'significant impact criteria' are defined for each MNES group (listed threatened ecological communities, listed threatened species, listed migratory species etc.) to assist in determining whether any of the impacts upon MNES from the Surat Gas Project are significant.

These guidelines have informed the development of the impact assessment process for each technical discipline assessed as part of the Surat Gas Project EIS and SREIS. The impact assessment methodology used for terrestrial ecology and aquatic ecology are detailed in Sections 4.4 and 4.5 below.

## 4.1 The Environmental Framework Approach

The impacts at a specific location cannot be fully described until the location of infrastructure is known. Impacts can be described based on the likely typical impacts of project activities. With that knowledge, greater certainty about potential impacts can be achieved by identifying those areas that are not amenable to certain types of development, and if they were developed, how development should proceed. This approach relies on identifying constraints to development and establishing environmental management controls that should apply to project activities in these constrained areas.

Known as the environmental framework approach, this internal process has been developed by Arrow to manage the impacts of coal seam gas development where the location of infrastructure becomes progressively known over the life of the project. The framework approach manages the impacts of the project in the planning phase (site selection) for geographically extensive projects, as well as in the construction and operation phases. Environmental controls are applied that reflect the sensitivity or vulnerability of environmental values at a particular location. Constraints mapping, an integral part of the environmental framework, is informed by the EIS and SREIS findings and will guide the selection of sites and routes to avoid and minimise impacts.

The environmental framework establishes the basis for detailed ecological surveys as the locations of project infrastructure are confirmed enabling site specific assessments of potential impacts. Preconstruction clearance surveys will be required once the exact location of project infrastructure is known to confirm the desktop or ecological assessment for the site, and to determine any additional (site specific) management measures required to protect identified listed species. Consistent with the framework approach, ecological assessments were carried out in survey areas 2, 9, 7, 8, and F, as the planned locations of project infrastructure. The assessments for the survey areas confirmed the findings of the EIS for terrestrial ecology communities and species that were expected at the sites. The mitigation measures set out in the EIS were confirmed as adequate to manage development at these sites.

Constraints mapping will inform Arrow's internal field development planning and the selection of sites for facilities and infrastructure. Once the site is selected any additional constraints identified during field surveys will inform the planning for the site and any adjustments required to avoid or mitigate the constraint. Where a significant environmental constraint cannot be avoided, the development of the site will be considered in consultation with the relevant authorities.

## 4.2 EPBC Guidance

The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009a), defines a significant impact as follows:

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

The EPBC Act Policy Statement 1.1 'Significant Impact Guidelines: Matters of National Environmental Significance' (DEWHA, 2009a) also defines when a significant impact is likely:

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

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

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

Significance assessment was adopted in the EIS for technical studies where an understanding of the vulnerability of the environmental asset or resource was important to the assessment. For example, an understanding of the sensitivity of ecosystems in their current state provides a sound basis for determining the severity of potential impacts. Potential impacts that arise through the management of materials and substances (e.g., waste) are more appropriately assessed using the principles of risk management. Compliance assessment was adopted in the EIS for environmental aspects regulated by statutory guidelines, e.g., air quality, noise and vibration. Chapter 7 of the EIS, Impact Assessment Method provides a more detailed description of the methods used to undertake the impact assessment, including of MNES.

The magnitude and significance of the impacts was quantified in the EIS. Impacts with a high significance were given priority for the development of mitigation measures. Technical studies undertaken for the SREIS have further validated the impact assessment undertaken in the EIS, and where necessary an update is provided to the significance of impacts. This update follows the methodology as detailed in Chapter 7 of the EIS, Impact Assessment Method unless stated otherwise in the relevant technical study.

## 4.3 Identifying and Assessing MNES

MNES identified in the EPBC Act referral submitted to the Australian Government on 2 February 2010 were investigated and assessed in the EIS. Technical studies were commissioned to describe the existing environment, identify environmental values, assess potential and residual impacts, and propose mitigation and management measures, as well as inspection and monitoring.

Technical studies relevant to the assessment of MNES include:

- Aquatic Ecology Impact Assessment (Appendix J of the EIS).
- Terrestrial Ecology Impact Assessment (Appendix K of the EIS).
- Aboriginal Cultural Heritage Impact Assessment (Appendix Q of the EIS).
- Non-Indigenous Heritage Impact Assessment (Appendix R of the EIS).

Arrow undertook an initial EPBC Protected Matters Search on 29 October 2009 to support Referral No. 2010/5344. The search identified 45 listed threatened species, 17 listed migratory species and six listed threatened ecological communities to be potentially present in or within 5 km of the project development area, which forms the study area for this assessment.

Further desktop searches were undertaken, which included searches of the following databases:

- Regional ecosystem mapping and high-value regrowth vegetation mapping (Queensland Government).
- Regional Ecosystem Description Database managed by the Department of Environment and Resource Management (DERM), now EHP.
- Queensland Herbarium's records system (HERBRECS).
- Queensland Herbarium's site-based floristic database (CORVEG).
- EHP's WildNet, including a 10 km additional search buffer.
- Queensland Museum's fauna collections database, including a 10 km additional search buffer.
- Birds Australia Atlas, including a 10 km additional search buffer.
- Internal flora and fauna databases held by 3D Environmental and EcoSmart Ecology.
- Biodiversity planning assessment for the Brigalow Belt South bioregion using DERM's Biodiversity Assessment and Mapping Methodology to provide information on biodiversity significance, essential habitat and regional wildlife corridors.

A further EPBC Protected Matters Search was undertaken on 21 February 2011 as part of the terrestrial ecology impact assessment study to capture any new species listed since the original search in 2009. For reasons unknown, one migratory species, common greenshank (*Tringa nebularia*), that was identified in 2009, was not identified in this search.

An additional threatened ecological community, Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions was identified as being potentially present in or within 5 km of the project development area after becoming listed as 'endangered' under the EPBC Act in March 2011.

Terrestrial flora and fauna field surveys in the project development area were then conducted over three periods, from October to December 2009, during May 2010 and during February to March 2013. Surveys undertaken in 2013 were as a result of project description changes and new information being available as to where some major infrastructure would be located. These surveys targeted known infrastructure locations at the four identified CGPF locations and one TWAF location to provide baseline information and to assess the likelihood of MNES being present.

Survey methodologies, including details of the related desktop assessments, are found in Section 4 of Appendix K of the EIS, Terrestrial Ecology Impact Assessment and Section 4 of Appendix 9, Supplementary Terrestrial Ecology Assessment.

Aquatic ecology field surveys were undertaken at eleven sampling sites during November 2009 (early wet season) and May 2010 (after the wet season) with further survey work (targeting known infrastructure locations at the four identified CGPF locations) during February to March 2013. An extensive desktop review was also undertaken to augment the field surveys to provide baseline information and to determine the likelihood of MNES occurring in the project development area. Survey methodologies, which also include details of the corresponding desktop assessments, are found in Section 3 of Appendix J of the EIS, Aquatic Ecology Impact Assessment and Section 3 of Appendix 8, Supplementary Aquatic Ecology Assessment.

Areas of Indigenous archaeological or cultural significance in the project development area were identified through a desktop study, including searches of relevant Indigenous cultural heritage databases and lists. No World Heritage Properties or National Heritage Places were identified in either of the protected matters searches undertaken for the project.

Consultation had commenced with Indigenous (Aboriginal) parties, but formal negotiations on cultural heritage management and Indigenous land use have not been finalised. Arrow proposes to meet its 'duty of care' obligations under Queensland legislation either through a suitable native title agreement or agreements that do not expressly exclude cultural heritage or through an approved cultural heritage management plan. Arrow will comply with the *Aboriginal Cultural Heritage Act 2003* (Qld) as the project progresses.

Areas of known non-Indigenous heritage sites were identified through research and consultation with local groups and individuals. Zones with a high potential to contain historic sites and places were also identified and assessed. Targeted field investigations were then undertaken in these zones leading to the identification and documentation of additional historical places and sites.

## 4.4 Impact Assessment – Terrestrial Ecology

Habitat descriptors used to describe flora and fauna habitat within the terrestrial ecology assessment, adapted from the Biodiversity Assessment Mapping Methodology developed by the Environmental Protection Authority (EPA) 2002 (now known as EHP) (DERM, 2008) are described below:

- 'Core Habitat Known': Identifies habitat where a spatially accurate confirmed record of a particular species exists (e.g., Herbrecs or survey record). Core habitat known is attributed to the particular habitat polygon in which it occurs, based on either regional ecosystem (RE) mapping provided by EHP or high resolution habitat mapping developed for a specific purpose.

'Core Habitat Known' also applies to a 1 km buffer around all spatially accurate (< 400 m accuracy) species records.

- 'Core Habitat Possible': Previous records of a particular species are not known to occur within a given area or habitat, although specific habitat features are present which are known to be favoured by the species and the habitat occurs within the species known geographic range.
- 'General Habitat': Where a species has not been recorded in a given location and habitat accounts for some of the features favoured by a particular species. The habitat occurs on the margins of a species known geographic range. Otherwise, the habitat is suitable for the species although has been subject to intensive survey and the species has not been recorded.
- 'Absence Suspected': The species has not been recorded in a given location and habitat features are not suitable (or sub-optimal) for survival of a given species or population.

'Essential Habitat' as regulated under the *Vegetation Management Act 1999* (Qld) (VM Act) is included as an additional data layer within habitat mapping profiles for individual species. As Essential Habitat may be drawn from a number of data sources, both verified and non-verified, its classification is considered sub-ordinate to the classification of 'Core Habitat Known'. It will however generally be captured within the classification of 'Core Habitat Possible'.

The terrestrial ecology assessment assigns the following levels of confidence to habitat mapping for individual flora species:

- 'High': Habitat mapping is based on known recent (post 1980) records of a species with a high degree of precision (< 500 m). Habitat mapping has been undertaken for specific assessment purposes based on intensive field survey with mapping produced at a spatial scale of >1:25,000.
- 'Medium': Habitat mapping has been undertaken a spatial scale of 1: 25,000 to 1: 50,000 based on targeted field survey and assessment. Heterogeneous habitat (RE) polygons are not contained, or used extensively in the habitat mapping database.
- 'Low': Assessment has been undertaken broadly with limited field survey using 1:100,000 scale RE data as a basis for habitat mapping. The habitat mapping database makes extensive use of heterogeneous habitat polygons.

The following levels of confidence have been applied to habitat mapping for individual fauna species:

- 'High': Habitat mapping is based on known recent (post 1980) records of a species with a high degree of precision (< 500 m). The species habitat requirements are well known, and easily attributed to individual RE types.
- 'Medium': Habitat requirements for the species are moderately well known, but can appear in unexpected locations/habitats; and/or, particular habitat requirements of the species can be attributed, with some moderate degree of accuracy, to individual REs.
- 'Low': Habitat requirements of the species are relatively poorly known and patterns of occurrence are difficult to predict; and/or, particular habitat requirements cannot be easily attributed to any particular RE.

Habitat mapping confidence for fauna species does not consider inaccurate RE mapping, but rather is based on an assumption that all RE mapping is correct.

The assessment of ecological impacts undertaken in the terrestrial ecology technical study draws from both extensive desktop investigations and targeted field assessment. A qualitative assessment of impacts has been undertaken to define sensitivity of habitats, local flora populations and fauna populations. This is in respect to disturbance within the project development area based on known ecological attributes including life span and life cycle, resilience to disturbance and the capacity of the population for rehabilitation.

### 4.4.1 Sensitivity assessment

A sensitivity ranking for ecological communities is provided in Table 4.1, flora species in Table 4.2 and fauna species in Table 4.3.

**Table 4.1 Terrestrial ecological community sensitivity rankings**

| Sensitivity Ranking | Descriptor |
|---|---|
| Not Sensitive | No short-term or long-term project impacts are likely to adversely affect the ecological community and the habitat is resilient to changes in habitat structure or condition. This includes:<br>• A habitat whose floristic structure is relatively simple and edaphic conditions favour re-establishment of native groundcovers following disturbance ( An example might be a habitat formed by a species with repeatedly demonstrated rapid and abundant post-disturbance recruitment providing strong population resilience and rapid recovery).<br>• A habitat that exists in a highly degraded state prior to disturbance. |
| Low | The ecological community has a high resilience to project related impacts, or the habitat of the species is already highly disturbed due to historic activities. An ecological community is resilient to change and able to quickly recover after disturbance because it demonstrates the following features:<br>• It comprises species that are able to regenerate rapidly through coppicing and the species seeds abundantly.<br>• The habitat occupies soil or landform types that do not favour extensive invasion of exotic species following disturbance.<br>• Habitat structure and general floristic composition are generally restored to near natural condition in a short to moderate time frame (15 to 20 years).<br>• The habitat is amenable to rehabilitation and seed stock of the dominant constituent species are generally readily available. |
| Moderate | The ecological community is capable of regeneration following disturbance although original habitat structure and general floristic composition may take many years to recover and require some intervention to ensure natural ecological process is restored. The habitat may have several of the following features:<br>• The floristic composition of the habitat comprises a suite of species, the majority of which are capable of post disturbance regeneration via coppicing although seeding events may be irregular and local seed bank short lived.<br>• The habitat is relatively resilient to the impact of edge effects including dust generation, weed invasion although soil conditions will tend to favour displacement of native ground covers and shrubs with exotic species in the absence of intervention.<br>• The habitat is capable of persisting and regenerating on roadsides following disturbance although original floristic composition may never be restored in the absence of intervention. |

**Table 4.1 Terrestrial ecological community sensitivity rankings (cont'd)**

| Sensitivity Ranking | Descriptor |
|---|---|
| High | The ecological community has a relatively low resilience to disturbance and impacts may lead to a long-term loss of habitat integrity causing permanent decline in habitat extent and condition. The habitat typically has several of the following features:<br>• Is dominated by perennial species with limited or irregular germination although some regeneration via coppicing may occur.<br>• Comprises a relatively diverse floristic composition in the shrub and ground cover layers with a high proportion of species incapable of persisting following disturbance.<br>• The habitat is highly susceptible to edge effects and may suffer severely from edge effects such as dust and weed invasion, often manifest in habitat dieback.<br>• Soil conditions favour expansion of exotic weeds over native ground covers.<br>• Intensive intervention is required to re-establish natural vegetative structure and composition. |
| Extremely high | The habitat has extremely low resilience to disturbance and impacts are likely to lead to permanent structural and floristic change and long term decrease in habitat occupancy. The ecological community has several of the following features:<br>• The habitat is dominated by perennial species which lack the capacity for vegetative regeneration via coppicing.<br>• Aggressive exotic coloniser species typically take residence and ultimately displace native species in areas of disturbance.<br>• The habitat depends on highly specific edaphic conditions which are readily destroyed following disturbance (e.g., soil compaction) and difficult to restore.<br>• The habitat is highly susceptible to grazing pressure which may interfere with the habitats ability to recolonise.<br>• The habitat condition continues to decline years after impact due to an inability to tolerate disturbance and aggressive displacement by exotic species.<br>• The amenability of the habitat to rehabilitation is poor or unknown and constituent species not readily available.<br>• The habitat may become extinct (at the local scale) due to inability to recover from disturbance. |

**Table 4.2 Terrestrial flora species sensitivity ratings**

| Sensitivity Ranking | Descriptor |
|---|---|
| Not Sensitive | No short-term or long-term project impacts are likely to adversely affect the local populations of this species, or the population may benefit from the project (e.g., aggressive coloniser species that benefit from disturbance) and is resilient to changes in habitat structure or condition. For example, an annual or ephemeral species which repeatedly demonstrated rapid and abundant post-disturbance recruitment providing strong population resilience and expansion following disturbance.<br>The species exists in a highly disturbed impacted habitat already. |
| Low | The local populations of this species have a high resilience to project related impacts, or the habitat of the species is already of a low degree of intactness and condition due to previous disturbances.<br>A disturbance may cause short-term impacts but is unlikely to cause local extinction, with no long-term impact expected on abundance, extent or integrity of the local population. The population is resilient to change and able to quickly recover after disturbance because the species has several of the following features:<br>• Is an annual or biennial herb with previously documented abundant post-disturbance recruitment.<br>• Is a perennial known to survive disturbances through vegetative persistence via coppicing, and also produces abundant seed germination.<br>• Has a long-lived local seed reserve (e.g., a hard-seeded legume), and/or its seed disperses long distances via wind, water or animals (e.g., daisies).<br>• Seedlings are known to mature to produce seed within two years of germination. |
| Moderate | The local populations of this species have a moderate resilience to disturbance. Short-term impacts (over one or two generations) may lead to a loss of abundance or extent, but are unlikely to cause extinction of the local population. The species can recolonise and only minor long-term impacts are expected on the abundance, extent and integrity of the local population because the species has several of the following features:<br>• Is an annual or biennial herb which is expected to have abundant post-disturbance recruitment, based on characteristics of the species or closely related species.<br>• Has a long-lived local seed reserve (e.g., a hard-seeded legume), and/or its seed disperses long distances via wind, water or animals (e.g., daisies).<br>• Is a perennial capable of vegetative persistence following disturbance via coppicing and scattered seedlings.<br>• A perennial incapable of vegetative persistence following disturbance via coppicing, but will likely recruit abundant post-disturbance seedlings, with those seedlings expected to require less than six years to mature.<br>• Known to persist in moderately disturbed areas, such as roadsides. |

**Table 4.2 Terrestrial flora species sensitivity ratings (cont'd)**

| Sensitivity Ranking | Descriptor |
|---|---|
| High | The local populations of this species have a fairly low resilience to disturbance. Impacts may lead to a long-term decrease in its abundance and/or extent, or may affect the long-term integrity of the local population causing it to decline permanently or become locally extinct. The species regenerates or recolonises with difficulty after disturbance because the species has several of the following features:<br>• Is a perennial with limited or irregular germination.<br>• The population may remain at a declined density for years after the disturbance until seed germination occurs sporadically in later years.<br>• Seedlings take six to ten years to mature to produce seed.<br>• Has capacity for some vegetation regeneration via coppicing.<br>• Has a local seed reserve likely to persist for several years, or seed disperses long distances via wind, water or animal.<br>• Seed reserves are short lived, with most seeds likely to be dead or eaten within months of seed drop.<br>• Is known to be negatively impacted by normal grazing pressures, or particularly susceptible to feral animals damage.<br>• Is known to be particularly impacted by invasion of common local weeds that are likely to invade disturbed sites. |
| Extremely high | The local populations of this species have very low resilience to disturbance. Impacts are likely to lead to the long-term decline or extinction of a local population. Natural recruitment or colonization would not replace or restore the population within several generations because the species has several of the following features:<br>• Is a perennial with only very occasional, erratic germination and lacks the capacity for vegetative regeneration via coppicing.<br>• Seedlings take more than ten years to mature to produce seed.<br>• If capable of vegetative regeneration via coppicing, then the coppice shoots take decades to mature to produce seed.<br>• Seed production is irregular, and seed reserves are ephemeral, with no seeds likely to survive many weeks of seed drop.<br>• Juvenile plants (e.g., saplings) are particularly sensitive to disturbance.<br>• It's population density is known to be significantly reduced by invasion of common local weeds that are likely to invade disturbed sites.<br>• Requires surrounding habitat to be in good condition for its population persistence (e.g., intact scrub without weed invasion).<br>• The population continues to decline years after the disturbance due to the inability to survive in a disturbed ecosystem.<br>The habitat containing the local population currently has a high degree of intactness and may represent benchmark condition in reference to examples of the habitat across its broader range. Therefore the local population is only known from undisturbed, high quality habitat that is sensitive to disturbance. A single disturbance is likely to have ongoing negative effects on this species, so that any post-disturbance survivors or new recruits are unable to tolerate the disturbed ecosystem. |

**Table 4.3 Terrestrial fauna species sensitivity assessment**

| Sensitivity Ranking | Descriptor |
|---|---|
| Not Sensitive | The species is known to exist in highly disturbed areas. Short-term or long-term disturbance may adversely affect local individuals of the species however it is likely that the population may benefit from the disturbance (e.g., species that benefit from disturbance, the creation of artificial edges and/or artificial water sources) due to resilience to change in vegetation [species] composition, habitat structure and/or condition. Typically the species is:<br>• Adapted or tolerant to open, simplified habitats (i.e., grazing land).<br>• An aggressive open generalist, or are tolerant of.<br>• Able to adapt to ongoing habitat modification resulting from long-term deleterious impacts (e.g., weed infestations).<br>• Highly mobile, and unlikely to be impeded by any movement barriers.<br>• Able to rapidly reproduce and colonise disturbed land due to a high fecundity. |
| Low | The species has several of the following features:<br>• Local populations of this species have a high resilience to disturbance, or the habitat of the species is already of a low degree of intactness and condition due to previous disturbances.<br>• Disturbance may cause short-term impacts but will not cause local extinction, with no long-term impact expected on abundance, extent or integrity of the local population.<br>• The local population is resilient to change and able to quickly recover following rehabilitation of suitable habitat. |
| Moderate | The species has several of the following features:<br>• Local populations of this species have a moderate resilience to disturbance.<br>• Short-term impacts during development may lead to a loss of abundance or a reduction in extent, but are unlikely (<30%) to cause extinction of the local population.<br>• The species may decline during construction activities, but declines during operation and maintenance, and decommissioning activities are not expected.<br>• A species can recolonise and only minor long-term impacts are expected on the abundance, extent and integrity of the local population following rehabilitation of suitable habitat. |
| High | The species has the following attributes:<br>• Local populations of this species have low resilience to disturbance. Impacts may lead to the long-term decline of a local population.<br>• The species is likely to decline during construction activities, but declines during operation and maintenance, and decommissioning activities is less likely. The local population may (>30% likelihood) become extinct.<br>• Natural recruitment or re-colonisation is unlikely to replace or restore the population following rehabilitation. |

**Table 4.3 Terrestrial fauna species sensitivity assessment (cont'd)**

| Sensitivity Ranking | Descriptor |
|---|---|
| Extremely high | The species has several of the following attributes:<br>• Local populations of this species have very low resilience to disturbance. Impacts are likely to lead to the long-term decline of a local population and these declines are likely to continue during operation and maintenance, and decommissioning.<br>• Natural recruitment or colonisation would not replace or restore the population. The local population is likely (>80% likelihood) to become extinct.<br>• Populations have declined historically.<br>• Small, restricted ranges or discrete isolated populations.<br>• Sedentary and highly susceptible to fragmentation.<br>• Specialised habitat requirements which may include being restricted to habitats that are discrete, highly fragmented and susceptible to degradation. |

### 4.4.2 Magnitude of Impacts

The magnitude of an impact on an environmental value is an assessment of the geographical extent, duration and severity of the impact. Applying these attributes enables the magnitude of an impact to be ranked as major, high, moderate, low or negligible as shown in Table 4.4.

**Table 4.4 Impact magnitude ranking definitions – terrestrial ecology**

| Magnitude Ranking | Descriptor |
|---|---|
| Negligible | The impact of disturbance does not extend beyond the project footprint. The impact will be difficult to detect when the activity or source of impact ceases. The impact occurs in areas mapped as 'absence possible' for the species and only affects a local population. |
| Low | The impact of disturbance does not extend beyond the project footprint. The impact will be detectable although recovery will occur in the short term (months) without the risk of long term impacts to the affected individuals or population. The impact occurs in areas mapped as 'general habitat' for the species and only affects a local population. |
| Moderate | The impact of disturbance may extend beyond the project footprint and affects a local or regional population. The impact is short term and can be managed by implementation of environmental controls. The impact occurs in areas mapped as 'general habitat' and 'core habitat possible' for the species and only affects a regional population. |
| High | The impact of disturbance extends beyond the project footprint affecting local ecosystem function in the surrounding area and a bioregional population or species. Impacts are medium to long term. Environmental controls and management actions specific to the species are required over a long period of time to mitigate impacts. The impact affects areas mapped as 'core habitat possible' and 'core habitat known' and affects local and regional populations. |
| Major | The impact of disturbance extends beyond the project footprint and local ecosystems affecting population or geographically dispersed population at a bioregional, national or world scale. Environmental controls and management actions have limited potential to reduce impacts or have not been proven for the species. The impact affects areas mapped as 'core habitat possible' and 'core habitat known' and involves local, regional and potentially national populations. |

### 4.4.3 Impact Significance Assessment

The significance of an ecological impact is derived from the risk matrix as provided in Table 4.5. This has been determined from the sensitivity of an ecological value and the magnitude of the impact it experiences. Descriptors for the impact significance ranking are given in Table 4.6.

**Table 4.5 Matrix for the assessment of the significance of an ecological impact (terrestrial)**

| | | Ecological Sensitivity | | | | |
|---|---|---|---|---|---|---|
| | | **Extremely High** | **High** | **Moderate** | **Low** | **Not Sensitive** |
| **Impact Magnitude** | **Major** | 25 | 24 | 22 | 19 | 15 |
| | **High** | 23 | 21 | 18 | 14 | 10 |
| | **Moderate** | 20 | 17 | 13 | 9 | 6 |
| | **Low** | 16 | 12 | 8 | 5 | 3 |
| | **Negligible** | 11 | 7 | 4 | 2 | 1 |

| **Impact Significance Ranking** | |
|---|---|
| **Major** | 23-25 |
| **High** | 20-22 |
| **Moderate** | 11-19 |
| **Low significance** | 4-10 |
| **Insignificant** | 1-3 |

**Table 4.6 Impact significance ranking definitions (terrestrial)**

| Significance Ranking | Descriptor |
|---|---|
| Negligible | An impact occurs to an ecological value that is of limited importance on a local or regional basis. The impact is largely reversible with degradation controlled by a range of standard mitigation and management measures that have been proven to be extremely effective. |
| Low | An ecological value is of local importance only and impacts will be of a transient nature that will not affect the long term viability of a local population. A range of mitigation and management measures are known to ameliorate or reverse the process of degradation. |
| Moderate | Although resilient to change, further degradation of an ecological value will occur due to the impact scale, or the activity has potential to increase the susceptibility of the ecological value to further change. Although important in the local ecological context, the value is widespread outside the area of impact and a range of management measures are known to facilitate recovery or replacement of the ecological value. |
| High | A high magnitude impact occurs when proposed activities exacerbate or accelerate the degradation of a unique or rare ecological value. Whilst management actions are known to ameliorate impacts, a full recovery of the value to pre-impact condition is a long term process (decades) which will require rigorous active management. In these cases, avoidance is the preferred primary mitigation measure. |

**Table 4.6 Impact significance ranking definitions (terrestrial) (cont'd)**

| Significance Ranking | Descriptor |
|---|---|
| Major | An impact occurs that causes major, long term and widespread harm to a habitat or ecological value that is irreplaceable because of its uniqueness or restricted occurrence. The impact is largely irreversible and no mitigation measures have been proven to ameliorate the impact, and avoidance is considered the only effective mitigation |

The Matters of National Environmental Significance – Significant Impact Guidelines (DEWHA, 2009a) provide a basis for the assessment of impact significance to species and ecological communities that are threatened at a national level. The guideline provides a list of 'significant impact criteria' for listed species and ecological communities that are 'critically endangered', 'endangered' or 'vulnerable'. An additional category of 'extinct in the wild' is also discussed although this category is not relevant to any species known from within the project development area. In general a significant impact is defined as one that will:

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

For threatened ecological communities, activities that have are significant impact are those that will or are likely to:

- Reduce the extent of an ecological community.
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.
- Adversely affect habitat critical to the survival of an ecological community.
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species.
- Interfere with the recovery of an ecological community.

An 'important population' is defined by DEWHA (2009) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

Forster (1997) also identifies an 'important population' as one that is viable in the long term, being populations that are located within intact habitats. Due to the highly fragmented nature of the Surat Gas project development area, all naturally occurring populations of listed species are considered important populations as these often key source populations for breeding and dispersal and necessary for maintaining genetic diversity.

## 4.5 Impact Assessment – Aquatic Ecology

The assessment of impacts on aquatic ecology followed the method detailed in the EIS and outlined in Section 3.5 of Appendix 8, Supplementary Aquatic Ecology Assessment. This method quantifies a significance rating of impacts as a function of the sensitivity of freshwater aquatic values and is summarised below.

### 4.5.1 Sensitivity assessment

A sensitivity ranking for aquatic values is provided in Table 4.7.

**Table 4.7 Aquatic ecology values sensitivity rankings**

| Sensitivity Ranking | Sensitivity Attribute | | | | |
|---|---|---|---|---|---|
| | **Conservation Status** | **Intactness** | **Uniqueness** | **Resistance to Change** | **Replacement Potential** |
| Low | • No formal conservation value.<br>• No fisheries value.<br>• Local or no ecotourism value.<br>• No species, habitat or communities or special conservation significance. | • Highly disturbed aquatic system.<br>• Poor quality aquatic habitat.<br>• Minimal value as movement corridor for fauna.<br>• Minimal value for spawning/nursery. | Unique on a local scale in terms of biota, communities or processes. | Highly tolerant or adaptive communities able to survive significant disturbance impacts. | Communities capable of rapidly recovering/regenerating after disturbance events. |
| Moderate | • Local government management.<br>• Moderate/marginal fishery values.<br>• State or local eco-tourism destination.<br>• Species of conservation interest (currently unlisted). | • Moderately disturbed aquatic system.<br>• Moderate to good quality habitat.<br>• Limited passage of aquatic fauna.<br>• Limited spawning/nursery opportunities. | Unique on a regional scale in terms of biota, communities or processes. | Moderately tolerant or adaptive communities. | Communities likely to exhibit moderate to good recovery following disturbance. |
| High | • Wild river status.<br>• World heritage status.<br>• Ramsar status.<br>• EPBC or NC Act listed communities or species.<br>• High value fishery.<br>• International eco-tourism destination. | • Undisturbed, pristine aquatic system.<br>• High quality aquatic habitat.<br>• Important movement corridor.<br>• Nursery/spawning area. | Unique on a national or international scale in terms of biota, communities or processes. | Poor tolerance to disturbance events, minor impacts may have catastrophic effect. | Disturbance likely to cause irreparable damage or permanent loss of values. |

### 4.5.2 Magnitude of Impacts

The magnitude of an impact on an environmental value is an assessment of the geographical extent, duration and severity of the impact. Applying these attributes enables the magnitude of an impact to be ranked as high, moderate, low as shown in Table 4.8.

**Table 4.8 Impact magnitude ranking definitions – aquatic ecology**

| Magnitude Ranking | Descriptor |
|---|---|
| Low | • The impact has the potential for localised effects on aquatic ecosystems up to 0.5 km away.<br>• The impact is short term (less than three months).<br>• The impact has potential for minor, short-term impairment of aquatic communities. |
| Moderate | • The impact has the potential to affect aquatic ecosystems within a 0.5 -20 km radius.<br>• The impact affects aquatic ecosystems for three months to two years.<br>• The impact has potential for temporary or partial loss of aquatic communities. |
| High | • The impact has potential to affect aquatic ecosystems over a wide spatial range (more than 20 km).<br>• The impact period is from two years to perpetuity.<br>• The impact has potential for complete loss of aquatic communities (i.e., shift to a fundamentally new assemblage). |

### 4.5.3 Impact Significance Assessment

The significance of an ecological impact is derived from the risk matrix as provided in Table 4.9. This has been determined from the sensitivity of an ecological value and the magnitude of the impact it experiences. Descriptors for the impact significance ranking are given in Table 4.10.

**Table 4.9 Matrix for the assessment of the significance of an ecological impact (aquatic)**

| | | Sensitivity of Freshwater Ecosystems or Species | | |
|---|---|---|---|---|
| | | **High** | **Moderate** | **Low** |
| **Magnitude of Impact** | **High** | Major | High | Moderate |
| | **Moderate** | High | Moderate | Low |
| | **Low** | Moderate | Low | Negligible |

**Table 4.10 Impact significance ranking definitions (aquatic)**

| Significance Ranking | Descriptor |
|---|---|
| Major | Typically associated with long term, widespread or very severe impacts on iconic environmental values of natural or international conservation significance. |
| High | May relate to lower magnitude impacts on iconic environmental values, or may be the result of long term, widespread or severe impacts to species of state significance, existing assemblages of flora and fauna, or the fundamental processes that enable their persistence. |

**Table 4.10 Impact significance ranking definitions (aquatic) (cont'd)**

| Significance Ranking | Descriptor |
|---|---|
| Moderate | Are associated with severe impacts on less sensitive environmental values, or to less severe impacts on environmental values of state or national significance, existing assemblages of flora and fauna, or the fundamental processes that enable their persistence. |
| Low | Are those that are relatively short term, low severity and localised, and that affect environmental values that are marginal or are tolerant of such disturbance events. |
| Negligible | Of such low magnitude or affect such low value ecosystems that no mitigation or avoidance strategies are warranted. |

# 5. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE IN THE SURAT GAS PROJECT DEVELOPMENT AREA

The EPBC Protected Matters Search, additional database surveys and field surveys undertaken for the terrestrial and aquatic ecology EIS assessments identified 32 EPBC Act listed flora species and 31 EPBC Act listed fauna species, 33 listed migratory species and six listed threatened ecological communities to be present or potentially present in or adjacent to the project development area. The searches and surveys also identified that the project will be undertaken in catchments that drain to or in the vicinity of two wetlands of international importance.

The Indigenous and non-Indigenous cultural heritage assessments undertaken in the EIS (Chapter 23, Indigenous Cultural Heritage and Chapter 24, Non-Indigenous Cultural Heritage) did not identify any World Heritage properties or National Heritage places.

Additionally, no nuclear actions or Commonwealth marine environments were identified to be present in or adjacent to the project development area.

## 5.1 Wetlands of International Importance

The EPBC Protected Matters Searches identified that the project will be undertaken in catchments that drain to or in the vicinity of wetlands of international importance: the Narran Lakes Nature Reserve and the Shoalwater and Corio Bays Area. There are no wetlands of international importance within the project development area.

The Narran Lakes Nature Reserve is a listed Ramsar wetland in northern New South Wales. The site is the terminal wetland of the Narran River, which is fed by the Condamine River. The Condamine River drains a substantial part of the project development area. Located approximately 75 km northwest of Walgett and 50 km northeast of Brewarrina, Narran Lakes provides habitat for migratory species and is of cultural significance to Indigenous people. The wetland is located some 500 km by river from the project development area.

The Fitzroy River, and its tributary the Dawson River, drain the northern part of the project development area. The Fitzroy River flows to the sea southeast of Rockhampton. The river mouth is 50 km south of the Ramsar wetlands of the Shoalwater and Corio Bays Area. The site comprises five major estuarine and marine environments, which represent the largest area in central east Queensland containing representative coastal, subcoastal and aquatic landscapes and ecosystems. The wetland complex is more than 500 km by river from the project development area.

Figure 5.1 shows these wetlands relative to the project development area.

Project-related activities are very unlikely to impact on these sites due to the large distances between the project development area and the Narran Lakes Nature Reserve and the Shoalwater and Corio Bays Area wetlands. Consequently, the MNES assessment did not include these sites. Arrow's protocols regarding discharges detailed in Attachment 8 of the EIS, Commitments Summary and updated in Attachment 4, Commitments Update will manage the impacts of discharge on water courses. Consequently, any discharges into watercourses which may eventually drain to these sites pose negligible risk.


| | | | | | |
|---|---|---|---|---|---|
| coffey environments | Date: 14.06.2013<br>MXD: 7040AE_12_GIS094_v1_1<br>File Name: 7040_12_ATT1_F05.01_GIS_GL | Arrow Energy<br>Surat Gas Project | arrow energy go further | Narran Lakes Nature Reserve and Shoalwater and Corio Bays Area | Figure No: 5.1 |

## 5.2 Listed Threatened Ecological Communities

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

- Critically endangered.
- Endangered.

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

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

The EPBC Protected Matters Searches identified six listed threatened ecological communities as being present or potentially present in and adjacent to the project development area, based on their likelihood of occurrence according to distribution. These communities are represented by 13 regional ecosystems under Queensland legislation (VM Act), as well as regrowth vegetation in some listed communities (brigalow).

Of the six listed threatened ecological communities identified in the desktop search, four were confirmed during field surveys, one was known to occur from database searches and one was not confirmed but considered as likely to occur based on previous records and vegetation mapping.

Table 5.1 summarises the listed threatened ecological communities along with their likelihood of occurrence within the project development area. The extent in hectares, the distribution of each community within identified sites for project infrastructure, and the detailed mapping area and project development area is provided within the relevant community profile in Appendix C of this attachment.

**Table 5.1 Listed threatened ecological communities and their likelihood of occurrence, structure and location within the project development area**

| EPBC Act–Listed Threatened Ecological Community | EPBC Status | Likelihood of Occurrence (EIS) | Location and Structure of Community (EIS) | Likelihood of Occurrence (SREIS) | Combined Total (ha) in Project Development Area |
|---|---|---|---|---|---|
| Brigalow (*Acacia harpophylla* dominant and co-dominant) | 'Endangered' | Present (field survey) | Field observations and regional ecosystem mapping suggest that *A. harpophylla* dominant and co-dominant communities are a common, although highly fragmented, ecosystem. These communities are recognised under the VM Act as REs 11.3.1, 11.4.3, 11.4.10, 11.9.5 and 11.9.6. | Present (field survey) | 7387 |
| Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland | 'Critically endangered' | Present (field survey) | This community was identified in narrow strips along road verges and stock routes. It is recognised under the VM Act as REs 11.3.21 and 11.3.24. | Present (field survey) | 678 |
| Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions | 'Endangered' | Likely | It is likely that small pockets occur in flood plain habitats in the project development area, particularly in areas from Chinchilla northwards. It is recognised under the VM Act as RE 11.3.3. This community occurs as a sub-dominant community in association with RE 11.3.25 and 11.3.4. | Present (field survey) | 206 |
| White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland | 'Critically endangered' | Likely | This is likely in the Captains Mountain area south of Millmerran. It is recognised under the VM Act as RE 11.8.2a. | Likely | 260 |

**Table 5.1 Listed threatened ecological communities and their likelihood of occurrence, structure and location within the project development area (cont'd)**

| EPBC Act–Listed Threatened Ecological Community | EPBC Status | Likelihood of Occurrence (EIS) | Location and Structure of Community (EIS) | Likelihood of Occurrence (SREIS) | Combined Total (ha) in Project Development Area |
|---|---|---|---|---|---|
| Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions | 'Endangered' | Possible | There is some potential for this ecological community to occur in small patches of brigalow throughout the project development area. It is recognised under the VM Act as REs 11.8.3 and 11.9.4a. | Present (database searches) | 35 |
| Weeping Myall Woodlands | 'Endangered' | Possible | This community is often associated with RE 11.3.2, which occurs extensively in the project development area. Field surveys did not locate any examples of this community, although scattered weeping myall trees were observed to be associated with RE 11.4.12, and it is therefore possible. | Present (field survey) | <1 |

Note: Combined total (ha) in project development area incorporates 3D Environmental dataset in detailed mapping area with EHP datasets outside detailed mapping area.

Detailed mapping was undertaken for the EIS within certain areas as shown on Attachment 3 of the EIS, Matters of National Environmental Significance Figures 4.2a-c. Detailed mapping areas were referred to in the EIS as ‘targeted survey areas’. These areas are referred to in the SREIS as ‘detailed mapping area’. ‘Targeted survey area’ is now applied to areas subject to field surveys completed to inform the SREIS. The detailed mapping dataset described below encompasses both the detailed mapping area and targeted survey areas.

A general comparison between detailed mapping undertaken during studies completed for the EIS and SREIS and EHP databases indicates the following:

- The Brigalow Ecological Community Brigalow (*Acacia harpophylla* dominant and co-dominant) may be undermapped with 1,307 ha identified in detailed mapping compared to 904 ha in the same area for EHP datasets.
- The Natural Grassland Ecological Community is likely to be overmapped with 200 ha delineated in detailed mapping compared to 290 ha identified in EHP datasets for the same area.
- The Coolibah- Black Box Ecological Community is likely to be overmapped with 12 ha delineated in detailed mapping compared to 165 ha identified in EHP datasets for the same area.

Minor discrepancies were also noted in the areas mapped for the Semi-Evergreen Vine Thicket Ecological Community. The Weeping Myall Ecological Community was not recorded in the detailed mapping area within EHP datasets, yet was recorded in detailed mapping undertaken for the SREIS, with an area of 0.85 ha at survey area 7.

Figures 5.2a-c show the location of these ecological communities within the project development area as mapped by EHP and as a result of detailed field surveys undertaken for the Surat Gas Project. Insets are shown on the figures of the five identified sites for project infrastructure (survey areas 2, 7, 8, 9 and survey area F) and the extent of these communities on these properties, if located during fieldwork in early 2013.

The 'endangered sub-dominant' field on the figure indicates areas where a listed threatened ecological community is mixed with an ecosystem that has no EPBC significance.

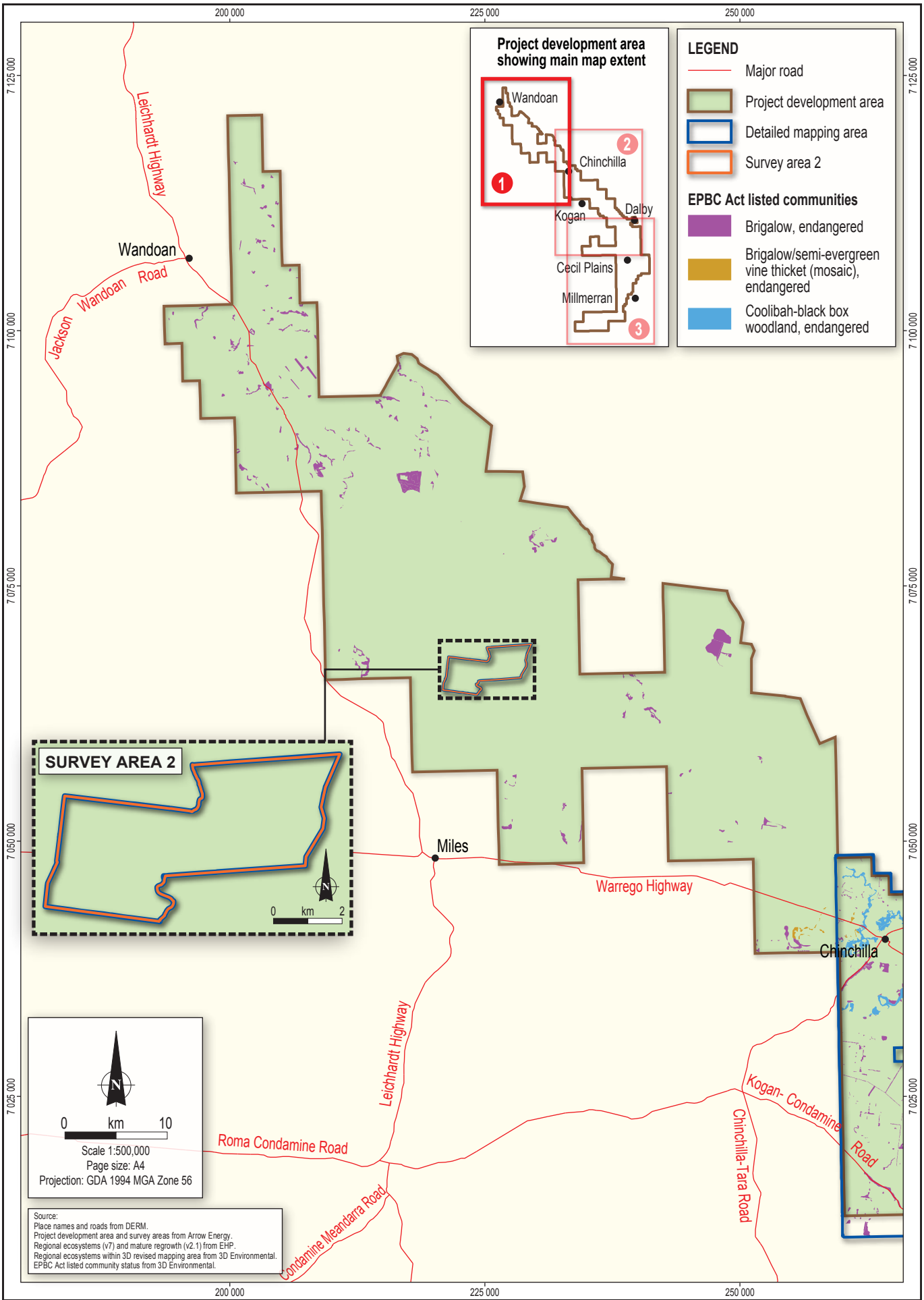
## 5.3 Listed Threatened Flora and Fauna Species

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

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

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

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.

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Date: 14.06.2013
MXD: 7040AE_12_GIS095_v1_1
File Name: 7040_12_ATT1_F05.02a_GIS_HB

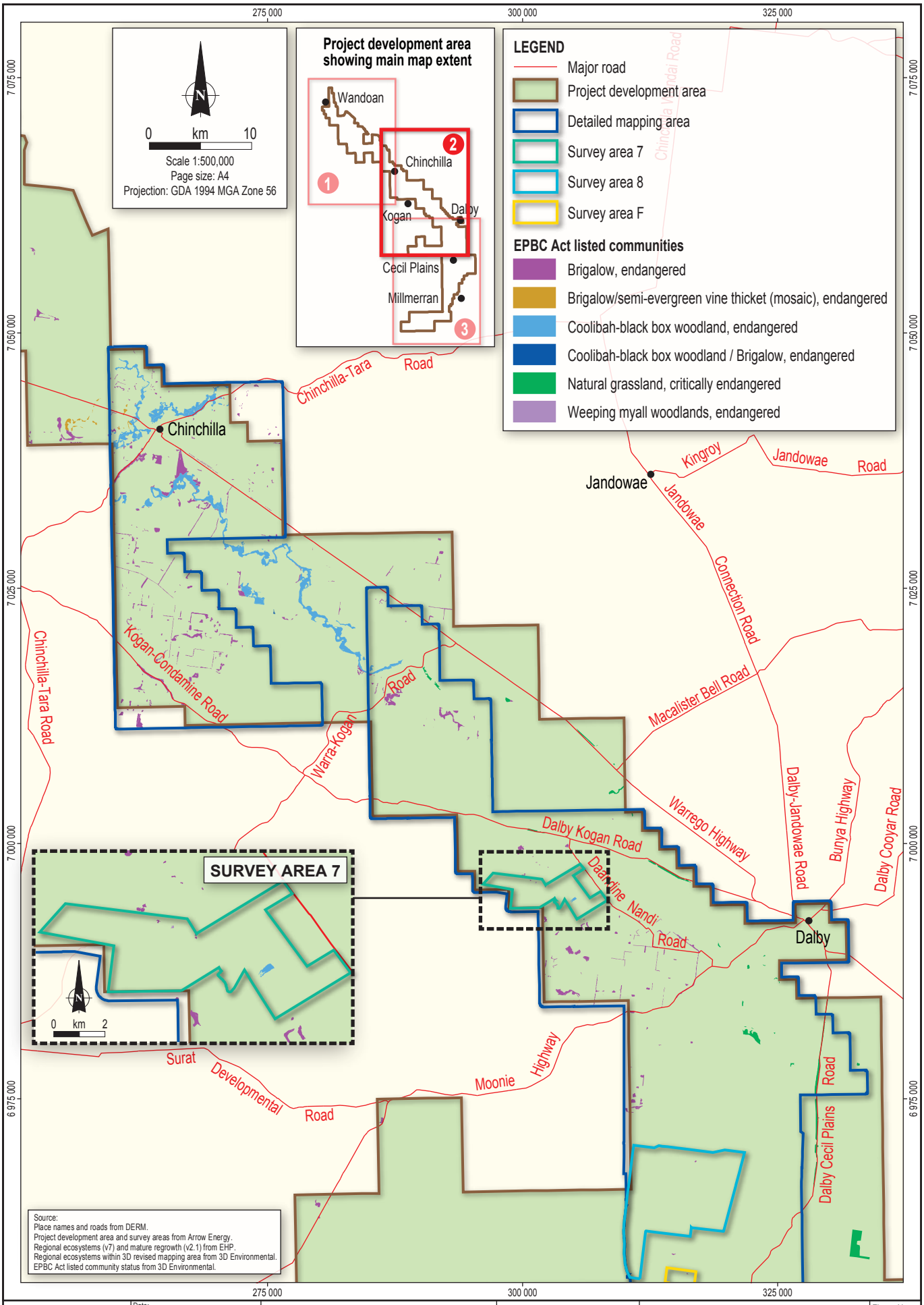
Arrow Energy

Surat Gas Project

arrow energy go further

# EPBC Act–listed threatened ecological communities (northern project development area), Map 1 of 3

Figure No: 5.2a

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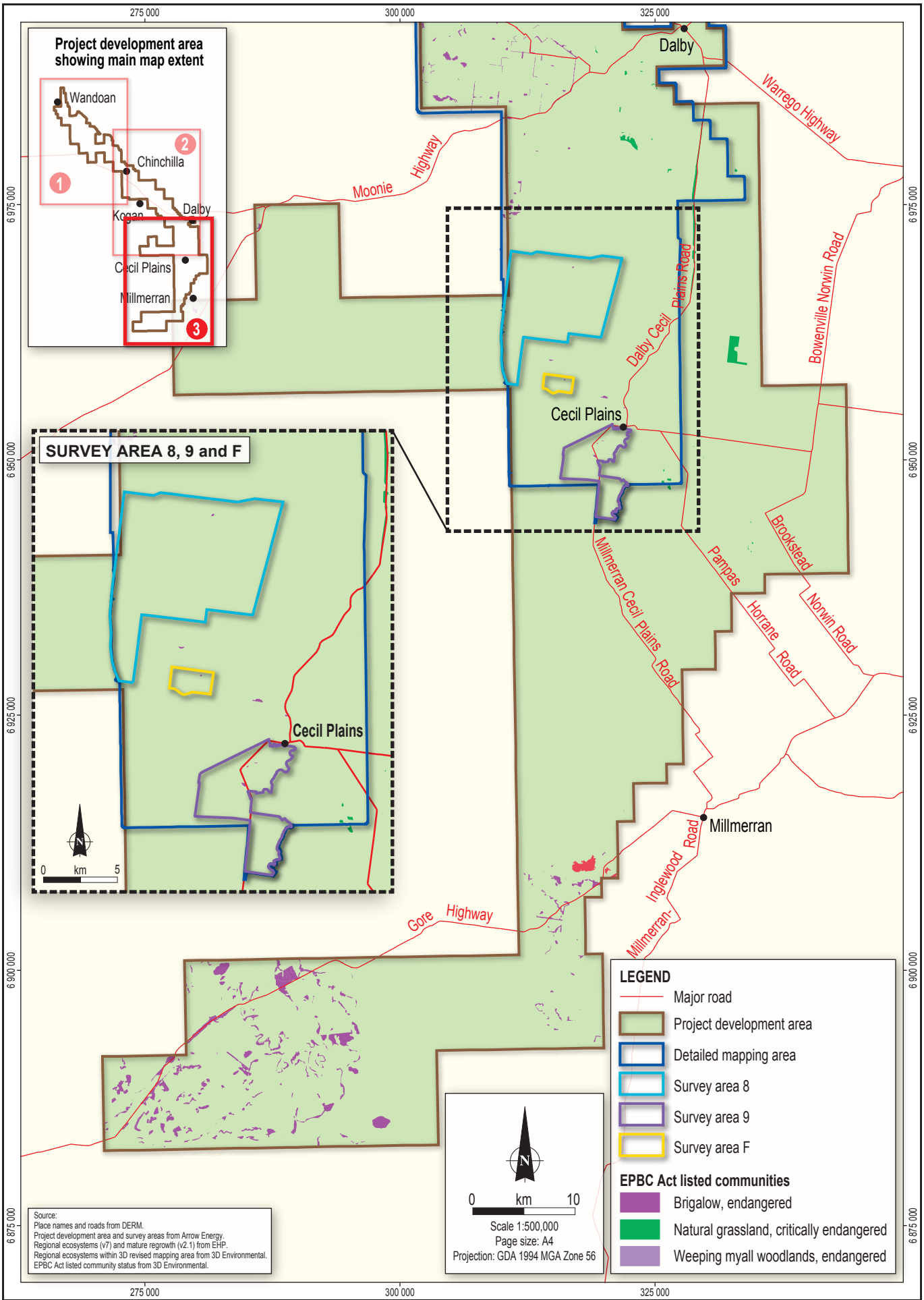
|---|---|---|---|---|---|
| coffey environments | Date: 18.06.2013<br>MXD: 7040AE_12_GIS096_v1_1<br>File Name: 7040_12_ATT1_F05.02b_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | EPBC Act–listed threatened ecological communities (central project development area), Map 2 of 3 | Figure No: 5.2b |

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Arrow Energy

Surat Gas Project

arrow energy go further

EPBC Act–listed threatened ecological communities (southern project development area), Map 3 of 3

Figure No: 5.2c

- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

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

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

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

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

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

The EPBC Protected Matters Search and additional database searches identified 32 EPBC Act listed threatened flora species and 31 EPBC Act listed threatened fauna species as being potentially present within the project development area and the 5 km buffer, based on their likelihood of occurrence according to the distribution of species and their habitats.

These listed species are identified as potentially occurring within the project development area with varying regularity. Some are restricted in extent and habitat (e.g., five-clawed worm-skink (*Anomalopus mackayi*)), while others are widely distributed (e.g., squatter pigeon (*Geophaps scripta scripta*)) and others are nomadic and most likely vagrant (e.g., Australian painted snipe (*Rostratula australis*)).

Other species were assessed within the literature review as being unlikely to occur within the study area, despite being identified within database searches. Following more detailed analysis, ten flora species and 19 fauna species were later excluded from the assessment as being unlikely to occur within the project development area.

Two EPBC Act listed flora species were recorded during the field surveys for the EIS; lobed blue-grass (*Bothriochloa biloba*) and Kogan wax flower (*Philotheca sporadica*). The record of Kogan wax flower was in a tenement which has since been relinquished by Arrow. No additional EPBC Act listed flora species were recorded during field surveys for the SREIS.

Two EPBC Act listed fauna species were recorded during the field surveys for the SREIS (none were recorded in EIS field surveys); the southeastern long-eared bat (*Nyctophilus corbeni*) and Murray cod (*Maccullochella peelii peelii*). Brigalow scaly-foot (*Paradelma orientalis*) was listed under the EPBC Act at the time of surveys but has since been delisted (as outlined in Section 3.2 of this attachment).

Table 5.2 and Table 5.3 summarise the listed threatened flora and fauna species along with their likelihood of occurrence within the project development area and their preferred habitat. Any MNES species that appears in database searches or the protected matters search for the Surat Gas Project, that were unlikely to be present in the project area based on being out of range or the lack of suitable habitat present, were discounted and dossiers for these species were not produced. A summary of these discounted species and the reasons for their omission from further assessment is presented in Section 5.5 of this attachment.

Detailed habitat requirements and ecology for each individual species likely to be present in the project development area, are provided in Appendix C of this attachment, along with an assessment of the likely impacts from the Surat Gas Project on the species. These impacts are also summarised in Section 9 of this attachment.

Figures 5.3a-c show locations of listed threatened flora and fauna species records in the study area from the field surveys completed to support the EIS and SREIS and spatially attributed records from database searches. Insets are shown on the figures of the five identified sites for project infrastructure (survey areas 2, 7, 8, 9 and survey area F) and species records on these properties, if located during fieldwork in early 2013.

Figures 5.4a-c show core habitat for the listed threatened flora and fauna species detailed in Appendix C. Insets are shown on the figures of the five identified sites for project infrastructure (survey areas 2, 7, 8, 9 and survey area F).

**Table 5.2 Listed threatened fauna species and their likelihood of occurrence, preferred habitat and location within the project development area**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Birds | | | | |
| Australian painted snipe[1] | *Rostratula australis* | 'Vulnerable' [2] | Present | The habitat within the project development area that might support this species includes waterbodies, particularly those with a mosaic of fringing vegetation and open mudflats. Probably restricted to Lake Broadwater, with records from this site, although it is not likely to have a regular presence within the project development area, appearing on a sporadic basis only. |
| Regent honeyeater | *Anthochaera phrygia* | 'Endangered' | Possible | The habitat for this species consists of dry eucalypt woodland and open forest, woodland, and rural and urban areas with mature eucalypts. This species favours box-ironbark associations. There are five known records of regent honeyeater within the project development area, with one record from Chinchilla and four records from Dalby. These records relate to transient individuals, and no known breeding populations are present. |
| Squatter pigeon (southern) | *Geophaps scripta scripta* | 'Vulnerable' | Present[3] | Squatter pigeons occur along the inland slopes of the Great Dividing Range west to Longreach and Charleville. The southern subspecies inhabits the southern portion of this range. The species is known to be present in the project development area, with records throughout, particularly in northern and central areas. Preferred habitat includes dry sclerophyll woodland with grassy understorey, nearly always near permanent water, and occasionally sown grasslands and pastures. |
| Mammals | | | | |
| South-eastern long-eared bat[4] | *Nyctophilus corbeni* | 'Vulnerable' | Present[5, 6] | This species is known to be present in the project development area, with a cluster of records approximately 30 km southwest of Millmerran and additional records near Miles. Preferred habitat includes dry open woodland (box or ironbark, savannah) and mallee, particularly riparian vegetation (river red gum (*Eucalyptus camaldulensis*), bull oak (*Allocasuarina luehmannii*), *belah* (*Casuarina cristata*) and cypress (*Callitris* spp.)) and vine thickets. |

**Table 5.2 Listed threatened fauna species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Fish | | | | |
| Murray cod, goodoo | *Maccullochella peelii peelii* | 'Vulnerable' | Present[6] | The species is known to exist in the general area and was recorded in SREIS field surveys at survey areas 2 and 9. Murray cod is known to be stocked as a recreational species. The watercourses within the Condamine River catchment and Lake Broadwater could provide habitat for the species. The species prefers waterways which are up to 5 m deep, with submerged logs and boulders, undercut banks and overhanging vegetation and is therefore often found in the main river channel and larger tributaries rather than in lower order channels. |
| Reptiles | | | | |
| Brigalow scaly-foot | *Paradelma orientalis* | 'Vulnerable' [7] | Present[6] | This species has been recorded previously within the project development area and was recorded in SREIS surveys. Largely restricted to the Brigalow Belt bioregion, it extends from approximately 200 km southwest of Charters Towers, south to Bendidee National Park and Eena State Forest. More prevalent in habitats that have few weeds with undisturbed ground surfaces and ground cracks or fallen debris or native tussock grasses. Most records occur in remnant habitats, but the species can also occur in young regrowth (two to three years old) and in modified habitats. |
| Dunmall's snake | *Furina dunmalli* | 'Vulnerable' | Present | This species has been historically recorded from Lake Broadwater and is also possible in other regions. Most records occur in remnant vegetation, including brigalow, open woodland and even tall forests. The species may occur in any woodland or forest vegetation type within the project development area, but it is probably absent from disturbed vegetation. This species is widely distributed and the project development area makes up only a portion of its distribution. The species is uncommon, difficult to locate and is encountered very sporadically. |

**Table 5.2 Listed threatened fauna species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Reptiles (cont'd) | | | | |
| Five-clawed worm-skink | *Anomalopus mackayi* | 'Vulnerable' | Present | The habitat within the project development area may support this species, and there are three known records from the project development area - two records from Dalby (to which the record may have been attributed based on it being the nearest town) and one from approximately 19 km east of Cecil Plains. The species prefers low open grassland with scattered trees to open grassy dry eucalyptus and callitris forest or woodland. RE 11.3.21 provides habitat for the species, which occurs as scattered remnants adjacent to stock routes in the Dalby area (Dalby Cecil Plains Road Significant Environmental Area). |
| Collared delma | *Delma torquata* | 'Vulnerable' | Present | This species ranges from Rockhampton in the north, south to Kenmore and inland to the Bunya Mountains. There are two known records of the species in the project development area, approximately 45 km southwest of Millmerran State Forest. Preferred habitat includes rocky areas associated with dry open eucalypt forests, though the species has been recorded from semi-evergreen vine thickets. |
| Darling Downs earless dragon[8] | *Tympanocryptis cf. tetraporophora* | 'Endangered' | Present | MNES database searches predict the presence of *Tympanocryptis cf. tetraporophora* within the project development area, with one known record 20 km east-southeast of Cecil Plains. RE 11.3.21 provides habitat for this species. The species is found predominantly between Toowoomba and Cecil Plains, within grasslands, including those on roadside verges. No known records west of Wilkie Creek. |
| Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle | *Rheodytes leukops* | 'Vulnerable' | Possible | The species was not recorded during field surveys; however, the database search indicates it could potentially be present within the northernmost section of the project development area within the Fitzroy drainage basin. The species occurs in rivers with a rock, gravel or sand substrate, with deep pools that are connected by shallow riffle zones. The small portion of the Fitzroy drainage basin in the project development area is not expected to provide suitable habitat for the species. |

**Table 5.2 Listed threatened fauna species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Reptiles (cont'd) | | | | |
| Yakka skink | *Egernia rugosa* | 'Vulnerable' | Possible | The yakka skink has a disjunct distribution, with isolated populations occurring from St George, north to Coen on the Cape York Peninsula. Habitat includes dry forests and woodlands, including poplar box alluvial soils, low ridges, cypress on sands, belah, mulga and gum-barked coolibah (*Eucalyptus intertexta*). There are no known records within the project development area however there are two records in proximity to the project development area approximately 20 km west of Chinchilla. |

1. Also listed as migratory (see Table 4.3).
2. Species upgraded to Endangered in April 2013 as discussed in Section 3.2, but after the project was declared a controlled action.
3. Upgraded from possible in EPBC referral to present.
4. Species known as greater long-eared bat in EIS .
5. Upgraded from possible in EIS to known in SREIS.
6. Identified during SREIS surveys.
7. Species delisted in April 2013 as discussed in Section 3.2 but retained in this assessment.
8. Species known as grassland earless dragon in EIS.

**Table 5.3 Listed threatened flora species and their likelihood of occurrence, preferred habitat and location within the project development area**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants | | | | |
| Austral toadflax, toadflax | *Thesium australe* | 'Vulnerable' | Present | This species is known from database records to be present in the project development area with three records to the north and west of Dalby. Preferred habitat includes roadside remnant and non-remnant grasslands and poplar box (*Eucalyptus populnea*) grassy woodlands on heavy soil alluvium. |
| Belson's panic | *Homopholis belsonii* | 'Vulnerable' | Present | This species is known to be present in the project development area from one historical record from Dogwood Creek north of Miles. There are existing HERBRECS records 4 km east of Dalby, in belah (*Casuarina cristata*) and yarran (*Acacia melvillei*) vegetation on grey to black alluvial soils. The Dalby to St George Stock Route is known to host significant populations of this plant. |
| Cobar greenhood orchid | *Pterostylis cobarensis* | 'Vulnerable' | Present | This species is known to be present in the project development area, from a single collection approximately 7 km north of Chinchilla on Auburn Road, with additional records to the north within Barakula State Forest. It usually occurs in localised populations and is known to occur in woodland of cypress pine, eucalypt woodland, open mallee, or cypress (*Callitris* spp. shrubland) on low stony ridges and slopes, among rocks on low hills, and on slopes above streams. |
| Curly-bark wattle | *Acacia curranii* | 'Vulnerable' | Present | This species has been recorded previously in the northwest of the project development area to the east of Gurulmundi. Suitable habitat includes dry sclerophyll forests and semi-arid woodlands where they may occur as widely scattered thickets in very species-rich healthy scrub with emergent eucalypts. |
| Finger panic grass | *Digitaria porrecta* | 'Endangered' | Present | This species is known from database records to be present in the project development area. Suitable habitat includes non-remnant derived grasslands on alluvium and cracking clays, native grasslands (RE 11.3.21), and eucalypt woodlands on heavy alluvial soils. |
| Hando's wattle, Percy Grant wattle | *Acacia handonis* | 'Vulnerable' | Possible[1] | Populations are known to occur approximately 10 to 20 km north of the project development area. There is potential for additional populations to be present within Barakula State Forest and in any suitable habitat adjoining the forest. |

**Table 5.3 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants (cont'd) | | | | |
| Tara wattle | *Acacia lauta* | 'Vulnerable' | Possible | This species is associated with sandy soils hosting ironbark woodland. Known populations have been mapped within REs 11.7.7, 11.7.4 and 11.7.5. The species is confined to a small region of the Darling Downs in southeast Queensland, between Inglewood and Tara, at its closest point 17 km from the project development area. Given the proximity of records to, and suitable habitat within, the project development area, its presence cannot be discounted. |
| Lobed blue-grass | *Bothriochloa biloba* | 'Vulnerable' | Present[2] | This species is present in the project development area. Existing database records indicate presence within the project development area in grasslands and woodland on alluvium. Existing records occur to the south of Miles and 10 km north of Cecil Plans on roadsides. |
| Machin's macrozamia[3] | *Macrozamia machinii* | 'Vulnerable' | Present | This species is known from database records to be present in the project development area in the southeastern parts in the Wondul Range, north of Inglewood. Habitat includes woodlands on undulating to hilly terrain at 300 to 500 m, with deep sandy soils, and on lateritic ridges. |
| Kogan wax flower[4] | *Philotheca sporadica* | 'Vulnerable' | Present[2] | This species is known from database records to be present in the project development area, and a number of discrete population clusters occur on the western margin of the project development area within the Braemar Creek catchment. Preferred habitat includes rocky lateritic and sandstone rises and low ridges in mixed eucalypt/callitris woodlands. |
| An unnamed mint-bush | *Prostanthera* sp. (Dunmore) | 'Vulnerable' | Present | This species is known from database records to be present in the project development area on the boundary between Wondul Range National Park and Badgery State Forest. Preferred habitat includes sandy soils on stony ridges, favouring areas amongst rocks. |
| Small-leaved denhamia | *Denhamia parvifolia* | 'Vulnerable' | Present[5] | Two records exist within the project development area southwest of Chinchilla. The preferred habitat for this species is remnant brigalow with a softwood species understorey or vine thicket elements (RE 11.3.1, 11.4.3, 11.5.16, 11.8.3, 11.9.4a, and 11.9.5), although it may occur in non-remnant vine thickets throughout the project development area. |

**Table 5.3 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

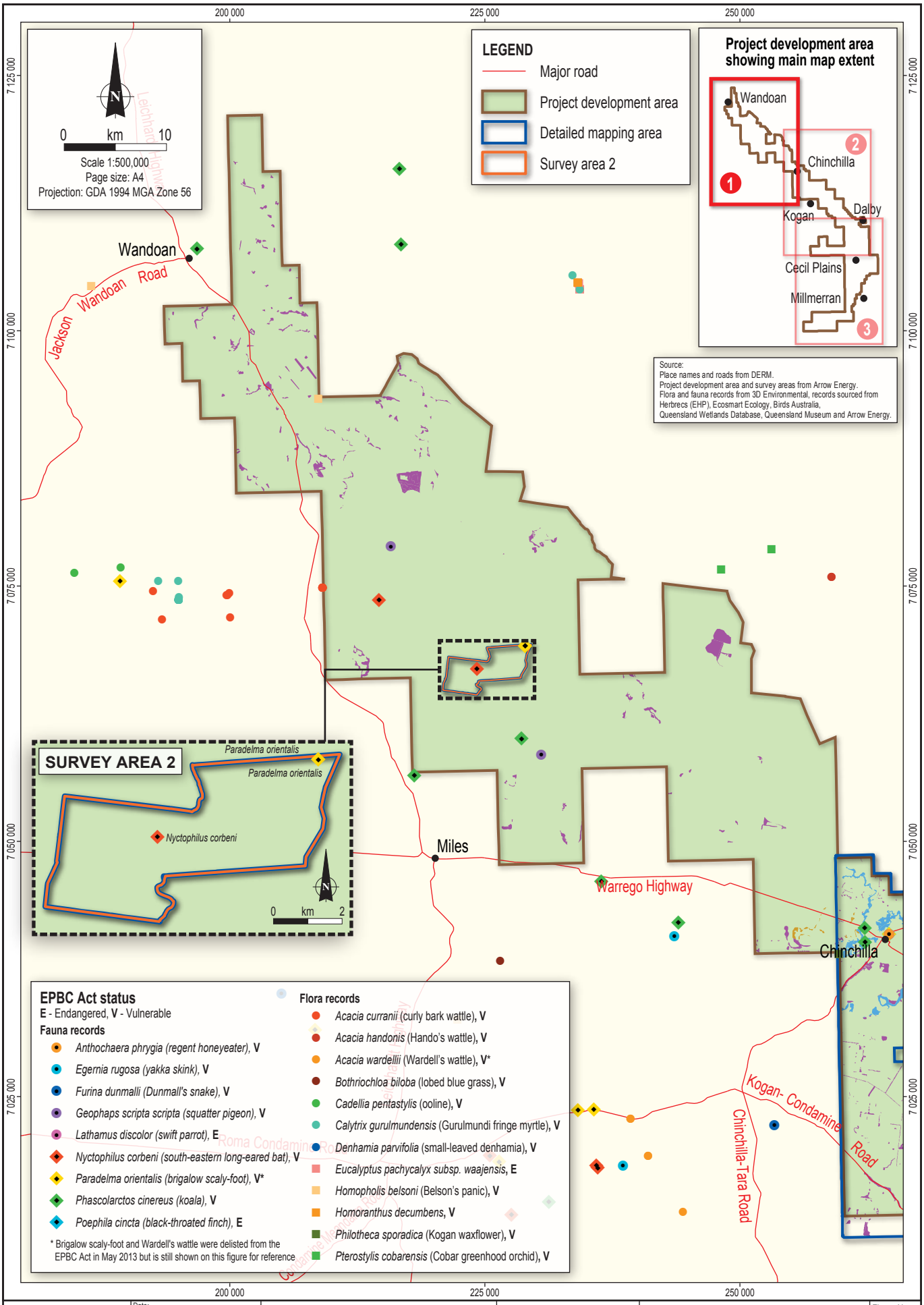
| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants (cont'd) | | | | |
| Xerothamnella[6] | *Xerothamnella herbacea* | 'Endangered' | Present | This species is known from database records to be present in the project development area, on the Millmerran-Goondiwindi road and 30 km east of Chinchilla. Preferred habitat is brigalow (*Acacia harpophylla*)/belah (*Casuarina cristata*) communities on alluvium or clay plains. |
| Hawkweed | *Picris evae* | 'Vulnerable' | Likely[7] | This species is known from database records to be present in the project development area on the Millmerran-Pittsworth Road, and is considered likely in the Dalby area. Preferred habitat includes eucalyptus open grassy woodland, Queensland blue grass (*Dichanthium sericeum*), and non-remnant roadsides, paddocks and cultivated areas. |
| An unnamed member of the Scrophulariaceae family | *Microcarpaea agonis* | 'Endangered' | Possible | The only known occurrence of this species is approximately 6 km outside of the project development area within RE 11.3.18 in the Boondandilla State Forest, approximately 55 km west of Millmerran. This species may occur in the project development area due to this population's close proximity to the area. This population is on the margins of a seasonally inundated swamp dominated by sedges, on sandy soil, consistent with RE11.3.27. |
| Austral cornflower, native thistle | *Rhaponticum australe* | 'Vulnerable' | Possible | This species could be present in the project development area. It is known from a large number of sites, ranging from Cania Gorge west of Gladstone, to Mount Moffat in the north, to Gatton in the south. It grows in eucalypt open forest with grassy understorey and native grasslands on roadsides and on road reserves with forest river gum (*Eucalyptus tereticornis*) and rough-barked apple (*Angophora floribunda*) on black clay soil. |
| Wardell's wattle[8] | *Acacia wardellii* | 'Vulnerable' [9] | Possible | This species is known from populations 20 to 30 km south-southwest of the project development area in addition to areas south of Roma, southwest of Chinchilla and in the Thomby Range in southeast Queensland. This species may occur along the western margins of the project development area south of the Condamine Kogan Road. |
| Gurulmundi fringe-myrtle[10] | *Calytrix gurulmundensis* | 'Vulnerable' | Possible | This species may occur in the northern parts of the project development area as there are records in the Waaje and Gurulmundi Wildflower areas in *Triodia* sp. grassland and shrubland approximately 10 km from the project development area. This species occurs in patches of shrubland on very shallow soils, in habitat consistent with RE 11.7.5. |

**Table 5.3 Listed threatened species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants (cont'd) | | | | |
| Ooline, scrub myrtle | *Cadellia pentastylis* | 'Vulnerable' | Possible | This species is recorded in brigalow open forest and fragmented softwood scrub vegetation in the Stones Country Resources Reserve West Gurulmundi area located west of the project development area. Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll vegetation, where it may be locally dominant in the canopy layer or occurring as an emergent. A population is also known from the Wiaga Creek area in southern portions of the project development area. However, herbarium records from this area date back to 1918, and the status of this population is not presently known. |
| Shiny-leaved ironbark | *Eucalyptus virens* | 'Vulnerable' | Possible[11] | This species has been recorded as far south as Inglewood and as far west as Mt Moffatt. It inhabits plateaux, sandstone escarpments or sandy soils on low rises. Suitable habitat does not exist within the project development area, although the proximity of records and suitable habitat makes the species possible. |
| King blue-grass | *Dichanthium queenslandicum* | 'Vulnerable'[12] | Possible | This species is known to occur from the Brigalow Belt North and South bioregions with records from the northern Darling Downs, Burnett, Leichhardt, South Kennedy and Mitchell pastoral districts. Potential habitats within the project development area are REs 11.3.2 and 11.3.21 and non-remnant derived grasslands on cracking clay. This species is unlikely to be present, as most records are from central Queensland over 150 km to the north, however, three old records 20 km from the project development area means the species cannot be discounted. |
| Queensland white gum, Queensland western white gum, lapunyah, scrub gum | *Eucalyptus argophloia* | 'Vulnerable' | Possible[13] | This species is known only from a small area northeast of Chinchilla. It grows on clay soils in association with brigalow (*Acacia harpophylla*) or grey box *(Eucalyptus microcarpa*) on flat terrain in areas that were formerly open forest. Database records indicate populations may occur north of the project development area on heavy alluvial soils. |

1. Downgraded from present in EPBC referral to possible.
2. Identified during EIS surveys.
3. Species known as an unnamed cycad in EIS.
4. Species known as small-leaved wax flower in EIS.
5. Upgraded from possible in EPBC referral to present.

6. Species known as an unnamed acanthus in EIS.
7. Downgraded from present in EPBC referral to likely.
8. Species known as an unnamed member of the Mimosaceae family in EIS.
9. Species delisted in May 2013 as discussed in Section 3.2 but retained in this assessment.
10. Species known as Gurulmundi heath-myrtle in EIS.
11. Upgraded from unlikely in EIS to possible in SREIS.
12. Species upgraded to Endangered in January 2013 as discussed in Section 3.2, but after the project was declared a controlled action.
13. Upgraded from unlikely in EPBC referral to possible.

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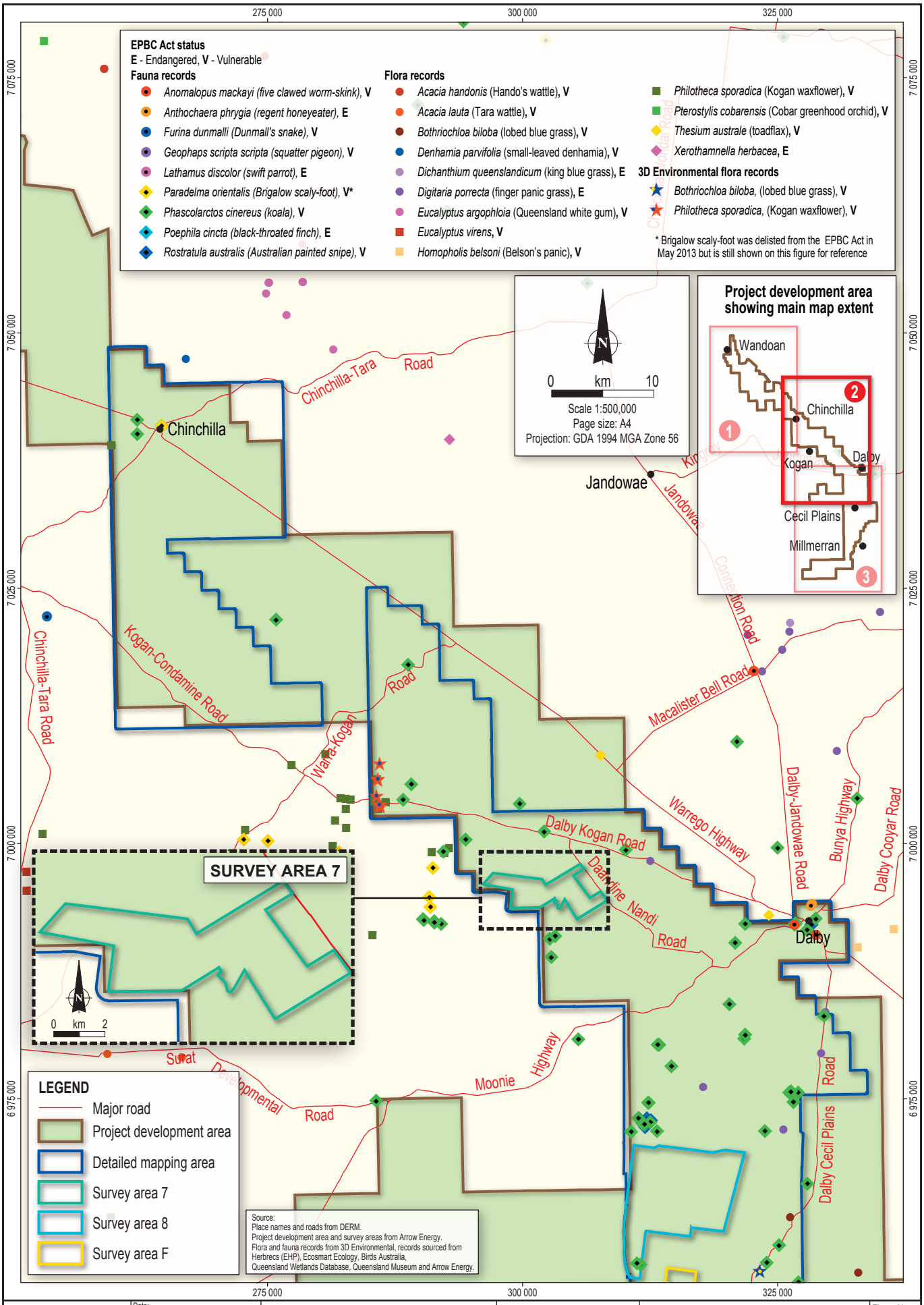
| coffey environments | Date: 18.06.2013<br>MXD: 7040AE_12_GIS098_v1_1<br>File Name: 7040_12_ATT1_F05.03a_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | EPBC Act–listed species records (northern project development area), Map 1 of 3 | Figure No: 5.3a |

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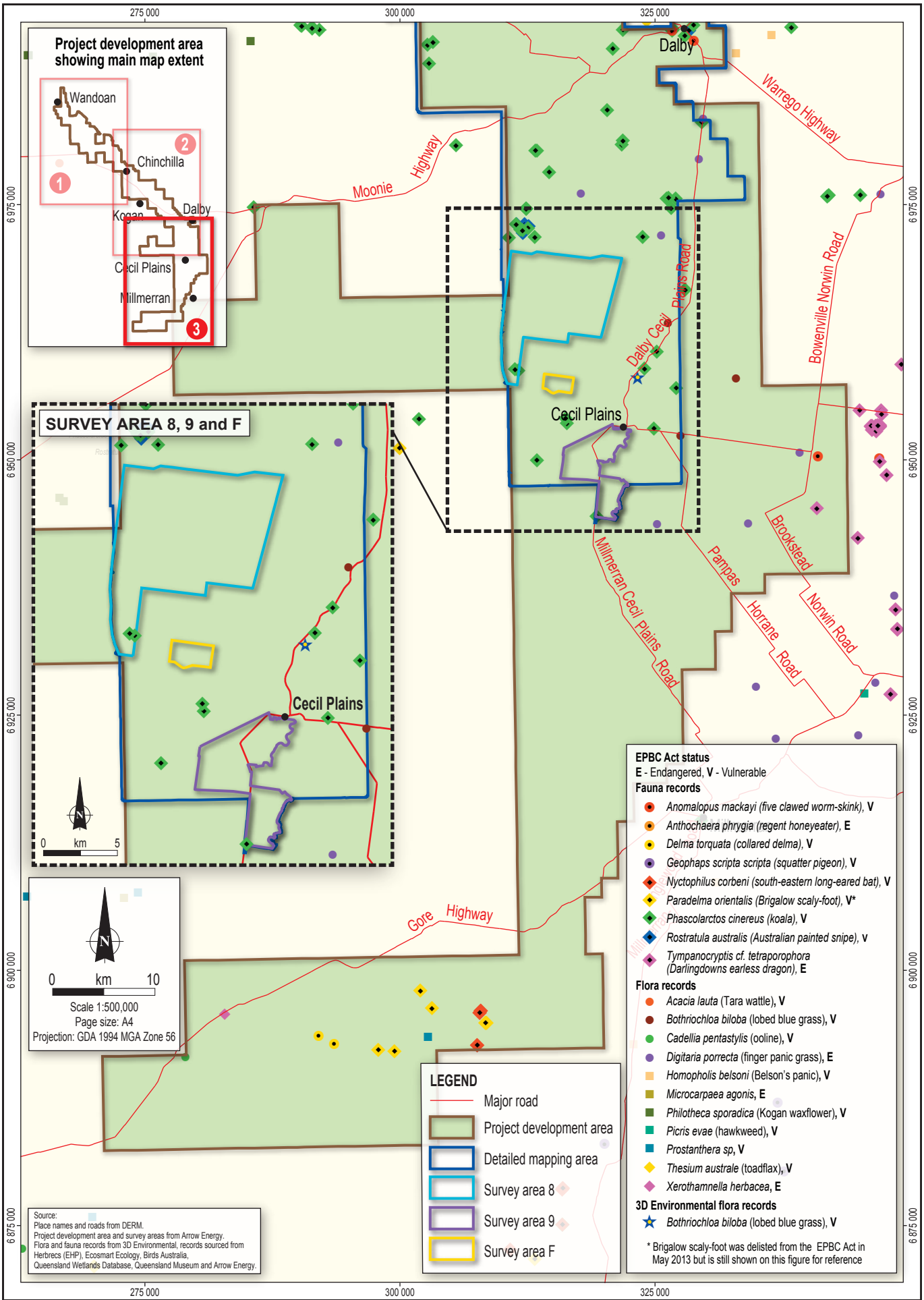
| coffey environments | Date: 18.06.2013<br>MXD: 7040AE_12_GIS099_v1_1<br>File Name: 7040_12_ATT1_F05.03b_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | EPBC Act–listed species records (central project development area), Map 2 of 3 | Figure No: 5.3b |




coffey environments

Date: 18.06.2013
MXD: 7040AE_12_GIS100_v1_2
File Name: 7040_12_ATT1_F05.03c_GIS_HB

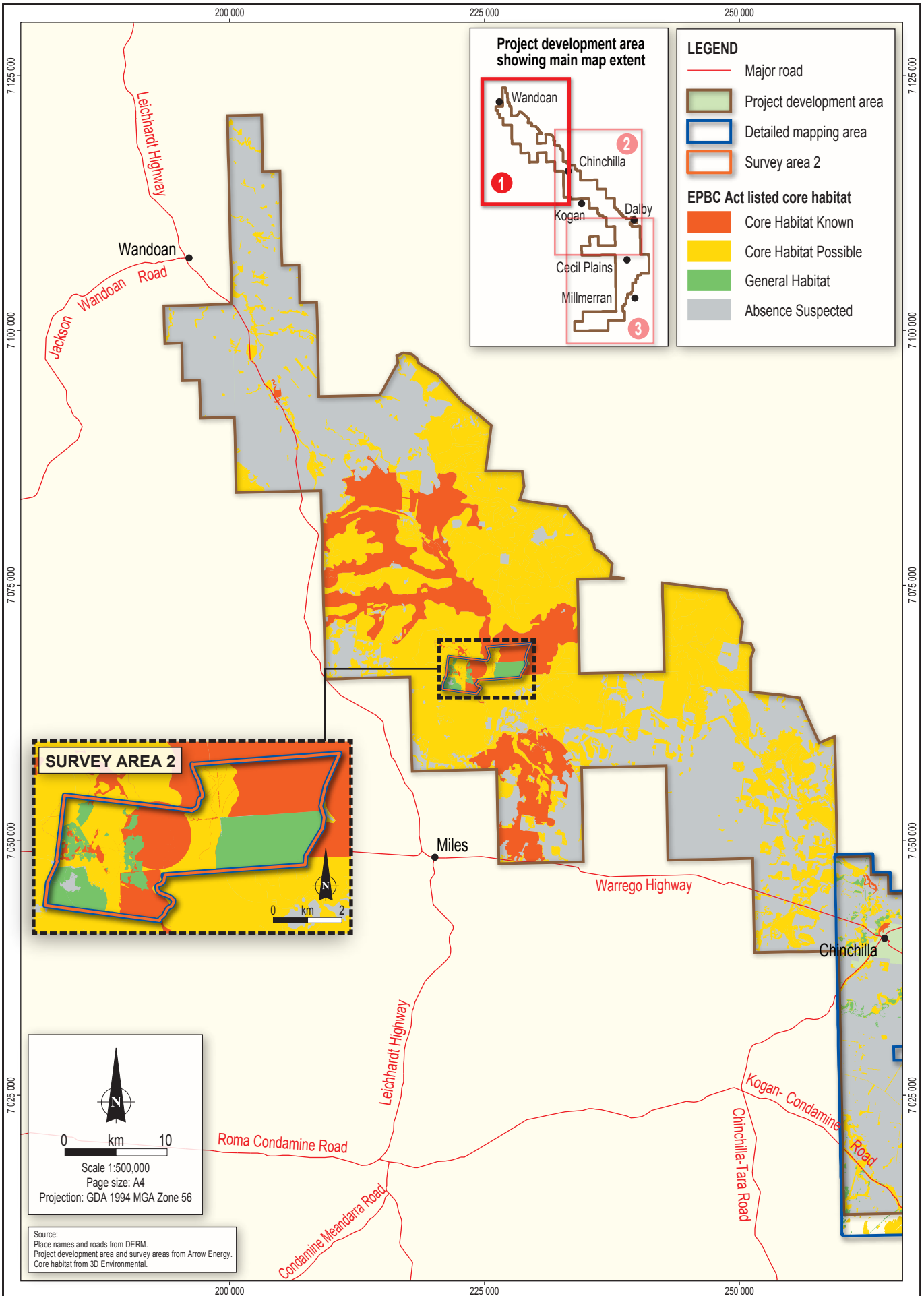
Arrow Energy

Surat Gas Project

arrow energy go further

EPBC Act–listed species records (southern project development area), Map 3 of 3

Figure No: 5.3c

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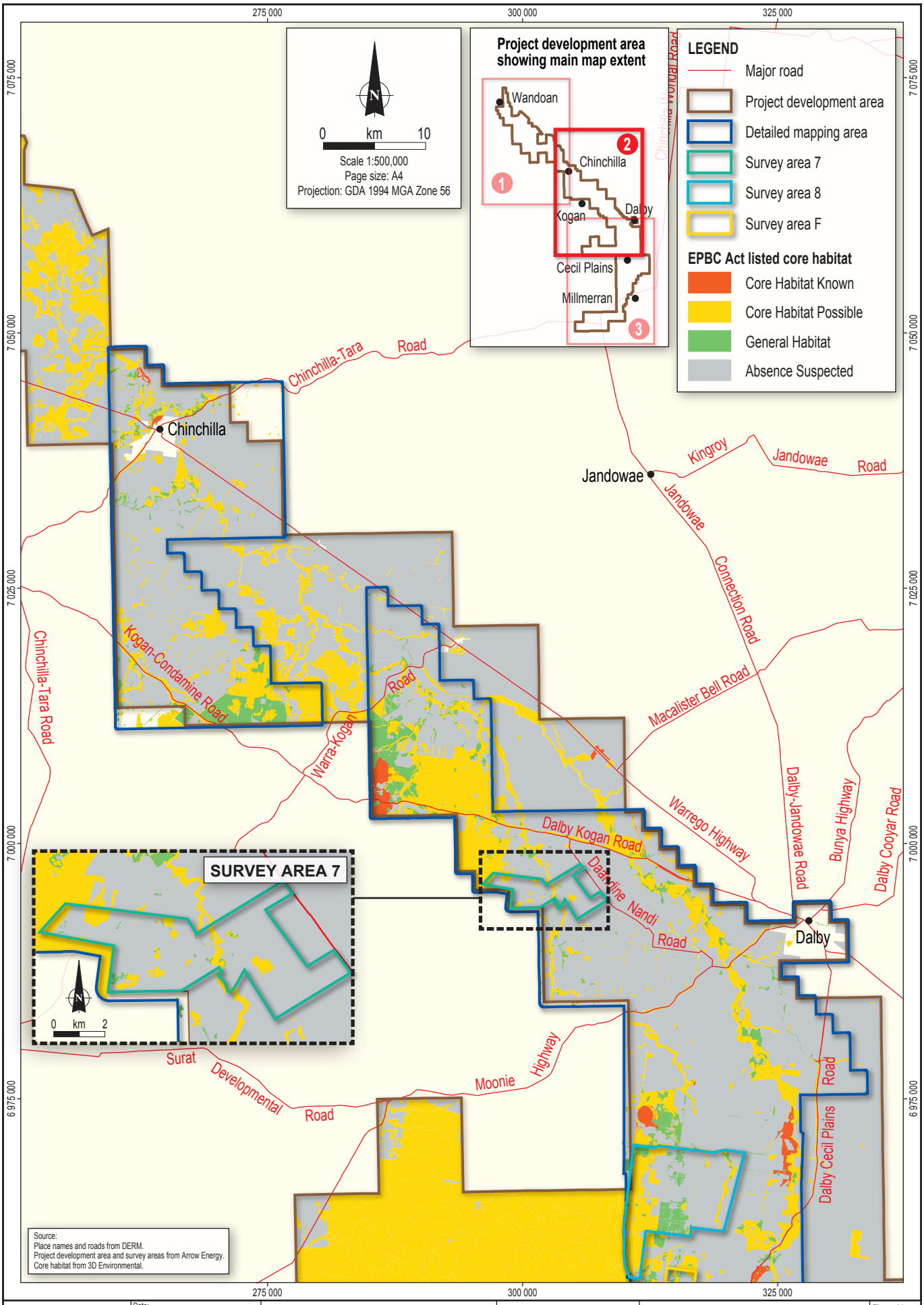
| coffey environments | Date: 14.06.2013<br>MXD: 7040AE_12_GIS101_v1_1<br>File Name: 7040_12_ATT1_F05.04a_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | Core habitat for EPBC Act–listed species (northern project development area), Map 1 of 3 | Figure No: 5.4a |

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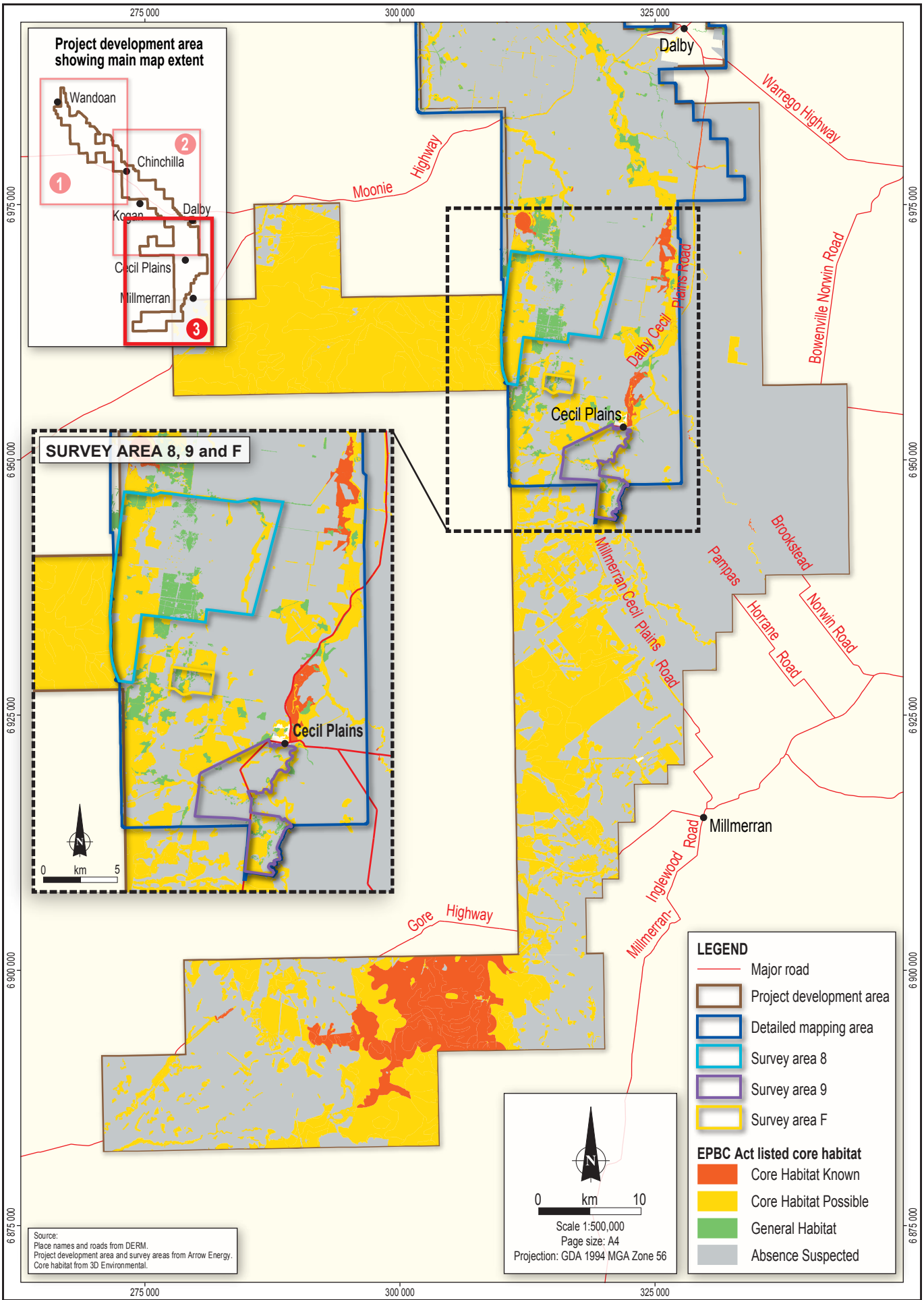
| coffey environments | Date: 18.06.2013<br>MXD: 7040AE_12_GIS102_v1_1<br>File Name: 7040_12_ATT1_F05.04b_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | Core habitat for EPBC Act–listed species (central project development area), Map 2 of 3 | Figure No: 5.4b |

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| coffey environments | Date: 14.06.2013<br>MXD: 7040AE_12_GIS103_v1_1<br>File Name: 7040_12_ATT1_F05.04c_GIS_HB | Arrow Energy<br>Surat Gas Project | arrow energy go further | Core habitat for EPBC Act–listed species (southern project development area), Map 3 of 3 | Figure No: 5.4c |

## 5.4 Listed Migratory Species

An action will require approval if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species listed below are also listed as threatened species. Species listed as threatened which are also listed as migratory (Australian painted snipe (*Rostratula australis*) and regent honeyeater (*Anthochaera phrygia*) are addressed in Appendix C of this attachment, and not discussed below.

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

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species.
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The EPBC Act Policy Statement 3.21 'Significant Impact Guidelines for 36 Migratory Shorebird Species' (DEWHA, 2009b) provides the framework for the assessment of potential impacts upon migratory shorebird species from the Surat Gas Project. The policy statement builds on the impact criteria listed above from EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance.

The policy statement is designed to help determine the impacts of proposed actions on migratory shorebird species, and to provide mitigation strategies to reduce the level or extent of those impacts. The policy aims to promote ecologically sustainable development that allows for the continued ecological functioning of important habitat for migratory shorebirds.

According to the guidelines, a site is considered to provide important habitat for migratory shorebirds if:

- The site is identified as internationally important.
- The site supports at least 0.1 per cent of the flyway population of a single species.
- The site supports at least 2,000 migratory shorebirds.
- The site supports at least 15 shorebird species.

The migratory shorebird policy statement outlines four principal threats to shorebirds within Australia. These threats are sourced from the criteria that should be considered when assessing impacts on migratory shorebirds from a project:

- Habitat Loss.
- Habitat Degradation.
- Disturbance.
- Direct Mortality.

The EPBC Protected Matters Search and other database searches identified 33 listed migratory species as being present or potentially present within the project development area:

- 11 migratory terrestrial bird species.
- 7 migratory wetland bird species.
- 15 migratory shorebird species.

Seven of these migratory species were recorded during the field surveys for the EIS or SREIS, the white-bellied sea-eagle (*Haliaeetus leucogaster*), white-throated needletail (*Hirundapus caudacutus*), great egret (*Ardea modesta*), rainbow bee-eater (*Merops ornatus*), spectacled monarch (*Symposiarchus trivirgatus*), rufous fantail (*Rhipidura rufifrons*) and Latham's snipe (*Gallinago hardwickii*).

All migratory species identified have been assessed as being known, probable or possible to occur based on previous records and the presence of suitable habitat within the project development area (see Table 5.4).

Some migratory species have Wildnet records within a 25 km radius of the centre of the five properties. This radius includes areas outside and inside the project development area. However, the records do not include specific locations and it is not possible to confirm records as being within the project development area. Species are consequently rated as probably or possibly occurring in the project development area or not known from Wildnet searches, dependent on the number of records and the ecology of each species. Only confirmed records from the EIS or SREIS field surveys are treated as 'known'.

A number of species have Wildnet records from the vicinity of the project development area although are unlikely to be present with any frequency, if at all. These species are rated as possibly occurring (Table 5.4), although more likely to be recorded as a rare vagrant only. One species, the garganey (*Anas querquedula*) although having no Wildnet or Birds Australia records in the vicinity of the project development area did appear in the EPBC referral search. The species is a very rare vagrant to Queensland and has been discounted from the assessment.

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Terrestrial Bird Species | | | | |
| Rainbow bee-eater[1] | *Merops ornatus* | Migratory | Present | The rainbow bee-eater is distributed across much of mainland Australia and occurs on several nearshore islands. It occurs mainly in open forests and woodlands, shrublands, and various cleared or semi-cleared habitats, including farmland and areas of human habitation. This species was recorded within the project development area during field surveys. It is common and widespread. |
| Rufous fantail[1] | *Rhipidura rufifrons* | Migratory | Present | The rufous fantail was recorded within the project development area during field surveys. The species prefers wet forests, of which there are none in the project development area. Transient individuals are present rather than permanent populations. |
| White-bellied sea-eagle[1] | *Haliaeetus leucogaster* | Migratory | Present | The white-bellied sea-eagle is known from previous records to occur in the project development area. It is likely to be restricted to areas such as Lake Broadwater and the Condamine River. |
| Eastern osprey | *Pandion cristatus* | Migratory | Possible | Eastern osprey occurs typically along the coastline of Australia, but can extend inland up major rivers or on large lakes. One Wildnet record from database searches. Any records in the project development area are likely to relate to vagrant individuals, and the species is likely to be a very rare visitor to the project development area. |
| Oriental Cuckoo | *Cuculus optatus* | Migratory | Possible | Oriental cuckoo occurs in rainforest, vine thicket and open forest and woodland in northern and eastern Australia in summer months, typically east of the Great Dividing Range. Any records in the project development area are likely to relate to vagrant individuals, and the species is likely to be a very rare visitor to the project development area. |
| Spectacled monarch[1] | *Symposiarchus trivirgatus* | Migratory | Present | The spectacled monarch is found predominantly along coastal northeast and eastern Australia occupying the understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation. These habitats are uncommon in the project development area. |
| White-throated needletail[1] | *Hirundapus caudacutus* | Migratory | Present | The white-throated needletail is recorded in all coastal regions of Queensland and New South Wales, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. It was recorded within the project development area during field surveys and is common and widespread. |

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Terrestrial Bird Species (cont'd) | | | | |
| Fork-tailed swift | *Apus pacificus* | Migratory | Probable | The fork-tailed swift is a non-breeding visitor to all states and territories of Australia. In Queensland, they are widespread west of the Great Divide, and they are commonly found west of the line joining Chinchilla and Hughenden. Preferred habitat includes inland plains, but they also occur above foothills or in coastal areas. A small number of records in the project development area and the species is unlikely to be a frequent visitor to the area. |
| Australian reed warbler | *Acrocephalus australis* | Migratory | Probable | Australian reed warbler prefers dense swamp vegetation in and adjacent to most wetland types. A number of records in the project development area and the species is likely to be restricted to reedy waterbodies such as Lake Broadwater. |
| Black-faced monarch | *Monarcha melanopsis* | Migratory | Probable | Black-faced monarch occurs along coastal northeast and eastern Australia. Prefers understorey of upland/lowland rainforests, thickly vegetated gullies and riparian vegetation. These habitats are uncommon in the project development area. A small number of records from the project development area and if present the species is likely to occur in small numbers on a transitory basis. |
| Satin flycatcher | *Myiagra cyanoleuca* | Migratory | Possible | In Queensland the satin flycatcher is widespread, although scattered in distribution. Found mostly in coastal areas however occasionally further west, this species is vagrant and is likely to be uncommon. Uncommon migrant to eastern Australia. Favours densely vegetated gullies in forests and tall woodlands. These habitats are uncommon in the project development area. A small number of records from the project development area and if present this species is likely to occur in small numbers on a transitory basis. |
| Migratory Shorebird Species | | | | |
| Latham's snipe, Japanese snipe[1] | *Gallinago hardwickii* | Migratory | Present | The range of Latham's snipe extends inland over the eastern tablelands in southeastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales. Preferred habitat includes open, freshwater wetlands with low, dense vegetation; however, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. This species is known from previous records and was recorded within the project development area during field surveys. |

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Shorebird Species (cont'd) | | | | |
| Curlew sandpiper | *Calidris ferruginea* | Migratory | Probable | In Queensland, scattered records of the curlew sandpiper occur in the Gulf of Carpentaria, with widespread records along the coast south of Cairns and sparsely scattered records inland. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater where the species may be present in small numbers. A number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Marsh sandpiper, little greenshank | *Tringa stagnatilis* | Migratory | Probable | The marsh sandpiper is widespread in coastal Queensland, but few records exist north of Cooktown. Preferred habitat includes permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats, as well as sewage farms and saltworks. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater where the species may be present in small numbers. A number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Wood sandpiper | *Tringa glareola* | Migratory | Possible | In Queensland, there are sparsely scattered records of wood sandpiper, generally around Cairns and further south. Preferred habitat is freshwater wetlands. There is suitable habitat within the project development area, but is likely to be restricted to Lake Broadwater. Only one Wildnet and Birds Australia record within the vicinity of the project development area. Species is likely to be a rare visitor only. |
| Sharp-tailed sandpiper | *Calidris acuminata* | Migratory | Probable | The sharp-tailed sandpiper is common both on intertidal and inland waters. Preferred habitat includes muddy edges of shallow fresh or brackish water. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater. A number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Bar-tailed godwit | *Limosa lapponica* | Migratory | Possible | The bar-tailed godwit is widespread along the east and southeast costs of Queensland, and usually prefers sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. It is also often found inland in small numbers. Only one Wildnet and Birds Australia record within the vicinity of the project development area. The species is likely to be a rare visitor only. |

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Shorebird Species (cont'd) | | | | |
| Black-tailed godwit | *Limosa limosa* | Migratory | Possible | The black-tailed godwit is mainly coastal and usually prefers sheltered bays, estuaries and lagoons with large intertidal mudflats or sandflats. It is also often found inland in small numbers. Only one Wildnet and Birds Australia record within the vicinity of the project development area and likely to be a rare visitor. |
| Pacific golden plover | *Pluvialis fulva* | Migratory | Possible | Widespread in coastal regions, the white-winged black tern it can be found far inland along major river systems, including the Darling Rivers and tributaries. Only one Wildnet record within the vicinity of the project development area and likely to be a rare visitor. |
| Common sandpiper | *Actitis hypoleucos* | Migratory | Possible | A scarce summer migrant to eastern Australia, the common sandpiper is known to inhabit the edges of rivers and streams from coastal areas to far inland. Only one Wildnet record within the vicinity of the project development area and likely to be a rare visitor. |
| Red-necked stint | *Calidris ruficollis* | Migratory | Possible | Distributed along most of Australia's coastland, the red-necked stint will move inland when conditions are suitable during times of temporary floodwaters. Likely to be scarce and only seen during times of passage through the area. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater where the species may be present in small numbers. A small number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Little curlew | *Numenius minutus* | Migratory | Possible | The little curlew is a vagrant species not common to the area. If found, it is likely to be on dry grasslands during times of passage. No Wildnet or Birds Australia records within the vicinity of the project development area and likely to be a very rare visitor. |
| Whimbrel | *Numenius phaeopus* | Migratory | Possible | Common along the coast of Queensland, the whimbrel is vagrant to the area and is only likely to be found during times of passage. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater. A small number of Wildnet and Birds Australia records within the vicinity of the project development area and the species is likely to be a rare visitor. |

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Shorebird Species (cont'd) | | | | |
| Oriental plover | *Charadrius veredus* | Migratory | Possible | Prefer short, dry grasslands but also occurs on claypans, sporting fields, lawns, around the margins of terrestrial wetlands. Only one Wildnet record within the vicinity of the project development area and likely to be a very rare visitor. |
| Ruff | *Philomachus pugnax* | Migratory | Possible | Ruff records are widely scattered at several locations throughout Queensland, this species likely to be found around wetlands and semi-temperate waterbodies. Vagrant species not common to the area. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater. Only one Wildnet record within the vicinity of the project development area and likely to be a very rare visitor. |
| Common greenshank, greenshank | *Tringa nebularia* | Migratory | Possible | In Queensland, the common greenshank is widespread in the Gulf country and eastern Gulf of Carpentaria. It has been recorded in most coastal regions, possibly with a gap between north Cape York Peninsula and Cooktown. Habitat preferences include a wide variety of inland and sheltered coastal wetlands, such as mudflats, saltmarshes and mangroves. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater where the species may be present in small numbers. A number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Migratory Wetland Bird Species | | | | |
| Great egret, white egret[1] | *Ardea modesta* | Migratory | Present | The great egret is widespread in Australia. Preferred habitat includes a wide range of wetland habitats, including inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial. This species was recorded within the project development area during field surveys. |
| White-winged black tern | *Chlidonias leucopterus* | Migratory | Possible | White-winged black tern are locally common around the Queensland coastline, this species is also found around inland waterbodies during seasonally favourable conditions. Presence likely to be limited to Lake Broadwater, although a scarce visitor to the project development area. |

**Table 5.4 Listed migratory species and their likelihood of occurrence, preferred habitat and location within the project development area (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Migratory Wetland bird Species (cont'd) | | | | |
| Glossy Ibis | *Plegadis falcinellus* | Migratory | Probable | Glossy ibis prefers inland freshwater wetlands with abundant aquatic flora. Suitable habitat within the project development area is likely to be restricted to Lake Broadwater and Long Swamp where the species may be present in small numbers. A number of Wildnet and Birds Australia records within the vicinity of the project development area. |
| Caspian tern | *Hydropogne caspia* | Migratory | Possible | Caspian tern is common around the Queensland coastline, this species is also found around inland waterbodies during seasonally favourable conditions. Presence likely to be limited to Lake Broadwater although no Wildnet records from the vicinity of the project development area. |
| Australian cotton pygmy-goose | *Nettapus coromandelianus albipennis* | Migratory | Probable | There are suitable freshwater waterbodies within the project development area to support the Australian cotton pygmy-goose. There are previous records from the general area. Suitable habitat within the vicinity of the project development area is likely to be restricted to Lake Broadwater where the species may be present in small numbers. |
| Cattle egret | *Ardea ibis* | Migratory | Probable | The cattle egret is widespread and common within Australia. Preferred habitat includes tropical and temperate grasslands, wooded lands and terrestrial wetlands. A small number of Wildnet and Birds Australia records within the vicinity of the project development area. |

1. Identified during EIS or SREIS field surveys.

Nearly half of the migratory species known to occur within the project development area are shorebird species, typical of estuarine habitats. These species are present in Australia during the northern hemisphere winter, although small numbers may occur during the rest of the year. These species may occur at Lake Broadwater and other permanent and semi-permanent watercourses, which are likely to provide suitable habitat for listed migratory species. Away from Lake Broadwater, the likelihood of important populations of any listed migratory species being present within the project development area has been assessed as low or very low.

Detailed habitat requirements and ecology of each individual species are provided in the Terrestrial Ecology Impact Assessment (Appendix K of the EIS). An update to the assessment following significant impact criteria for migratory species under the EPBC Act is provided in Appendix C of this attachment.

## 5.5 Species Discounted from Further Assessment

Desktop work undertaken for the supplementary terrestrial ecology and aquatic ecology studies facilitated the development of species dossiers on threatened species (flora and fauna) likely to be present within the project development area. The dossiers present a detailed analysis of the ecology of each species in question, related to the activities of the Surat Gas Project. This includes status, species ecology, distribution and breeding, threats, and occurrence in the region including any identified important populations or areas of core 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. The dossiers are contained in Appendix C of this attachment.

Any MNES species that appears in database searches or the protected matters search for the Surat Gas Project, that were unlikely to be present in the project area based on being out of range or the lack of suitable habitat present, were discounted, as discussed in Sections 5.3 to 5.4 and dossiers for these species were not produced. A summary of these discounted species and the reasons for their omission from further assessment, is presented in Table 5.5 and Table 5.6.

**Table 5.5 Fauna species discounted from the assessment of impacts on MNES**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Birds | | | | |
| Black-breasted button-quail | *Turnix melanogaster* | 'Vulnerable' | Unlikely | This species is restricted to coastal and near-coastal regions of southeastern Queensland and northeastern New South Wales. The main populations occur within southeast Queensland. Preferred habitat includes drier low closed forests, particularly semi-evergreen vine thicket, low microphyll vine forest, araucarian microphyll vine forest and araucarian notophyll vine forest. No known habitat within the project development area and no confirmed records from the area. |
| Red goshawk | *Erythrotriorchis radiatus* | 'Vulnerable' | Unlikely | This species is sparsely dispersed across coastal and subcoastal Australia, from western Kimberley Division to northeastern New South Wales, and occasionally on continental islands. Habitat includes coastal and subcoastal areas in wooded and forested lands of tropical and warm-temperate Australia.<br>Only two pre-1979 records of low spatial precision from the general area are known. The sparsity of records indicates this would only be a vagrant species in the area.<br>The project area is on the edge of the species range and with an estimated 100-140 pairs remaining in Queensland it is unlikely to be an area frequented by red goshawk. |
| Star finch (eastern), star finch (southern) | *Neochmia ruficauda ruficauda* | 'Endangered' | Unlikely | This species is believed to extend north to Bowen, west to beyond Winton and, based on recent records, south to near Wowan. It occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water. No confirmed records of this species within the project development area.<br>There has been no definite record of the nominate race since 1995 and although the population is estimated at less than 50 individuals it may be extinct. Presumed locally extinct and therefore unlikely to occur in the project development area. |
| Superb parrot | *Polytelis swainsonii* | 'Vulnerable' | Unlikely | This species occurs only in southeastern Australia. Vagrants have also been recorded in southern Queensland. It mainly inhabits forests and woodlands dominated by eucalypts. Records from the early 1900s are doubtful. No recent records in the project development area. |

**Table 5.5 Fauna species discounted from the assessment of impacts on MNES (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Birds (cont'd) | | | | |
| Swift parrot | *Lathamus discolor* | 'Endangered' | Unlikely | Records from southern Queensland have come from the Gold Coast, Noosa, Toowoomba, Warwick and Lockyer Valley areas and records from southeastern South Australia have come from the Bordertown-Naracoorte area. Habitat includes dry sclerophyll eucalypt forests and woodlands and occasionally wet sclerophyll forests. No recent (1980+) records of this species found within the project development area. Three pre-1965 records of low spatial precision from the general area. A migratory species that spends very little time in Queensland. Any possible current or future occurrence would be of vagrant individuals; these would be considered very rare. |
| Australasian bittern | *Botaurus poiciloptilus* | 'Endangered' | Unlikely | Historical records of the Australasian bittern occur near the project development area. One is from near the Condamine River north of the town Condamine. The other is from Chinchilla, which is within the area, though excised.<br>Today, this species is rarely recorded in Queensland, and possibly survives only in protected areas such as the Cooloola and Fraser regions.<br>Any occurrence in the project development area highly unlikely and would be of vagrant individuals. |
| Plains wanderer | *Pedionomus torquatus* | 'Vulnerable' | Unlikely | One un-dated (likely pre-1980) record from the project development area. The area is well outside of the core range of the species and only just borders the range of the species. Little or no suitable habitat is available in the project development area. It is considered that the record is either a vagrant individual or possibly an erroneous record. |
| Black-throated finch | *Poephila cincta* | 'Endangered' | Unlikely | One 1885 record from the project development area. The subspecies cincta is extinct in most places south of the Burdekin River and is now considered to extend southwards only as far as the upper Burdekin River basin over 500 km north. Presumed to be locally extinct. |
| Mammals | | | | |
| Brush-tailed rock-wallaby | *Petrogale penicillata* | 'Vulnerable' | Unlikely | Three post-1980 records from the project development area and known only from Wondul Range. As of 2008, this population was thought to be extinct. |

**Table 5.5 Fauna species discounted from the assessment of impacts on MNES (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Mammals (cont'd) | | | | |
| Spotted-tailed quoll | *Dasyurus maculatus maculatus* | 'Endangered' | Unlikely[1] | The spotted-tailed quoll (*Dasyurus maculatus maculatus*) is known to inhabit a variety of forested habitats, and may bepresent in the project development area within vine thickets, and dry sclerophyll forests.<br>The current status of this species in the Brigalow Belt is uncertain, with the last record of this species in 1990. The Granite Belt and the Border Ranges are the only regions in Queensland where this subspecies is still recorded regularly. Probably locally extinct. |
| Large-eared pied bat, large pied bat | *Chalinolobus dwyeri* | 'Vulnerable' | Unlikely | The species' current distribution is poorly known. Records exist from Shoalwater Bay, north of Rockhampton, through to the vicinity of Ulladulla, New South Wales, in the south. Habitat includes sandstone cliffs, fertile woodland valleys, rainforest and moist eucalypt forest at high elevation.<br>There is one record of the large-eared pied bat within 25 km of the project development area (within western Creek State Forest, northwest of Wondul National Park). In Queensland, the species occurs in areas with extensive cliffs and caves in the central Queensland sandstone belt. There is no suitable habitat in the project development area and the species is very unlikely to be present. |
| Northern quoll | *Dasyurus hallucatus* | 'Endangered' | Unlikely | The northern quoll (*Dasyurus hallucatus*) is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Cooktown in Queensland and as far west into central Queensland as the vicinity of Carnarvon Range National Park. Preferred habitat includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert.<br>The northern quoll was noted in database searches as an EPBC predictive result only. No known specimen or observation records. The species range is not in proximity to the project development area and it is unlikely to be present. |
| Long-nosed potoroo | *Potorous tridactylus tridactylus* | 'Vulnerable' | Unlikely | The long-nosed potoroo was noted in database searches as an EPBC predictive result only. No known specimen or observation records. In Queensland this species is generally found within 50 km of the coast and in areas with rainfall exceeding 750 mm per annum. |

**Table 5.5 Fauna species discounted from the assessment of impacts on MNES (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Mammals (cont'd) | | | | |
| Grey-headed flying-fox | *Pteropus poliocephalus* | 'Vulnerable' | Unlikely | The grey-headed flying-fox was noted in database searches as an EPBC predictive result only. Vagrant west of the Great Dividing Range. No known specimen or observation records. |
| Koala | *Phascolarctos cinereus* | 'Vulnerable' | Unlikely | Known to occur within the project development area, but listed after the Surat Gas Project was referred. This species has therefore not been the subject of detailed assessment (see Section 3.2). |
| Amphibians | | | | |
| Giant barred frog | *Mixophyes iteratus* | 'Endangered' | Unlikely | Within the bioregion, this species was known only from the Bunya Mountains and is now thought to be extinct in this location. The project development area does not encompass this location, or other areas of suitable habitat. |
| Fish | | | | |
| Australian lungfish | *Neoceratodus forsteri* | 'Vulnerable' | Unlikely | Australian lungfish is restricted to southeast Queensland, occurring east of the Great Dividing Range. It requires still or slow-flowing, shallow, vegetated pools with clear or turbid water. The species has been translocated and persists at a number of sites. It was translocated to the Condamine River in the late 1800s (21 fish) but did not persist and is almost certainly no longer present. |
| Reptiles | | | | |
| Bell's turtle, Namoi River turtle, Bell's saw-shelled turtle | *Elseya belli* | 'Vulnerable' | Unlikely | In Queensland, this species is only known from Bald Rock Creek more than 150 km from the project development area. No known specimen or observation records. The species range is not in proximity to the project development area and it is unlikely to be present. |
| Border thick-tailed gecko | *Uvidicolus (Underwoodisaurus) sphyrurus* | 'Vulnerable' | Unlikely | This species is known to occur north to Durikai State Forest, which is south of the project development area (80 km). There is no known specimen or sighting to suggest this species might occur within the project development area. |
| Ornamental snake | *Denisonia maculata* | 'Vulnerable' | Unlikely | The nearest known record of ornamental snake is 160 km to the north of the project development area, with known populations of this species occurring south to the Dawson River valley. There is no known specimen or sighting to suggest this species might occur in the project development area. |

1. Downgraded from possible in EIS to unlikely in SREIS.

**Table 5.6 Flora species discounted from the assessment of impacts on MNES**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants | | | | |
| An unnamed member of the Sterculiaceae family | *Commersonia argentea* | 'Vulnerable' | Unlikely | This species occurs from near Injune and west along the Great Dividing Range towards Tambo in central Queensland. Its distribution overlaps with:<br>• Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions.<br>• The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.<br>• Bluegrass (*Dichanthium* spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South).<br>• Brigalow (*Acacia harpophylla* dominant and co-dominant).<br>• White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.<br>No records within the 25 km buffer of the project development area boundary, with the nearest record in the vicinity of Kragra, 45 km to the northeast. Major population known from Kadarga 80 km northeast of project development area. The species is unlikely to occur based on the lack of previous records, and marginal habitat being present. |
| Tall velvet sea-berry | *Haloragis exalata* subsp. *velutina* | 'Vulnerable' | Unlikely | This species occurs from near Kempsey, north to Carnarvon National Park inland of Bundaberg. It occurs in rainforest and rainforest margins and adjacent grassland and open grassy woodland above 500 m altitude.<br>All collection records from Bunya Mountains 60 km northeast of Dalby where it occurs in moist open forests, often on vine forest margins. The habitat in the project development area is unsuitable for the species and it is unlikely to occur. |
| An unnamed member of the Asclepiadaceae family | *Tylophora linearis* | 'Endangered' | Unlikely | This species grows in dry scrub, open forest and woodlands. Database records indicate the habitat and range of this species occur outside the project development area.<br>No records in study area. The nearest reported collection is from Glenmorgan 100 km west of study area. This species is unlikely to occur due to a lack of suitable habitat in the project development area. |

**Table 5.6 Flora species discounted from the assessment of impacts on MNES (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants (cont'd) | | | | |
| An unnamed member of the Lamiaceae family | *Westringia parvifolia* | 'Vulnerable' | Unlikely | This species is known from a small area near Yelarbon and Inglewood in southeast Queensland. It grows with mallee box (*Eucalyptus bakeri*) and green mallee (*E. viridis*) and between clumps of spinifex (*Triodia* sp.) on sandy and stony soils.<br>Three low precision records (+16 km) located near Inglewood 25 km south of project development area. These collections from 1948, 1910 and 1908 are all historical and poorly confined spatially. Suitability of habitat in the project development area is marginal. The species is unlikely to occur based on the lack of previous records, and marginal habitat being present. |
| Wandering pepper-cress | *Lepidium peregrinum* | 'Endangered' | Unlikely | This species occurs in scattered refugia in northeastern New South Wales and southeastern Queensland. Historically it was recorded from the Blue Mountains, northeastern New South Wales and southeastern Queensland.<br>Major population in the Bunya Mountains 60 km north east of Dalby where it is associated with moist, disturbed location. A single specimen is shown to occur 60 km southwest of Dalby, approximately 35 km north west of project development area on roadside margins. The description of the collection reads as Mount Glorious and it is possibly erroneous. This specimen is not included in Herbrecs collections. The species is unlikely to occur based on the lack of previous records, and marginal habitat being present. |
| An unnamed member of the myrtle family | *Homoranthus decumbens* | 'Endangered' | Unlikely | Five Herbrecs records all from the Waaje Scientific area, 16 km northeast of the project development area where the species occurs on sandy soils within shrubland RE11.7.5. Habitat within the project development area is marginally suitable for the species. The localised, highly endemic nature of the known population, suggests that the species is unlikely to occur in the project development area. |
| An unnamed cycad | *Macrozamia conferta* | 'Vulnerable' | Unlikely | The nearest record for this species is 25 km south-southeast of Millmerran. Although the precise locality is not provided in the record, it indicates the species occurs well outside the project development area. The species is unlikely to occur based on the lack of previous records, and marginal habitat being present. |

**Table 5.6 Flora species discounted from the assessment of impacts on MNES (cont'd)**

| Species | | EPBC Act Status | Likelihood of Occurrence | Location and Preferred Habitat |
|---|---|---|---|---|
| **Common Name** | **Scientific Name** | | | |
| Plants (cont'd) | | | | |
| Siah's backbone | *Streblus pendulinus* | 'Endangered' | Unlikely | The species is endemic to Norfolk Island. It is not listed in the Census of Queensland Flora where it is recognised as *Streblus brunonianus*. This species is found in rainforest habitat which is not present within the project development area. |
| Salt pipewort | *Eriocaulon carsonii* | 'Endangered' | Unlikely | The Surat Underground Water Impact Report (OGIA, 2012) prepared by the Queensland Water Commission identified listed fauna and flora species associated with spring complexes within the Surat Basin.<br>*Eriocaulon carsonii* was identified to be associated with a spring complex (situated outside of the project development area) (Figure 8-2 of the OGIA report) with a relationship to groundwater systems potentially impacted by the Surat Gas Project.<br>The spring is located outside of the project development area 35 km from the boundary and will not be directly impacted by project related activities.<br>The relationship of the spring complex with potentially affected groundwater systems is described in the groundwater assessment of the SREIS (Chapter 8, Groundwater). Should modelling show a significant change in spring function that could potentially impact vegetation communities and associated species, Arrow will need to determine the required action through the Spring Impact Mitigation Strategy.<br>The nearest confirmed record of *Eriocaulon carsonii* is located 50 km northeast of the project development area in the Taroom district.<br>Species associated with groundwater dependent ecosystems are discussed further in Section 5.5.1. |
| Hairy-joint grass | *Arthraxon hispidus* | 'Vulnerable' | Unlikely | |
| Lesser swamp-orchid | *Phaius australis* | 'Endangered' | Unlikely | |

### 5.5.1 Groundwater Dependent Ecosystems and Species

Spring complexes and groundwater dependent ecosystems were discussed in Chapter 14 of the EIS, Groundwater, Section 14.3.3 as well as within EIS technical studies Appendix G, Groundwater Impact Assessment, and Appendix K, Terrestrial Ecology Impact Assessment.

Appendix K of the EIS, Terrestrial Ecology Impact Assessment, Section 6.8.6 states that there are no known groundwater dependant ecosystems in the project development area.

Groundwater dependent ecosystems are recognised in Queensland in discharge areas of the Great Artesian Basin, and not located in Tertiary aquifers (younger geological units associated with overlying fluvial and alluvial sediments), as part of regional ecosystems 2.3.39, 4.3.22 and 6.3.23 which are listed as Endangered under the VM Act. These regional ecosystems are not present in the project development area and were not found to be present during field investigations (Unpublished Report).

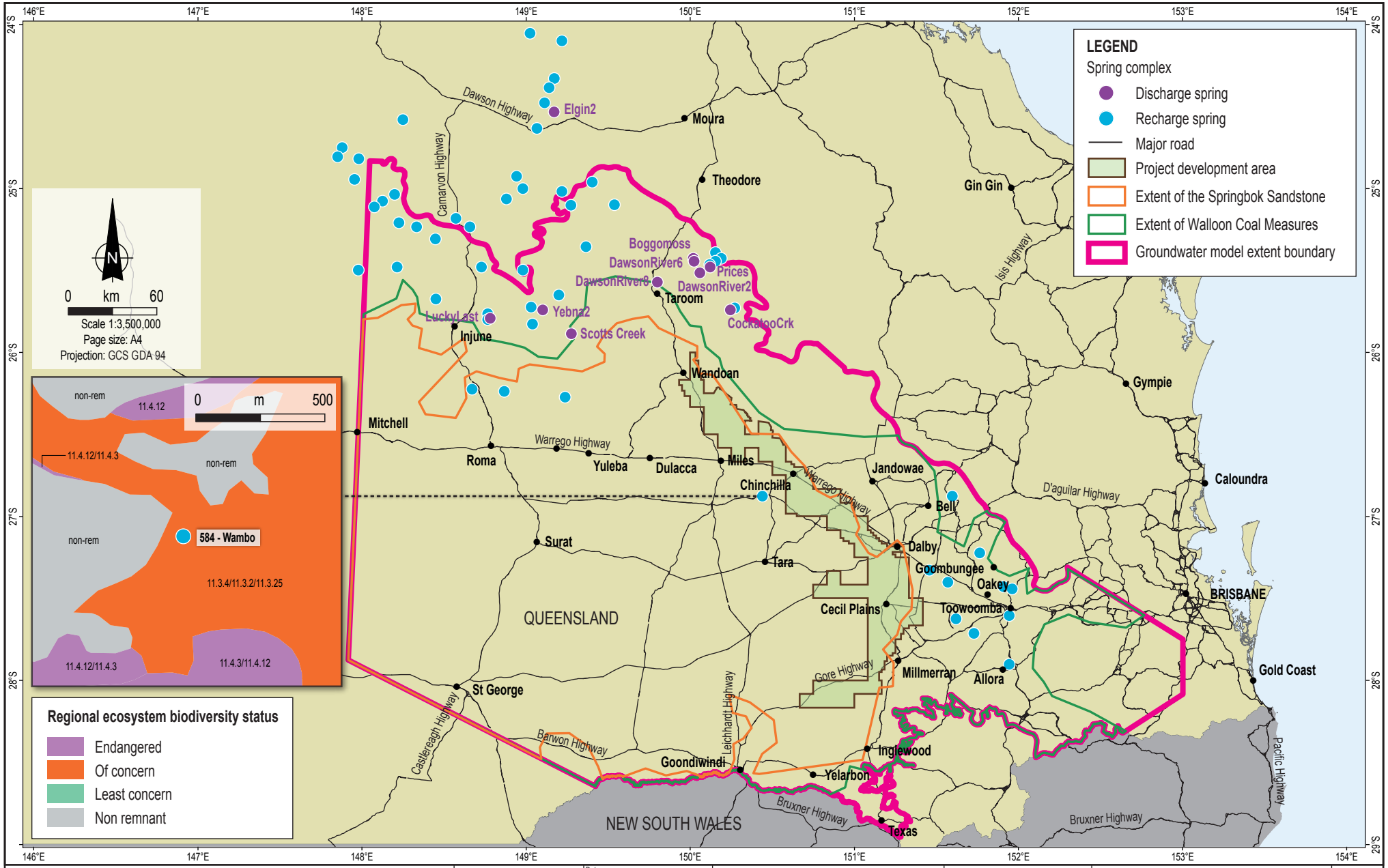
Since the EIS was finalised, additional information on groundwater dependent ecosystems has become available, as discussed in Chapter 8, Groundwater. A number of desktop studies and field investigations (hydrogeological, ecological and botanical) have been conducted within the Surat Cumulative Management Area (CMA) by the Office of Groundwater Impact Assessment (OGIA), and used to inform the Underground Water Impact Report (UWIR) (OGIA, 2012) prepared by the Queensland Government.

A reduced groundwater level, and/or changes to groundwater quality in groundwater dependent ecosystem source aquifers are the primary mechanisms by which detrimental impacts can occur on MNES species associated with the ecosystem. The groundwater modelling results presented in the Surat CMA UWIR confirm that the findings of the groundwater impact assessment presented in Chapter 14 of the EIS, Groundwater; and Appendix G of the EIS, Groundwater Impact Assessment, are conservative in relation to predicted groundwater drawdown levels.

The additional information on groundwater dependent ecosystems allows a greater understanding of potential source aquifers and the ecological communities they support. The information indicates that the following types of groundwater dependent ecosystems have the potential to occur within the project development area

- Ecosystems dependent on the surface expression of groundwater via:
  - Springs, spring wetlands and spring-fed watercourses.
  - Groundwater discharge to rivers and wetlands.
- Ecosystems dependent on the subsurface presence of groundwater via plant roots accessing shallow groundwater. These ecosystems are termed vegetation groundwater dependent ecosystems.

This additional information was previously unavailable to Arrow. The implications of this information on the assessment of MNES in the project development area are discussed below. The approximate location of known groundwater springs, spring wetlands, and spring-fed watercourses presented in the EIS and those identified in the Surat Underground Water Impact Report are shown on Figure 5.5.




Source:
Place names and roads from GEODATA250k.
Groundwater model extent, Walloon Coal Measures and Springbok Sandstone extents boundaries from Schlumberger.
Project development area from Arrow Energy.
Springs from Queensland Herbarium (January 2012).
Regional ecosystems (v6.1) from EHP.

coffey environments

Date: 14.06.2013
MXD: 7040AE_12_GIS029_v1_1
File Name: 7040_12_ATT1_F05.05_GIS_GL

Arrow Energy

Surat Gas Project

arrow energy go further

Approximate location of known groundwater springs and groundwater dependent ecosystems

Figure No: 5.5

### *Springs, Spring Wetlands and Spring-fed Watercourses*

One spring complex, identified since the EIS was finalised, was assessed for the potential presence of Groundwater Dependent Communities and Species of interest under the EPBC Act and the VM Act. This complex is located 35 km west of the project development area and may be inter-related to the groundwater systems potentially impacted by the Surat Gas Project.

Three EPBC Act listed flora species, *Eriocaulon carsonii, Arthraxon hispidus* and *Phaius australis,* were identified as being potentially present in association with the spring complex (situated outside of the project development area) (Figure 8-2 of OGIA, 2012). The supplementary terrestrial ecology assessment (Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 5.2.3) excludes these species from being present within the project development area. Field investigations found these species to be absent from the spring complex (Unpublished Report).

The spring is located outside of the project development area, and is unlikely to be directly impacted by project related activities. This area will not be exposed to Arrow's clearance activities nor any direct disturbance. Terrestrial ecology values associated with the identified spring complex are unlikely to be impacted.

The Fitzroy River turtle (*Rheodytes leukops*) is also described within the context of a groundwater dependent ecosystem due to the potential movement between spring-fed watercourses identified in the Surat CMA.

The Fitzroy River turtle is only known to occur within the Fitzroy Basin, not the Murray-Darling Basin (within which the vast majority of the project development area is situated). A small portion of the project development area falls within the Dawson River catchment of the Fitzroy Basin.

No specimen of Fitzroy River turtle has been recorded within the project development area. Database search results did return the species as 'possibly' occurring within the small portion of the project development area occurring within the Dawson River catchment.

No individuals were collected by routine turtle sampling methodologies employed during field surveys in early 2013. The small portion of the project development area occurring within the Dawson River catchment (Fitzroy Basin) is not expected to support suitable habitat for the Fitzroy River turtle.

The relationship of the spring complex with potentially affected groundwater systems is described in the groundwater assessment, Appendix 4, Supplementary Groundwater Assessment).

### *Groundwater discharge to rivers and wetlands*

In 2008, CSIRO commissioned a study as part of the Murray-Darling Basin (MDB) Sustainable Yields project series to assess surface water-groundwater interactions in nominated catchments throughout the MDB (Parsons et al, 2008). Discharge of groundwater from the watertable to surface water features (as distinct from discharge from spring sources) known as baseflow or a gaining stream, can be an important source of water for the maintenance of ecosystem function.

The study indicated the Condamine River to be a losing river throughout most of the Central Condamine River Alluvium with a high to medium confidence level in this assessment. In areas of the Central Condamine River Alluvium where significant development of groundwater resources has occurred historically, primarily for agriculture and stock and domestic purposes, groundwater levels in the surrounding aquifer have declined to the point where there is now disconnection between the river and groundwater (i.e., the groundwater table is below the base of the river bed).

A search of the EPBC Act Protected Matter: Nationally Important Wetlands directory identified seven wetlands within the Surat CMA (Appendix 4, Supplementary Groundwater Assessment, Figure 5.4). One of these wetlands, Lake Broadwater, is located within the project development area. The lake is not expected to be groundwater dependent based on site description details (Environment Australia, 2001) which indicate that it is surface water fed, whereby water supply to the lake is via surface runoff, floodout and stream flow. Lake Broadwater is known to go dry.

### *Vegetation Groundwater Dependent Ecosystems*

Vegetation groundwater dependent ecosystems are areas of vegetation that are potentially dependent on the shallow subsurface presence of groundwater. Within the project development area, vegetation groundwater dependent ecosystems are concentrated in the northeast between Wandoan and Chinchilla, and in the southwest between Tara and Inglewood.

These areas are typically associated with well vegetated areas of parks, reserves and state forests, with dry eucalyptus woodlands to open woodlands primarily on sand-plains or depositional plains.

Vegetation groundwater dependent ecosystems are generally absent in the region where the Condamine Alluvium is present (Appendix 4, Supplementary Groundwater Assessment, Figures 5.1 and 5.6).

### *Management of Groundwater Dependent Ecosystems in Queensland*

The Queensland regulatory framework administered by the OGIA provides that the Surat UWIR include a Spring Impact Management Strategy that considers all potentially affected springs within the Surat CMA. The UWIR also contains requirements for ongoing groundwater monitoring under the Water Monitoring Strategy. Responsible tenure holders are assigned certain groundwater and spring monitoring and mitigation responsibilities under the UWIR, which are enforced by EHP.

There are no potentially impacted springs identified within the project development area. Arrow is not the designated responsible tenure holder for any potentially impacted springs outside the project development area.

Should the groundwater level and quality data collected as part of the Spring Impact Management Strategy and the Water Monitoring Strategy show significant changes in spring function or associated source aquifer groundwater levels that could potentially impact vegetation communities and associated species, Arrow will determine the required action through the periodic reporting an review obligations under the UWIR. These requirements will also determine the actions to be taken in the event that a previously unidentified groundwater dependent ecosystem is identified. Arrow is also involved in the preparation of a Joint Industry Plan for an Early Warning System for the Monitoring and Protection of EPBC Springs with other coal seam gas proponents operating within the Surat CMA.

These management measures will also be informed by future research directions identified by OGIA, specifically related to improving the knowledge about springs (including watercourse springs). The objective of the research is to improve spring monitoring techniques and existing knowledge about springs in the Surat CMA in relation to their hydrology, ecological and cultural values.

## 5.6 Areas of Value to MNES

Habitat mapping for individual MNES communities and species is presented in Appendix C of this attachment. Habitat mapping will inform the development of the constraints mapping process that is integral to the environmental framework.

Arrow has already successfully implemented the environmental framework described in Chapter 8 of the EIS, Environmental Framework, Section 8.5. The framework has been applied to site selection for facilities associated with approved developments, specifically the Dalby Expansion Project. In those instances, ecological surveys comprised an important part of the planning process, confirming the suitability of sites identified, using constraints mapping. The constraints maps also informed the design of the facility layouts to avoid habitat of value to MNES.

The regional environmental constraints identified in the EIS will be used to guide field development plans for the Surat Gas Project across the project development area. The constraints have also informed the selection of the initial four sites for the proposed CGPFs and one TWAF. Ultimately, site selection will aim to avoid constrained areas as well as those areas designated as 'no go' e.g., Lake Broadwater Conservation Park. Early identification of sensitive areas (including critical habitat) allows Arrow the best opportunity to avoid sensitive areas to the greatest extent practicable.

The constraints maps will be developed and incorporated into field development plans.

### 5.6.1 Lake Broadwater

Lake Broadwater represents the main wetland of significance in the project development area. The lake is an important wetland located in the central part of the project development area approximately 30 km southwest of Dalby. Lake Broadwater is likely to provide suitable habitat for many threatened flora and fauna species. The lake could also be seasonally inhabited by EPBC Act–listed species, such as the Murray cod and migratory birds.

Lake Broadwater is a Category A Environmentally Sensitive Area under Queensland legislation that is protected by buffers that preclude certain types of development. The buffers protecting Lake Broadwater are included in constraints mapping prepared as part of the 'environmental framework', as 'no go' and highly constrained areas. These buffers reflect the current guidelines under the EP Act, Model Conditions for Level 1 Environmental Authorities for Coal Seam Gas Activities) (DERM, 2011). Arrow will develop buffers in accordance with legislative requirements applicable at the time.

Figure A10.7 within Attachment 10 of the EIS, Preliminary Constraints Maps, specifically shows the 'no go' and highly constrained areas that reflect the buffers on Lake Broadwater. No project activities are planned at Lake Broadwater or within its buffers and will not directly impact on habitat for MNES species or communities associated with the lake.

Habitat type and use is described for individual listed MNES species in Appendix C of this attachment. Maps of suitable habitat (core, known and possible) for each EPBC listed species are provided in Appendix C to this attachment, and will demonstrate where Lake Broadwater is core habitat known, core habitat possible or general habitat for each MNES species.

Chapter 16 of the EIS, Aquatic Ecology, Section 16.7.1 provides further information on how mitigation measures will be implemented to minimise direct and indirect impacts on Lake Broadwater from erosion and sediment transport into the watercourses within the project development area, including those that flow into the lake, such as Wilkie Creek.

No clearing or levelling will occur in the vicinity of Lake Broadwater Conservation Park, consistent with the example ESA buffers (derived from the guidelines under the EP Act, Model Conditions for Level 1 Environmental Authorities for Coal Seam Gas Activities (DERM, 2011)). This example was used to inform ecological assessments in the EIS and SREIS. It is noted that regulatory policy is evolving to an outcome-based approach.

The ecological assessments have confirmed that setback of project infrastructure from sensitive areas protects the associated environmental values. Impacts to sensitive areas will be avoided or minimised through environmental management controls that reflect the sensitivity of the environmental value. The need for buffers and buffer distances will be determined by legislative requirements at the time of development of a site or management measures set out in species-specific management procedures.

Lake Broadwater Conservation Reserve, described as Lot 68 on plan DY1009, and Lake Broadwater Resource Reserve, described as Lot 69 on plan DY1009, are listed exclusions from tenure (in particular Petroleum Lease 198) held by Arrow.

Any significant reduction in runoff into the lake could have an adverse impact on inflows to the lake in drier years. Development of the CGPF at survey area 8 will not include significant areas of new water storage within the catchment of Lake Broadwater, as only limited water storage is proposed. The discharge of coal seam gas water is not being considered at this site and poses no risk to Lake Broadwater. Water will be transferred to one of the water treatment facilities to be located in survey areas 2 or 9.

Survey area 8 has two watercourses running through the property. The northwestern tributary running south to north through the existing well field is an intact valley fill and the main watercourse feeding Lake Broadwater (off tenure). This stream type is highly susceptible to erosion, and concentration of overland flows from project infrastructure or removal of vegetation could initiate erosion and incision through this waterway. Upstream propagation of an erosion head through this reach could endanger wells, pipelines and road infrastructure.

Arrow has committed to a number of management measures to reduce indirect impacts on Lake Broadwater as a result of erosion and sediment transport in surrounding watercourses and ephemeral systems, as detailed in Chapter 16 of the EIS, Aquatic Ecology, Table 16.7. Further assessment is required within survey area 8 at the detailed design stage of project infrastructure to identify and address any potential impacts to altered hydrology offsite that could reduce flows to Lake Broadwater, or increase erosion from waterways on survey area 8 and possible subsequent runoff into Lake Broadwater. Site specific design and associated management measures will be developed during the detailed design stage of project infrastructure to address potential impacts (as discussed in Chapter 9, Surface Water).

### 5.6.2 Bioregional Corridors

Corridors provide a vital ecological role in fragmented landscapes. They contribute to:

- The movement of animals, thereby maintaining migration and dispersal. This role may be particularly important if a species breeds in areas separated from its normal feeding area, or requires access to refugia.
- Improved recruitment by reducing mortality during dispersal.
- Preventing and reversing local extinctions by allowing the recolonisation of patches.
- The exchange of genes between sub-populations, increasing effective population size, reducing genetic drift and inbreeding depression.
- Maintaining inherent species richness at a patch and landscape scale.

The Biodiversity Planning Assessment (BPA) (DERM, 2008) for the Brigalow Belt shows state significant corridor vegetation is scattered throughout the project development area. The scale of

the project development area precludes detailed description of all corridor vegetation, although some obvious aggregations, are noted as follows:

- A broad east-west trending corridor passing through Barakula and Gurulmundi State Forests to the north of Chinchilla. Survey area 2 is located adjacent to the border of this corridor within minor intrusions of the corridor noted on the northern boundary of the property. Development activities associated with other proponents have cleared a 80-100 m wide strip of vegetation through the central portion of this corridor.
- A series of remnant patches to the immediate west of Chinchilla (around the Baking Board region), which forms a chain of 'stepping-stones' in a north-south direction connecting a large area of remnant habitat south of the Kogan-Condamine Road to State Forest regions to Chinchilla's north. This corridor is outside of the project development area and is unlikely to be impacted by the proposed development activities.
- Riparian vegetation along the Condamine River, which extends in a south to east orientation through the central portion of the project development area provides an extensive continuous corridor. This corridor passes through survey area 9 in the southern portion of the project development area.
- A major bioregional corridor which trends in a north to south direction crosses the southern part of the project development area. This bioregional corridor of state significance is associated with Bringalilly State Forest and Wondul Range National Park. The corridor is bisected by the Gore Highway which connects Millmerran and Goondiwindi. The majority of this corridor is outside the project development area, and is unlikely to be affected by project activities.

Increased fragmentation in the Brigalow Belt South poses a significant risk to existing terrestrial ecology values. The impact of corridor loss will depend on the existing value and function of the corridor, the types of species affected, and the habitat structure of modified areas. Accordingly, project related impacts can only be quantified on a property-by-property and species-by-species basis.

The potential susceptibility of individual MNES fauna species (assessed as potentially present within the project development area) to fragmentation of vegetation contained in corridors is provided in Table 5.7 below. The evaluation provided relates to a fauna species' ability to move across open ground (i.e., between populations or habitat patches) and does not reflect the species sensitivity to loss of habitat. Further discussion on potential fragmentation impacts on a species or community basis is provided within Appendix C of this attachment within individual community or species profiles, as appropriate.

Some MNES flora species may also be impacted by any changes to vegetation corridors, most obviously those where ecology and reproduction is governed to a significant degree by fire. Fragmentation of wildlife corridors has potential to interrupt the natural movement of fire across the landscape leaving fire dependent species susceptible to habitat change associated with either fire exclusion or too little fire. The susceptibility to fragmentation of MNES flora species is discussed in Table 5.8 below.

**Table 5.7 Susceptibility to fragmentation of MNES fauna species**

| Species | EPBC Act Status | Possible Susceptibility to Fragmentation | Notes |
|---|---|---|---|
| Darling Downs earless dragon *Tympanocryptis cf. tetraporophora* | Endangered | High | Never observed away from cover or seen crossing roads. Not expected to leave grasslands with any frequency and unlikely to cross any substantially cleared areas. Species not associated with corridors in the project development area. |
| Collared delma *Delma torquata* | Vulnerable | Very High | Never observed to cross roads, rarely ever found active. Fragmentation is highly likely to restrict individuals to fragmented areas. |
| Brigalow scaly-foot *Paradelma orientalis* | Vulnerable [1] | Moderate | Observed crossing roads (~30 m) and probably able to cross up to 50 m. Ability to cross 100 m unknown. |
| Five-clawed worm-skink *Anomalopus mackayi* | Vulnerable | Very High | Never observed away from cover, unlikely to cross any substantially cleared areas. Not expected to leave grasslands and cover with any frequency. |
| Yakka skink *Egernia rugosa* | Vulnerable | High | Strongly associated with burrows, rarely seen to move far from burrows. Ability to move across open areas is unknown. |
| Dunmall's snake *Furina dunmalli* | Vulnerable | Moderate | Observed crossing roads (~30 m), but general movements are virtually unknown. |
| Regent honeyeater *Anthochaera phrygia* | Endangered | Very Low | Highly mobile, nomadic, following flowering events. Unlikely to be affected by fragmentation. |
| Squatter pigeon *Geophaps scripta scripta* | Vulnerable | Very Low | Frequents road edges and cleared grassy areas, mobile, unlikely to be impacted by fragmentation. |
| Australian painted snipe *Rostratula australis* | Vulnerable [2] | Very Low | Strongly associated with waterbodies and aquatic vegetation, rarely seen out of aquatic habitats. Unlikely to be affected by fragmentation. |
| South-eastern long-eared bat *Nyctophilus corbeni* | Vulnerable | High | Known only from large patches of vegetation. Assumed to cross small clearings based on the presence of management tracks (i.e., <30 m) within known habitat, but ability to cross larger clearings (>50 m) unknown. |

1. Species delisted in April 2013 as discussed in Section 3.2 but retained in this assessment.
2. Species upgraded to Endangered in April 2013 as discussed in Section 3.2, but after the project was declared a controlled action.

**Table 5.8 Susceptibility to fragmentation of MNES flora species**

| Species | EPBC Act Status | Possible Susceptibility to Fragmentation | Notes |
|---|---|---|---|
| Curly-bark wattle *Acacia curranii* | Vulnerable | High | Many acacia species require habitat contiguity to promote natural movement of fire through the landscape. Fire at regular intervals is required to promote recruitment and seed germination. Too frequent fire may also result in failure of plants to reach maturity and complete the reproductive cycle. |
| Hando's wattle *Acacia handonis* | Vulnerable | High | |
| Wardell's wattle *Acacia wardellii* | Vulnerable [1] | High | |
| Tara wattle *Acacia lauta* | Vulnerable | High | |
| Machin's macrozamia *Macrozamia machinii* | Vulnerable | High | Like many of the acacia species, *Macrozamia machinii* is likely to be heavily reliant on fire to complete their reproductive cycle. Fire exclusion as may occur within highly fragmented habitats may alter habitat ecology, resulting in senescence of a population. Too frequent hot fires may result in plants being destroyed prior to reproductive maturity. |
| An unnamed mint-bush *Prostanthera sp. (Dunmore)* | Vulnerable | Moderate | Little known about the ecology of these species and likely response to fragmentation although they are typically associated with intact contiguous remnants. |
| Shiny-leaved ironbark *Eucalyptus virens* | Vulnerable | Moderate | |
| Gurulmundi fringe-myrtle *Calytrix gurulmundensis* | Vulnerable | Moderate | |
| Kogan wax flower *Philotheca sporadica* | Vulnerable | Moderate | |
| Cobar greenhood orchid *Pterostylis cobarensis* | Vulnerable | Moderate | |

**Table 5.8 Susceptibility to fragmentation of MNES flora species (cont'd)**

| Species | EPBC Act Status | Possible Susceptibility to Fragmentation | Notes |
|---|---|---|---|
| King blue grass *Dicanthium queenslandicum* | Vulnerable [2] | Low | These species occur in the project development area in habitats that have been heavily fragmented. Impacts to bioregional corridors and other areas of broadscale contiguous vegetation will have limited impact of these species. |
| Finger panic grass *Digitaria porrecta* | Endangered | Low | |
| Belson's panic *Homopholis belsonii* | Vulnerable | Low | |
| Lobed blue grass *Bothriochloa bilboa* | Vulnerable | Low | |
| Xerothamnella *Xerothamnella herbaceae* | Endangered | Low | |
| Austral cornflower *Rhaponticum australe* | Vulnerable | Low | |
| Hawkweed *Picris evae* | Vulnerable | Low | |
| Austral toadflax *Thesium australe* | Vulnerable | Low | |
| Queensland white gum *Eucalyptus argophloia* | Vulnerable | Low | |

1. Species delisted in April 2013 as discussed in Section 3.2 but retained in this assessment.
2. Species upgraded to Endangered in January 2013 as discussed in Section 3.2, but after the project was declared a controlled action.

# 6. ISSUES AND POTENTIAL IMPACTS

Project activities have the potential to cause both direct and indirect impacts on MNES, with the level of impact depending upon the type of activity proposed (e.g., field development, construction of roads, or operation of infrastructure). Further details are provided in the EIS (Chapter 16, Aquatic Ecology and Chapter 17, Terrestrial Ecology) of the assessment of impacts on MNES from project activities and in different project phases (construction, operation and decommissioning). Community or species specific impacts of the project are addressed within the individual species or community profiles presented in Appendix C of this attachment.

## 6.1 Project Activities with Potential to Impact MNES

Project activities that may cause potential adverse impacts on MNES species and communities during the construction, operations and decommissioning phases of the project are described below.

### Construction

The project activities most likely to adversely impact on MNES species and communities are the construction of production wells and associated low- and medium-pressure gas and water gathering pipelines and the construction of high-pressure gas pipelines, through:

- Site clearance.
- Ground disturbance and soil movements.
- Potential spills of hazardous materials.
- Vehicle movement (which potentially leads to fauna strikes and the spread of weeds and pathogens).
- Construction activities that create barriers to fauna movement or pathways for pest species.
- Trenching (which, when left open, may entrap animals and interfere with fauna movement pathways).
- Light and noise emissions.
- Storage of putrescible waste.

Construction of the production facilities will also involve these activities; however, they will be localised to the site, which will be selected to reduce impacts on terrestrial flora and fauna.

### Operations

During operations, the following project activities could impact upon environmental values:

- Release or spill of waste water or hazardous materials.
- Vehicle movements.
- Light and noise emissions.
- Storage of putrescible waste.

### Decommissioning

During the decommissioning phase, impacts on MNES will be similar to those of the construction and operations activities. These impacts will occur in addition to those from the removal of

infrastructure (e.g., pipelines and foundations), which will involve ground disturbance. These activities will predominately occur in previously disturbed areas.

Potential direct and indirect impacts on the environmental values from associated project activities are outlined below.

## 6.2 Habitat Fragmentation and Isolation of Populations

Vegetation clearance has the potential to impact upon intact corridors that connect the landscape. These corridors facilitate movement of species and help to maintain genetic diversity among populations. Site clearing during construction of the wells, pipeline and facilities will be the main cause of habitat loss. Arrow will implement a buffer zone from the high bank of watercourses (as deemed necessary during the preconstruction clearance survey or as specified in species management plans) in accordance with legislative requirements at the time, so that no development or clearance occurs within these buffers (other than construction of watercourse crossings for roads, pipelines and discharge infrastructure and associated stream monitoring equipment).

Habitat fragmentation resulting from project activities may lead to:

- An altered landscape (and hence habitat) mosaic.
- Modification of large core unmodified habitats that may be structurally varied, contain source populations and have high habitat heterogeneity.
- Increased barriers to movement, isolating populations or reducing movement rates.
- Reduced movement of aquatic biota.
- Impacts to significant wildlife corridors.

Clearing within corridors may isolate populations or reduce movement, creating subpopulations within a larger population. The severity of the impact of modifying vegetation within corridors on populations and species will have varied effects on species movement rates. The magnitude of impact will be directly related to the final location of infrastructure and the extent to which MNES species and communities can be avoided. In the event that avoidance is not possible, production facilities, such as CGPFs and field compression facilities, are likely to have a less significant impact than wells, gathering lines and access tracks. Production facilities are non-linear and will most likely only affect the movement of smaller ground dwelling species (some small lizards) and arboreal mammals.

## 6.3 Habitat Loss or Degradation

Known and potential MNES habitat may be lost through clearing of vegetation for the gas and water gathering systems, access roads, temporary camps, production wells and production facilities.

Habitat degradation could result from dust generated by vehicle movement, noise, light spill, decline in water quality, or the spread and invasion of pest flora and fauna species and exposure to contaminants.

A decline in water quality could result from unplanned discharges of sediment-laden water, sanitary wastewater or contaminated water. Accidental spillage of sanitary wastewater could increase the occurrence of algal blooms due to its slightly higher temperature and nutrient-rich composition.

If exotic plants are not managed, the project has the potential to increase their abundance and facilitate their dispersal, which may have negative economic and social effects, as well as negative impacts on native vegetation and biodiversity. Mechanisms of weed dispersal from project activities are generally associated with:

- Crossing the watercourses during pipeline construction or vehicle washdown runoff, particularly for aquatic weeds.
- Movement of equipment and machinery, particularly machinery sourced from adjacent regions.
- Ground disturbance, such as grading, removal and relocation of topsoil.

Project-related activities have the potential to increase pest fauna abundance, which could lead to increased competition with and predation of native fauna, as well as habitat degradation (e.g., through wallowing and foraging by feral pigs). In particular, pest abundance and distribution may increase due to:

- The construction of linear infrastructure, which may create pathways and increase dispersal capability.
- The construction of dams, which can provide a permanent water source for feral animals and thereby increase their abundance and distribution. In addition, dams may attract cane toads, increasing the risk of toxic ingestion in predatory species, such as Dunmall's snake.
- Putrescible waste dumps, which can become a food resource for a variety of pest fauna species, leading to an increase in their abundance.

Lake Broadwater has been identified as potential habitat for MNES species. The Lake Broadwater catchment has already been significantly affected by surrounding agriculture. As a result, sedimentation is likely to already be high; and minor soil disturbance upstream may lead to additional sediment contributions. However, other unmitigated impacts, particularly weed infestation and altered water quality, have the potential to affect environmental values. These impacts could reduce the value of Lake Broadwater to migratory species.

## 6.4 Fauna Mortality

Fauna mortality can occur as a result of habitat loss and degradation, but also from entrapment in pipeline trenches and dams, clearing activities, vehicle strikes, increased predation, or displacement and starvation as a result of vegetation clearance.

## 6.5 Edge Effects

Edge effects occur where project activities encroach on the perimeter of a vegetation community. The extent, structural complexity and type of disturbance at the perimeter of the community determines the degree to which ecosystem function is affected, particularly the extent to which the community can continue to provide viable habitat.

Changes resulting from edge effects include modified composition and structure of the community (as perimeter plants are exposed to different light conditions and the drying affects of wind) and refuge loss (as fauna species withdraw deeper into the community).

## 6.6 Alteration of Ecological Processes

Ecological processes could be altered as a result of project activities, including fire frequency, fire intensity, fire extent and surface water flow conditions.

Specifically, the project will include construction activities (i.e., welding) and operations activities (i.e., flaring) that have the potential to increase the risk of ignition and fire if not conducted in accordance with applicable procedures. Furthermore, the clearing of forests will alter the natural burning patterns through artificially created fire breaks along access roads and pipeline right of way (ROWs).

Increased erosion and surface water flow disturbance may result from emergency discharge, ground clearance, physical obstructions and increased runoff due to ground compaction. This flow disturbance and altered water quality could impact on vegetation communities and fauna, particularly migratory bird species inhabiting natural wetlands.

## 6.7 Discharge to Watercourses

Discharge from the water treatment facility co-located with CGPF2 (survey area 2) into Bottle Tree Creek and from the water treatment facility co-located with CGPF9 (survey area 9) into the Condamine River, has been proposed as one of the options for managing coal seam gas water.

Discharge of treated or untreated coal seam gas water at survey area 2 and survey area 9 could impact on the aquatic ecosystems of the receiving watercourse (discussed in Chapter 10, Aquatic Ecology, Section 10.5). Potential impacts include:

- Changes in the composition of aquatic assemblages as a result of changes in the timing and magnitude of watercourse flows.
- Changes in the aquatic community composition as a result of potentially altered water chemistry and physical characteristics (e.g., turbidity, pH, tannic acids, temperature, dissolved oxygen, ionic composition and macro/micro nutrients).
- Changes in the geomorphological processes that create, or assist in the formation of, habitat inhabited by aquatic assemblages; particularly those supporting species of conservation significance (e.g., deep pools and undercut banks).
- Creation of conditions that could facilitate the spread and the establishment of pest species (e.g., the establishment of higher base flows in other regions of the Murray-Darling Basin is thought to have provided favourable conditions for carp over native fish species).

The potential impacts associated with discharges are restricted to the operations (during and/or between water releases) and decommissioning phases (when the systems return to pre-existing flow conditions) of the project.

Potential impacts on aquatic ecosystems will be determined by the scale of the change in flow conditions and characteristics of each of the two receiving watercourses.

The surface water assessment concluded that the discharge of coal seam gas to watercourses in survey areas 2 and 9 is unlikely to have significant impacts on erosional and sedimentation processes on the receiving systems. An increase in the duration of stream flow could alter aquatic ecosystem composition and facilitate the spread of non-indigenous and invasive species by providing longer periods when pools and reaches of the watercourse are connected, when the system would normally be disconnected.

The potential impact on aquatic ecosystems of discharging treated or untreated coal seam gas water at survey areas 2 and 9 was assessed as having a low significance during periods of high flow and high significance during periods of base flow. Mitigation measures to be applied to discharges during base flow conditions in the watercourse are presented in Chapter 10, Aquatic Ecology, Section 10.6. The significance of the residual impacts (following implementation of the mitigation measures) on the watercourses varies from low to high (Chapter 10, Aquatic Ecology, Section 10.7.)

## 6.8 Fire Sensitive Species

A number of MNES listed species were identified as being sensitive to changes in fire regime during the development of species dossiers (Appendix 9, Supplementary Terrestrial Ecology Assessment), such as Tara wattle (*Acacia lauta*), curly-bark wattle (*Acacia curranii*) and collared delma (*Delma torquata*). Impacts from changes to the fire regime are discussed within each species profile, as applicable, in Appendix C of this attachment and include the fragmentation of habitat and too frequent fires to allow seedlings to mature.

# 7. ENVIRONMENTAL PROTECTION OBJECTIVES

The environmental protection objectives for MNES remain as stated in the MNES attachment of the EIS (Attachment 3, Section 6) namely:

- To avoid or minimise adverse effects on and to protect terrestrial ecosystems and associated biodiversity and habitat of EPBC communities.
- To protect areas identified for avoidance.
- To minimise EPBC Act–listed habitat loss and fauna mortality.
- To control the introduction or spread of new or existing pest flora or fauna.

# 8. AVOIDANCE, MITIGATION AND MANAGEMENT MEASURES

Avoidance, mitigation and management measures have been proposed through the development of technical studies for the EIS and SREIS to achieve the identified environmental protection objectives.

The mitigation and management measures set out in the EIS and SREIS are Arrow's commitments to the effective management of the potential environmental and social impacts of the project.

Vegetation communities described as MNES under the EPBC Act and classified by regional ecosystems under Queensland's VM Act are protected secondarily under the EP Act. The Environmental Protection Regulation 2008 provide a mechanism to enforce the EP Act and allows an assessment of the risk that an environmentally relevant activity poses to environmentally sensitive areas. The classification of Category A, Category B and Category C environmentally sensitive areas are based on a ranking of environmental sensitivity and enable the protection of EPBC communities through assigned buffers (in accordance with legislative requirements at the time of development).

The buffer distances presented in the EIS informed the ecological assessments undertaken for the SREIS. The assessments have confirmed the findings of the EIS, in stating that adequate setback of project infrastructure from sensitive areas is required to protect the associated environmental values. Impacts to sensitive areas will be avoided or minimised through environmental management controls that reflect the sensitivity of the ecological asset. Offsets will be required for unavoidable impacts.

Arrow will develop these procedures based on the legislative requirements at the time of development of particular areas and sites based on the information on MNES species habitat requirements in the species profiles in Appendix C to this attachment.

Additional measures to those proposed in the EIS, where specific to a species or a community are included within relevant community and species specific dossiers presented in Appendix C of this attachment.

Mitigation measures proposed in Sections 8.1 to 8.6 are as presented in the EIS. General measures are applicable to all MNES, or to certain MNES groups (e.g., listed communities, migratory species).

Mitigation measures that are additional to those proposed in Attachment 3 of the EIS, Matters of National Environmental Significance, Section 7, are also presented below at the end of each relevant section, and a note made that the measure was developed during the preparation of the SREIS.

## 8.1 Avoidance

Arrow undertakes as a matter of standard procedure a desktop site selection process. Once a potential site is identified, detailed, field-based ecological assessment is carried out to identify and avoid sensitive locations known to be of value to EPBC Act–listed flora and fauna species. Construction activities (such as clearing) will be routinely observed by a spotter-catcher to check that the activity is being conducted within the approved area and according to agreed methods.

Arrow will avoid, where practicable, listed threatened ecological communities and the habitat of listed flora, fauna and migratory species, as follows:

- Avoid the following areas:
  - Wondul Range National Park and Lake Broadwater Conservation Park (Category A ESAs).
  - Chinchilla Sands Local Fossil Fauna Site.
  - 'Critically endangered' EPBC Act communities within the project development area (REs 11.3.21, 11.3.24, and 11.8.2a), including three natural grassland road reserves (Dalby Kogan, Dalby St George and Dalby Cecil Plains). [C217]
- Aim to avoid:
  - Additional national- and state-listed communities: Brigalow (REs 11.3.1, 11.4.3, 11.4.10, 11.9.5, 11.9.6), Semi-evergreen vine thickets (REs 11.9.4a, 11.8.3), Weeping Myall Woodlands, and Coolibah – Blackbox Woodlands (RE 11.3.3).
  - Category B ESAs.
  - Category C ESAs, including Gurulmundi State Forest, Binkey State Forest and Barakula State Forest.
  - Wyaga-Kindon Ooline populations.
  - Stock routes and state or bioregional wildlife corridors.
  - Essential and core habitat (supporting listed wildlife species).
  - State forests and resources reserves.
  - State-listed 'of concern' regional ecosystems. [C218]
- Manage potential impacts to Category A, B and C ESAs through implementation of buffers in accordance with legislative requirements at the time. [C227]

### Additional Commitments Derived from SREIS Studies

The following additional commitments were developed as a result of the technical studies undertaken for the SREIS:

- Design infrastructure to avoid disturbance of state significant vegetation and other high value ecological corridors, where practicable. [C557]
- Demarcate in order to restrict access to any ground truthed populations of *Microcarpaea agonis* identified adjacent to work sites. [C559]

## 8.2 General Measures

The following mitigation and management measures presented in the EIS were developed to address the potential impacts of the project on MNES, including EPBC Act–listed communities, flora, fauna and migratory species.

- Design gathering lines and tracks to avoid watercourses, drainage lines and riparian areas (particularly permanent watercourses or perennial aquatic habitat), where practicable. [C191]

- Manage potential impacts on Lake Broadwater Conservation Park (Category A ESA) through implementation of relevant buffers in accordance with legislative requirements at the time of development in this region. [C156]
- Arrow will implement a buffer zone from the high bank of all watercourses to prevent development or clearance occurring within the buffer (other than construction of watercourse crossings for roads and pipelines, discharge infrastructure and associated stream monitoring equipment). Determine the buffer zone distance in accordance with the legislative requirements at the time of development or through preconstruction clearance surveys. [C157]
- Develop an erosion and sediment control plan and install and maintain appropriate site-specific controls, established on the basis of the sensitivity of the surrounding environment. [C034]
- Conduct preconstruction clearance surveys and include as a minimum:
  - Vegetation mapping at a scale suitable for site specific planning.
  - Identification of core habitats and listed species
  - Identification of site-specific sensitive areas that require avoidance or buffer areas. [C232]
- Conduct preconstruction clearance surveys to identify any additional areas that may need to be avoided. [C220]
- Mark site boundaries clearly for site-specific sensitive areas that require avoidance. [C228]
- Develop management procedure, inclusive of buffers where required, for threatened communities and species as and when project activities are identified as likely to have an impact on these values. [C224]
- Develop site specific monitoring programs for threatened species and communities based on the identified risk to the conservation or maintenance of a viable population. [C303]
- Where avoidance is not possible, and significant residual impacts remain to threatened species and communities, implement an offset strategy approved by a relevant government agency and comply with reporting conditions of an offset plan. [C219]
- Clear areas progressively and implement rehabilitation as soon as practicable following construction and decommissioning activities. [C015]
- Design facilities to ensure natural surface water flows are not impounded, e.g., by installing culverts on roads and stormwater diversion ditches around production facilities. [C221]
- Develop fire plans for production facilities. [C223]
- Demarcate buffers and inform workers and machinery operators of buffer locations when working within the vicinity of national- and state-listed species, communities and areas identified for avoidance. [C230]
- Consider the preconstruction clearance survey baseline characterisation when rehabilitating project sites. [C244]
- Implement site planning, preparation and management requirements in accordance with a developed and approved decommissioning and rehabilitation plan. [C245]
- Decommission the pipeline corridors in a manner that minimises potential impacts on the environment. [C246]

- Identify areas for rehabilitation. [C247]
- Prioritise areas for rehabilitation based on the preconstruction clearance survey baseline characteristics. [C248]
- Advise, through procedures and plans, on requirements for rehabilitation in identified areas that are no longer in use. [C250]
- Carry out routine monitoring of rehabilitated sites. [C478]
- Reinstate self-supporting drainage lines. [C251]
- Inspect rehabilitation areas after decommissioning for regrowth similar to the surrounding environment. [C252]
- Minimise the disturbance footprint and vegetation clearing. [C020]
- Confine project traffic to designated roads and access tracks, where practicable. [C033]
- Erect fauna-exclusion fences around project dams. [C243]
- Dispose of food scraps in large skips or bins that prevent animal access. Empty these storage devices regularly in a manner that does not involve disposal to onsite trenches or waste dumps. [C258]
- Select plant species for the purposes of rehabilitation that are specific to the original ecosystem and of local provenance, wherever practicable. [C253]
- Identify declared weeds during the preconstruction clearance survey. [C193]
- Develop a declared weed and pest management plan in accordance with the Petroleum Industry - Pest Spread (including coal seam methane gas) minimising pest spread advisory guidelines (Biosecurity Queensland, 2008), or relevant legislation at the time. Undertake species-specific management for identified key weed species at risk of spread through project activities (mesquite, parthenium, African love grass and lippia). Increase weed control efforts in areas particularly sensitive to invasion. The pest management plan should include, as a minimum, training, management of pest spread, management of pest infestations, requirements for crossing and working around pest fences and monitoring the effectiveness of control measures. [C188]
- Design washdown facilities to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas. Treat or dispose of washdown solids in a registered landfill. [C187]
- When siting production facilities, avoid wetlands and consider the following:
  - Stream processes that may result in channel migration (either over time or as a result of project activities) and areas that are highly susceptible to erosion (i.e., dispersive soils).
  - Downstream values of nearby watercourses or wetlands.
  - Minimising changes to natural drainage lines and flow paths.
  - Flooding regimes and areas subject to inundation. [C151]
- Do not wash down vehicles in watercourses. [C180]
- Install and maintain appropriate sediment and erosion control structures at work sites. [C261]

- Where used for dust suppression on roads or for construction and operations activities, coal seam gas water quality will be in accordance with the relevant permits and/or consents. [C176]
- Prohibit disturbance or harassment of wildlife and the unauthorised collection of flora and forest products. [C256]
- Apply appropriate international, Australian and industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels and lubricants). [C035]
- Apply appropriate international, Australian and industry standards and codes of practice for the design and installation of infrastructure associated with the storage of hazardous materials (such as chemicals, fuels and lubricants). [C048]
- Discharge water from project activities at a rate and location that will not cause or exacerbate erosion. Install erosion protection measures, including energy dissipation structures, at discharge outlets. [C066]
- Inspect erosion and sediment control measures following significant rainfall events and carry out repairs and/or maintain as required to retain the effectiveness of the measures. [C505]
- Carry out corrective actions immediately upon the identification of any contamination of soil or groundwater that has occurred as a result of project activities. [C038]
- Advise all relevant personnel of the location and extent of weed infestations in the vicinity of work areas and the risks involved in moving from one site or property to another. [C179]
- When sourcing maintenance materials, check materials such as bedding sand, topsoil and sand bags for weeds and plant materials or animal pathogens. Request a weed hygiene declaration form from the supplier where there is possible risk of contamination in products or materials. [C190]
- Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites. [C099]
- Train field personnel to identify key pest species and to maintain constant vigilance of weeds and pest fauna species throughout the project life to ensure early detection and intervention. [C259]
- Avoid transport of equipment across watercourses unless an appropriate crossing that minimises disturbance to the watercourse bed and banks and to riparian vegetation, is available. [C194]
- Locate self-contained portable toilet facilities at designated work sites at appropriate distances from watercourses, where they are accessible to all operations and maintenance personnel. Regularly maintain the facilities and dispose of sewage and greywater from toilet facilities via a chemical treatment system, or transport to a municipal sewage treatment plant using a licensed contractor. [C182]

No additional mitigation and management measures were proposed in technical studies completed for the SREIS.

## 8.3 Mitigation and Management Measures for Ecological Communities

In addition to the general measures identified above, further mitigation and management measures (expressed as commitments) were developed to protect significant ecological communities and respond to potential impacts identified on MNES listed ecological communities. These include:

- Construct production wells, gathering lines and access tracks within cleared areas, where practicable, with the aim of avoiding remnant vegetation and high-value regrowth. [C240]
- Reduce the width of construction ROWs within areas of sensitivity to the greatest extent practicable without compromising the safety of workers. [C231]
- Inform relevant workers, including contract plant and machinery operators of the location of significant remnant vegetation and buffers and use qualified personnel to guide clearing activities. [C229]

No additional mitigation and management measures were proposed in technical studies completed for the SREIS.

## 8.4 Mitigation and Management Measures for Flora Species

In addition to the general measures identified above, further mitigation and management measures (expressed as commitments) developed to protect significant flora species and respond to potential impacts identified on MNES listed flora species were presented in the EIS. These include:

- Translocate or propagate significant species where it is deemed necessary for use during rehabilitation or in offsets, in accordance with relevant legislation. [C239]
- Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable. [C242]

The following additional commitments were developed as a result of technical studies undertaken for the SREIS.

- Record the location of any newly identified populations of Machin's macrozamia (*Macrozamia machinii*) and confidentially notify relevant authorities. [C563]
- Develop a site specific management plan to reduce changes to wetland habitat hydrology, including water quality, in areas of ground-truthed populations of *Microcarpaea agonis* adjacent to work sites. [C558]
- Salvage seed from threatened flora species unavoidably disturbed for use in rehabilitation as propagation material or natural regeneration. [C541]

## 8.5 Mitigation and Management Measures for Fauna Species

In addition to the general measures identified above, further mitigation and management measures (expressed as commitments) were developed to protect significant fauna species and respond to potential impacts identified on MNES listed fauna species. These include:

- Design dams to have an egress (escape point) for wildlife. [C214]

- Retain woody debris, logs and rocks for use in rehabilitation, spreading them over part or all of the corridor or, as a minimum, piled along the edge of the cleared corridor to provide refuge for crossing fauna. [C238]
- Review site-specific management plans before moving stockpiled logs and vegetation to avoid reduce potential for fauna mortality. [C473]
- Use appropriately trained personnel or a spotter-catcher to capture injured wildlife, where possible. If further action is required, consult with a qualified vet to determine appropriate action. [C237]
- Minimise the time a trench is left open. Construct exit points when construction is within 1 km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity. [C233]
- Inspect and manage open trenches in accordance with the following:
  - Inspect trenches for the presence of fauna daily (preferably in the morning), as well as immediately prior to closing a trench.
  - Have appropriately trained personnel remove any fauna from a trench to minimise stress to the animal and to avoid personal injury.
  - Record details of trapped fauna for inclusion in the EHP Wildnet database. [C500]
- Fell trees away from existing stands where practicable. Where trees unavoidably fall into a stand, leave trees in situ to emulate natural tree fall and provide habitat for ground-dwelling species, where practicable. [C241]
- Retain habitat trees, where practicable. [C234]
- Implement noise control techniques in accordance with the project's noise and vibration commitments and standard industry noise suppression techniques. [C254]
- Assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter-catcher and roll them so that the hollows are facing upwards allowing fauna to escape. [C235]
- Reduce light spill resulting from project activities to reduce disturbance to nocturnal fauna. [C255]
- Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife. [C260]
- Obtain all relevant permits required under the *Fisheries Act 1994* (Qld), including permits for construction of waterway barriers or disturbance of fish habitat. [C192]
- Construct watercourse crossings in a manner that reduces sediment release to watercourses, stream bed scouring (e.g., the crossing location will be at low-velocity, straight sections, with the pipeline or road orientated as near to perpendicular to water flow as practicable), obstruction of water flows and disturbance of stream banks and riparian vegetation. Avoid, where practicable, the use of rock gabions, as they are unsuited to watercourses of the region. [C164]
- Design flumes used to construct watercourse crossings to a suitable size to maintain flows and enable fish passage. Protect the bed of the watercourse from scouring at the site of the downstream discharge of any flumes or pipes. [C196]

- If diversion of watercourse flows using pumps is required, screen the pump intakes with mesh to protect aquatic life. [C198]

No additional mitigation and management measures were proposed in technical studies completed for the SREIS.

## 8.6 Mitigation and Management Measures for Migratory Species

In addition to the general measures identified above and fauna specific measures, a further management measure was developed to protect significant migratory species and respond to potential impacts identified on MNES listed migratory species. The management measure expressed as a commitment is:

Avoid construction activities in waterbodies frequented by migratory species. [C225]

The following additional management measure expressed as a commitment was developed as a result of technical studies undertaken for the SREIS:

Ensure Arrow's overhead distribution powerlines are visible when construction is planned in proximity to waterbodies frequented by an important population of listed migratory bird species. [C562]

## 8.7 Recovery Plans

Recovery plans for some listed threatened species and ecological communities have been developed under the EPBC Act.

Recovery plans set out the research and management actions necessary to support the recovery of listed threatened species or ecological communities. The aim of a recovery plan is to maximise the long term survival in the wild of a threatened species or ecological community. Recovery plans aim to provide a planned and logical framework to address the decline of threatened species or ecological communities.

Recovery plans should therefore inform, where practical, the development of management measures specific to a community or species if an impact on that community or species has been identified as likely to occur.

Details from the recovery plans that are relevant to the project have been considered in the assessment of impacts on MNES and development of mitigation and management measures by the technical studies. Recovery plans specific to an EPBC Act listed community or species are detailed in Appendix C under each profile as applicable.

# 9. SUMMARY OF IMPACT ASSESSMENT

The implementation of the avoidance, mitigation and management measures set out in Section 8 will avoid adverse impacts from project activities, or reduce the severity of their magnitude on MNES species and communities in the project development area.

Table 9.1 shows the predicted significance of impacts prior to implementation of management measures (unmitigated impacts) and the significance of impacts following implementation of the recommended management actions (residual impacts).

If an individual MNES species or community is avoided, direct significant impacts will be avoided on that individual MNES. Some species retain a high residual impact where avoidance is not possible and other management and mitigation measures are implemented instead. These species have all been assessed as having an 'extremely high' sensitivity and Arrow has committed to avoid known areas of core habitat for these species where practicable. Two threatened ecological communities have been identified for total avoidance ('Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland' and 'White box-yellow box-Blakely's red gum grassy woodland and derived native grassland').

Profiles have been developed for all MNES communities and species of relevance to the Surat Gas Project (Appendix C of this attachment) which include an assessment of the significance of impacts of the project on the MNES species and communities across the whole project development area. These qualitative assessments have been undertaken to define the sensitivity of habitats, local flora and fauna populations, and to assess the magnitude of impacts on these MNES. The assessments address the likely disturbance to MNES within the project development area based on known ecological attributes including life span and life cycle, resilience to disturbance and the capacity of the population for recovery and rehabilitation.

At this stage, the precise locations are not known for the facilities and infrastructure across the project development area. The MNES assessment therefore has taken a precautionary approach in assessing residual impacts for each MNES on the basis that avoidance may not be possible in many cases, although avoidance is the first preference in site and route selection for habitat for MNES.

The profiles also include an assessment to determine whether there is a significant impact on a community or species under EPBC guidelines within the properties that have been identified for the development of four CGPFs and a worker's accommodation facility. The assessments on MNES at the five properties follow the criteria set out in the MNES significant impact guidelines and will inform the final site selection based on identified constraints.

Activities at these sites have been identified as possibly causing localised significant impacts under the MNES criteria, although across the project development area, impacts may be assessed as being of low significance based on extensive availability of habitat and broad species distribution. The assessments have assumed complete clearance at the property level as the exact location of infrastructure on each site is not known and are therefore inherently conservative in their findings.

As with the five development areas assessed in the profiles, further areas identified for development will be surveyed and assessed prior to construction for potential impacts to MNES ecological communities, flora and fauna species habitat and individuals. Communities and habitat for MNES species will be avoided where possible.

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Community Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Threatened Ecological Community** | | | | | | | |
| Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland | Extremely high | Major | Major | Avoid | N/A – community will be avoided | N/A, community will be avoided | No |
| White Box-Yellow Box- Blakely's Red Gum Grassy Woodland and Derived Native Grassland | Extremely high | High | Major | Avoid | N/A – community will be avoided | N/A, community will be avoided | No |
| Brigalow (*Acacia harpophylla* dominant and co-dominant) | High | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to this ecological community. | Low | Moderate | Yes (MNES Referral Guidelines 1 and 2) |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Community Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Threatened Ecological Community (cont'd)** | | | | | | | |
| Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions | High | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to this ecological community. | Low | Moderate | No |
| Weeping Myall Woodlands | High | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to this ecological community. | Low | Moderate | Yes (MNES Referral Guidelines 1 and 2) at survey area 7 (see Appendix C for details) |
| Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions | High | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to this ecological community. | Negligible | Low | Yes (MNES Referral Guidelines 1 and 2) at survey area 7 (see Appendix C for details) |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Fauna- Mammals, Reptiles and Birds** | | | | | | | |
| Southeastern long-eared bat (*Nyctophilus corbeni)* | Moderate | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to these species. | Moderate | Moderate | Yes (MNES Referral Guidelines 1, 2 and 9) at survey area 2 and survey area F (see Appendix C for details) |
| Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora)* | Extremely high | High | Major | | Moderate | High | No |
| Fitzroy River turtle, Fitzroy tortoise, Fitzroy turtle (*Rheodytes leukops)* | High | Low | Moderate | | Low | Moderate | No |
| Yakka skink (*Egernia rugosa*) | High | High | High | | Low | Moderate | No |
| Brigalow scaly-foot (*Paradelma orientalis*) | Moderate | Moderate | Moderate | | Low | Low | Yes (MNES Referral Guidelines 1 and 2) at survey area 2 (see Appendix C for details) |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Fauna- Mammals, Reptiles and Birds (cont'd)** | | | | | | | |
| Collared delma (*Delma torquata*) | Extremely high | Major | Major | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to these species. | High | Major | No |
| Five clawed worm-skink (*Anomalopus mackayi*) | Extremely high | Major | Major | | High | Major | No |
| Australian painted snipe (*Rostratula australis)* | Moderate | Moderate | Moderate | | Moderate | Moderate | No |
| Regent honeyeater (*Anthochaera phrygia)* | High | High | High | | High | High | No |
| Dunmall's snake (*Furina dunmalli)* | Moderate | Moderate | Moderate | | Low | Low | No |
| Squatter pigeon (southern) (*Geophaps scripta scripta*) | High | Low | Moderate | | Low | Moderate | No |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Fauna- Mammals, Reptiles and Birds (cont'd)** | | | | | | | |
| Murray cod, goodoo (*Maccullochella peelii peelii*) | High | Low to High [1] | Moderate to Major | Preliminary discharge guidelines have been developed to reduce the impacts of coal seam gas water discharges to watercourses located in the survey area 2 and survey area 9 properties. The guidelines were developed based on the findings of the literature review, a review of the spells analysis and through technical professional discussions which drew on previous experience in other comparable aquatic systems (including for the Murray-Darling Basin).<br>A preliminary guideline of a 20% deviation from the current flow conditions was developed for discharges of coal seam gas water. Extended periods of sustained low flow would also be maintained (including no flow). Bottle Tree Creek at survey area 2 (and to a lesser extent the Condamine River at survey area 9) are ephemeral in nature and this indicative deviation level would limit the extent of adverse impacts on aquatic ecosystem function in these watercourses.<br>See SREIS Chapter 10, Aquatic Ecology, Section 10.4.5 for further details. | Low | Moderate | Yes (MNES Referral Guidelines 7 and 9) at survey area 2 and 9 (see Appendix C for details) |

1. The magnitude of the project impacts from the continuous releases of coal seam gas water into receiving waterways is considered to be 'high'. The magnitude of all other project impacts is considered to be 'low'. See species profile in Appendix C for details of this assessment, and the assessment of whether a significant impact is expected at known properties.

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Flora** | | | | | | | |
| Kogan wax flower *(Philotheca sporadica)* | Moderate | Major | High | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to these species. | Moderate | Moderate | No |
| An unnamed mint-bush (*Prostanthera sp*. (Dunmore D.M.Gordon 8A)) | Extremely high | High | Major | | Moderate | High | No |
| Austral toadflax, toadflax (*Thesium australe)* | High | Moderate | Moderate | | Low | Moderate | No |
| Belson's panic (*Homopholis belsonii)* | High | High | High | | Low | Moderate | No |
| Curly-bark wattle (*Acacia curranii*) | Moderate | High | Moderate | • Salvage seed from threatened flora species unavoidably disturbed for use in rehabilitation as propagation material or natural regeneration. [C541] | Moderate | Moderate | No |
| Hando's wattle, Percy Grant wattle. (*Acacia handonis*) | Moderate | Moderate | Moderate | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to this species. | Moderate | Moderate | No |
| Tara wattle (*Acacia lauta*) | Moderate | Moderate | Moderate | | Low | Low | No |
| Small-leaved denhamia (*Denhamia parvifolia*) | Extremely high | Moderate | High | | Moderate | High | No |
| An unnamed acanthus (*Xerothamnella herbacea*) | High | High | High | | Moderate | Moderate | No |
| Austral cornflower, native thistle (*Rhaponticum australe*) | Moderate | Moderate | Moderate | | Low | Low | No |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Flora (cont'd)** | | | | | | | |
| Gurulmundi fringe myrtle (*Calytrix gurulmundensis*) | Extremely high | High | Major | Commitments made by Arrow documented within Attachment 4, Commitments Update, are sufficient to mitigate impacts to these species. | Moderate | High | No |
| Ooline, scrub myrtle (*Cadellia pentastylis)* | Extremely High | Moderate | High | | Moderate | High | No |
| Hawkweed (*Picris evae)* | Moderate | Moderate | Moderate | | Low | Low | No |
| Wardell's wattle (*Acacia wardellii*) | Moderate | Moderate | Moderate | | Moderate | Moderate | No |
| Cobar greenhood orchid (*Pterostylis cobarensis*) | High | High | High | | Moderate | Moderate | No |
| Finger panic grass (*Digitaria porrecta*) | High | High | High | | Low | Moderate | No |
| King blue grass (*Dichanthium queenslandicum*) | High | Low | Moderate | | Low | Moderate | No |
| Lobed blue grass (*Bothriochloa biloba*) | Moderate | High | Moderate | | Moderate | Moderate | No |
| Queensland white gum (*Eucalyptus argophloia*) | Moderate | Low | Low | | Negligible | Low | No |
| Shiny-leaved ironbark (*Eucalyptus virens*) | High | Moderate | Moderate | | Low | Moderate | No |

**Table 9.1 Impact assessment, showing unmitigated and residual impact significance (cont'd)**

| MNES | Values Sensitivity | Pre Mitigated Impacts Across Project Development Area | | Species Specific Mitigation Measures | Residual Impact Across Project Development Area | | Significant Impact at known properties (Y/N) |
|---|---|---|---|---|---|---|---|
| | | Magnitude | Significance | | Magnitude | Significance | |
| **Flora (cont'd)** | | | | | | | |
| An unnamed member of the Scrophulariaceae family (*Microcarpaea agonis*) | Extremely high | Major | Major | • Develop a site-specific management plan to reduce changes to wetland habitat hydrology, including water quality, in areas of ground-truthed populations of *Microcarpaea agonis* adjacent to work sites. [C558]<br>• Demarcate in order to restrict access to any ground truthed populations of *Microcarpaea agonis* identified adjacent to work sites. [C559] | High | Major | No |
| Machin's macrozamia (*Macrozamia machinii*) | Extremely high | Major | Major | • Record the location of any newly identified populations of Machin's macrozamia (*Macrozamia machinii*) and confidentially notify relevant authorities. [C563] | High | Major | No |

Note: Significant impact (Y/N) determined in species profiles in Appendix C against MNES significant impact guidelines criteria on the five known properties.

In some cases, the residual impact has remained at the same level as the unmitigated impact after considering the effect of implementation of mitigation measures. The implementation of environmental controls outlined in Section 8 of this attachment will reduce the overall magnitude of impact on each species or community. The reduction in the magnitude of impact may be insufficient to lower the broad level of magnitude (i.e., low, moderate, high, very high) although within these categories the magnitude of impact may have in fact reduced.

Planning of field development will use constraints mapping to consider the presence and potential presence of MNES species and communities. The conceptual layout will be refined as a result of preconstruction clearance surveys undertaken by suitably qualified person(s). Preconstruction clearance surveys will be undertaken prior to vegetation clearance, including in areas potentially containing MNES. Data collection will be ongoing and the results used to refine areas of known and possible core habitat for threatened species.

The avoidance of ‘core habitat known’ will be a priority in the planning and design of project infrastructure and the selection of sites. Areas classed as ‘core habitat known’ will be avoided if practicable, and will not require additional survey work on this basis. If clearing is planned in areas of core habitat known or possible, survey work appropriate to the species or community in question will be conducted before any site works are undertaken.

Site assessment and ecological survey methods appropriate for each listed threatened species, migratory species, their habitat and listed threatened ecological communities will be applied, and a record will be kept of these surveys and results submitted to the Australian government on request.

Preconstruction clearance ecological surveys inform any further refinement of the conceptual gas field layout, particularly the location and arrangement of production facilities and routes for medium pressure gas pipelines. The outcome of field surveys informs the detailed design of the gas field and selection of equipment and construction methods that address the environmental constraints. The environmental management controls (standard operating procedures) applicable to the proposed activities at the selected sites or routes are identified and incorporated in the work plans. An outline of approach for these surveys is presented and discussed in SREIS Chapter 11, Terrestrial Ecology.

Site management measures will be developed and approved prior to construction. These measures will include additional site specific measures to the commitments outlined in the EIS and SREIS as required.

Measures for management of MNES species, including methods for translocation of MNES species, amendments to clearing plans (in terms of methods used and/or timing of clearing) and offsets will be developed dependent on what species or habitat is identified.

Arrow will aim to carry out project activities to avoid MNES species and communities where practical, although this may not always be possible. Some species have high to major residual impacts as the assessment assumes that populations will be present within the project development area and that the species cannot be avoided (therefore the significance of impacts would be high). The characteristics of the species of high or extremely high sensitivity, that retain high to major residual impacts, are summarised below. This information will assist Arrow to implement preconstruction clearance surveys that will establish the presence and status of these species within the project development area, and develop site specific management plans where necessary.

- ***Anomalopus mackayi.*** The species mainly occurs in native grasslands and Arrow will aim to avoid core habitat for this species.

- ***Anthochaera phrygia.*** The habitat for this species consists of dry eucalypt woodland and open forest, woodland, and rural and urban areas with mature eucalypts. There are no known breeding populations within the project development area. If populations are discovered, Arrow will aim to avoid these areas.
- ***Delma torquata.*** This species has been found as a small number of individuals approximately 12 km west of Wondul Range National Park. The bulk of records occur outside the project development area. The species is often found in very small, restricted populations. Preconstruction clearance surveys will aim to identify the location of this species in development areas so core habitat can, where possible, be avoided.
- ***Tympanocryptis cf. tetraporophora.*** Native grasslands listed as essential habitat for species, but also regularly recorded in sorghum crops adjacent to native grassland verges. Arrow will aim to determine the presence of this species through preconstruction clearance surveys and will aim to avoid any identified areas of core habitat.
- ***Macrozamia machinii.*** This species is mainly located in the Wondul Range which Arrow intends to avoid. Arrow will aim to avoid any other locations where this species is found to occur.
- ***Calytrix gurulmundensis.*** This species was found outside the project development area and just along the border of the area. Arrow will aim to determine the presence of this species through preconstruction clearance surveys and will aim to avoid any identified areas of core habitat.
- ***Prostanthera* sp. (Dunmore).** Arrow will identify the presence of this species through preconstruction clearance surveys, aim to avoid any identified areas of core habitat and use appropriate buffers to protect identified populations of the species.
- ***Cadellia pentastylis*.** Arrow will identify the presence of this species through preconstruction clearance surveys, aim to avoid any identified areas of core habitat and use appropriate buffers to protect the species.
- ***Denhamia parvifolia.*** Arrow will identify the presence of this species through preconstruction clearance surveys, aim to avoid any identified areas of core habitat and use appropriate buffers to protect identified populations of the species.
- ***Microcarpaea agonis.*** The only known occurrence of this species is approximately 6 km outside of the project development area. Arrow will take the potential presence of this species into account in designing preconstruction clearance surveys, aim to avoid any identified areas of core habitat and use appropriate buffers to protect the species if preconstruction clearance surveys discover additional populations adjacent to work sites.

Where avoidance is not possible, Arrow will minimise the area of habitat or number of species affected by reducing the right of way and workspace requirements and through micro-siting or realignment of facilities and infrastructure.

Recovery plans (identified under each species or community profile where applicable) and offset plans will also be implemented on a site-specific basis as required. Arrow's offsets strategy relevant to MNES species and communities is discussed in Section 12 of this attachment.

# 10. POTENTIAL DISTURBANCE AREAS

Residual impacts on MNES from loss of vegetation and habitat may not be able to be avoided in all situations, although EPBC Act-listed communities and habitat will be avoided where practicable and the footprint of any impacts minimised.

Threatened communities present or potentially present in the project development area and their extents, as defined by Queensland Government mapping and from targeted field surveys, are listed in Table 10.1, along with a preliminary estimate of the area potentially disturbed as calculated in Attachment 7, Draft Environmental Offset Strategic Management Plan.

Offset calculations are based on a combination of advanced field layout (where development has matured) and a generic grid-layout. The intersect of the conceptual field layout and REs/habitat for MNES provides an indication of areas of disturbance. Significant further refinement will be required to develop a final offsets proposal as infrastructure locations become known. Arrow will develop a staged offsets approach which aims to incentivise the avoidance of sensitive areas.

The precise location of project infrastructure is yet to be determined, and will be guided by the environmental constraints identified within particular areas. This environmental framework approach, developed by Arrow, allows for the maximum possible area of vegetation and habitat loss to be avoided. The actual area of disturbance will likely be significantly lower than the conceptual disturbance area based on the current conceptual field layout shown in Table 10.1.

**Table 10.1 Potential area of disturbance of EPBC Act-listed threatened ecological communities in the project development area**

| Ecological Community | EPBC Act Status | Existing Within Project Development Area (ha) | Area Within Conceptual Field Development Layout (ha) |
|---|---|---|---|
| Brigalow (*Acacia harpophylla* dominant and co-dominant) | Endangered | 7,387 | 106.4 |
| Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland | Critically Endangered | 678 | 0 (No disturbance authorised) |
| Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions | Endangered | 206 | 8.1 |
| White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland | Critically Endangered | 260 | 0 (No disturbance authorised) |
| Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions | Endangered | 35 | 0 |
| Weeping Myall Woodlands | Endangered | <1 | 0.8 |

# 11. CUMULATIVE IMPACTS

The Surat Gas Project lies within the Brigalow Belt South Bioregion and contains vegetation communities and flora and fauna species of national significance. This bioregion is a major pastoral and agricultural area with much of the natural vegetation heavily cleared as a result of land development. The resulting landscape is one of isolated patches of remnant, disturbed and regrowth vegetation, which vary in size, shape and isolation. This is evident in the network of linear vegetation (both remnant and regrowth) along road verges and fence lines; and by the few larger stands of vegetation containing unbroken habitat preserved in areas that are either unsuitable for agriculture, or that have been preserved through alternative use.

Developments with the potential to contribute to cumulative impacts are those within the same bioregion and have contiguous project boundaries with the Surat Gas Project. These include other coal seam gas developments and pipelines, the Arrow Surat Pipeline, Cameby Downs Coal Expansion, Elimatta Coal and Wandoan Coal projects. Other less relevant developments are those with negligible predicted impacts to MNES. The cumulative impact assessment targeted ecological values that are at a greater residual risk of cumulative impact.

Two potential cumulative impacts to terrestrial ecology were identified:

- Habitat loss and fauna mortality.
- Fragmentation of habitat and isolation of populations.

These impacts are largely the result of vegetation clearance and ground disturbance works during construction.

An assessment of cumulative impacts undertaken in Attachment 3 of the EIS, Matters of National Environmental Significance identified a number of MNES communities and species with high potential for cumulative impact.

Further details on cumulative impacts at an individual MNES community or species level, are presented in the individual community and species dossiers presented in Appendix C to this attachment. The assessment has concluded that there is limited potential for cumulative impacts to be incurred to MNES as a result of Arrow's development actions, if avoidance of core habitat is achieved.

Cumulative impacts to MNES should be managed at the individual project scale and assisted by a collaborative approach between the proponents of interacting developments, particularly in regards to ongoing ecological studies and habitat offsets.

# 12. SURAT GAS PROJECT OFFSET STRATEGY

This section summarises the potential offset requirements, derived from the revised assessment provided by this report for the MNES species and communities for which the project was declared a controlled action under the EPBC Act.

The Australian Government's EPBC Act Environmental Offsets Policy provides the framework for the provision of offsets for MNES that are subject to significant impacts as a result of the project construction and operation.

The Environmental Offsets Assessment Guide (SEWPaC, 2012), which accompanies the policy, has been developed to give effect to the requirements of the policy, using 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 Surat Gas Project.

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 Surat Gas Project EIS was finalised, and governed by the Queensland Government Environmental Offsets Policy, June 2008 (EPA, 2008). This policy is currently under review (as of November 2012). However, the State Government has since 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 has developed an Environmental Offset Strategy that sets out is approach to the delivery of offsets across all of its projects.

Arrow's principles for environmental offsets are:

- 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.

Arrow has developed a Draft Environmental Offset Strategic Management Plan (Attachment 7, Draft Environmental Offset Strategic Management Plan), consistent with its Environmental Offset Strategy. This plan:

- Describes measures taken to avoid and minimise impacts.
- Identifies Arrow's conceptual area of disturbance.

- Presents evidence that there are opportunities to achieve the required offsets.
- Sets out Arrow'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 REs, to facilitate identification of potential offset sites. The document also provides an area (in ha) of the intersect between the conceptual field development layer, and areas of core habitat known for each MNES species or community. Preliminary indications are that the proportion of core habitat known for each MNES within the conceptual field development layer is small, and application of the framework approach will likely reduce this area further. Any offsets required, are likely be sourced from areas of suitable habitat for each MNES, identified under each RE. Preliminary assessment of the availability of regional ecosystems indicates that there are sufficient areas within which to identify potential offset sites.

# 13. OUTLINE OF ENVIRONMENTAL MANAGEMENT PLAN

Environmental management and mitigation measures specific to EPBC listed species and communities are set out in Section 8 of this attachment. Further details are provided in SREIS Attachment 2, Strategic Environmental Management Plan, which provides an update to Attachment 5 of the EIS, Environmental Management Plan.

Arrow will develop a series of management plans that will include specific species and impact specific protection and mitigation measures. These plans will include the following:

- Species management plan (see C224), including translocation (C482).
- Pest management plan (see C188).
- Fire management plan (see C223).
- Decommissioning and rehabilitation plan (see C245, C250).

The proposed structure of a species management plan is provided in Attachment 2, Strategic Environmental Management Plan. Management plans will be informed by community and species profiles in Appendix C of this attachment.

## Structure of Environmental Management Plan

The EMP details environmental values, issues and impacts, and associated management measures for Arrow to implement during construction, operation and decommissioning of the project. The plan has been developed in accordance with the project terms of reference and addresses environmental issues identified during the environmental impact assessment process. While the EMP is part of the EIS it is designed as a stand-alone document for reference and use during the project. As such, the plan is a 'living' document intended to be updated as the project proceeds through construction to operation and finally to decommissioning.

The EMP will inform the environmental management plan (EM Plan) that will be prepared to support the application for Arrow's environmental authority for the Surat Gas Project.

The key objectives of this environmental management plan are to:

- Document acceptable environmental protection commitments to manage potential impacts on the environmental values as a result of proposed activities and, in doing so, to help the administrating authority decide on the approval conditions for the EIS.
- Provide the community with evidence that the environmental management of the project is appropriate.

The environmental protection commitments of the EMP are based on site-specific environmental assessments from specialists, environmental best practices and proven research where available.

### *Environmental Management Plan Scope*

The EMP describes Arrow's approach to the management of environmental impacts associated with project activities, from planning and design through to decommissioning and rehabilitation. Broadly the EMP describes the following:

- Arrow's Health, Safety and Environmental Management System (HSEMS).
- Existing and proposed activities associated with the Surat Gas Project.

- Existing environment of the project development area and surrounds, including the identification of relevant environmental values.
- Potential impacts of the project's activities on identified environmental values.
- Environmental protection commitments for each of the following environmental elements to minimise the identified potential impacts:

  – Air quality.
  – Geology, landform and soils.
  – Landscape and visual amenity.
  – Terrestrial ecology.
  – Groundwater.
  – Surface water.
  – Aquatic ecology.
  – Coal seam gas water.
  – Dams.
  – Noise and vibration.
  – Waste.
  – Preliminary hazard and risk.
  – Indigenous cultural heritage.
  – Non-Indigenous cultural heritage.
  – Roads and transport.
  – Agriculture.

Each element of the plan provides a short summary of the existing environment and impacts pertaining to that discipline. Management measures for all project-related activities from design and planning through to decommissioning are detailed for each element.

# 14. INSPECTION AND MONITORING

This section describes proposed inspection and monitoring for MNES species and communities. The inspection and monitoring will observe and report on the performance of the proposed mitigation and management measures, with a focus on facilitating early intervention and remediation of identified non-conformances or the implementation of adaptive management if required.

Inspection and monitoring measures have been designed to extend throughout the project and beyond the decommissioning phase. The process of landscape recovery may be ongoing well beyond the life of the project and the risk of impact from disease, exotic species or changes to the population dynamics of threatened species will continue until the process of landscape stabilisation is complete.

Inspection and monitoring measures include:

- Inspect areas of avoidance to ensure that boundaries are clearly marked prior to clearing activities.
- Monitor clearing activities to ensure marked boundaries are adhered to.
- Inspect marked areas after clearing activities to ensure areas of avoidance remain and that no unauthorised encroachment has occurred.
- Supervise construction activities in sensitive areas to ensure appropriate methods (e.g., narrowing of ROW) are being implemented, where required
- Inspect and manage open trenches in accordance with the following:
  - Inspect trenches for the presence of fauna daily (preferably in the morning), as well as immediately prior to closing a trench.
  - Have appropriately trained personnel remove any fauna from a trench to minimise stress to the animal and to avoid personal injury.
  - Record details of trapped fauna for inclusion in the EHP Wildnet database.
- Carry out routine monitoring of rehabilitation success.
- Inspect and monitor the success of newly propagated or translocated listed species, in accordance with the approved translocation or management plan.
- Inspect erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures are maintained.
- Routinely inspect for pest flora and evidence of pest fauna species within project disturbed areas.
- Inspect food scrap bins and exclusion fences to ensure they are properly operated and maintained.
- Develop monitoring programs that are site-specific and based on the identified risk to the conservation or maintenance of a viable population.

# 15. ENVIRONMENTAL RECORD

Arrow is committed to the sound management of health, safety and the environment throughout all of its business activities. The company maintains a comprehensive and integrated Health, Safety and Environmental Management System (HSEMS) based on the principles of the International Standard for Environmental Management Systems - AS/NZS ISO 14001(AS/NZS, 2004) and the Australian Standard for Occupational Health and Safety Management System - AS/NZS 4801:2000 AS/NZS, 2001.

Arrow Energy Holdings Pty Ltd (Arrow) and/or its subsidiaries have received two penalty infringement notices (PINs) relating to non-compliances with Environmental Authority conditions issued under the Queensland Environment Protection Act 1997. The PINs related to:

1. Unauthorised clearing of a Category B Environmentally Sensitive Area; and
2. Unauthorised release of coal seam gas water to land.

Arrow is not aware of any other fines or prosecutions for breaches of environmental legislative requirements in the past five years.

# 16. REFERENCES

Biosecurity Queensland. 2008. Petroleum industry (including coal seam methane gas) minimising pest spread advisory guidelines. Department of Primary Industries and Fisheries. Brisbane, Queensland.

Coffey Environments. 2012. Surat Gas Project Environmental Impact Statement (EIS). Prepared by Coffey Environments Pty Ltd for Arrow Energy Pty Ltd, Brisbane, Queensland.

DERM. 2008. Biodiversity planning assessments (BAMM). A WWW publication accessed on 22 May 2013 at http://www.ehp.qld.gov.au/ecosystems/biodiversity/biodiversity_assessment_and_mapping_methodology_bamm.html. Queensland Government. Department of Environment and Resource Management. Brisbane, Queensland.

DERM. 2011. Ecological Equivalence Methodology Guideline Policy for Vegetation Management Offsets Queensland Biodiversity Offset Policy - Version 1. Queensland Government, Department of Environment and Resource Management. Brisbane, Queensland.

DEWHA. 2009a. Matters of National environmental significance, Significant Impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999. Department of the Environment, Water, Heritage and the Arts, Australia.

DEWHA. 2009b. Significant impact guidelines for 36 migratory shorebird species - EPBC Act policy statement 3.21. Australian Government, Department of the Environment, Water, Heritage and the Arts. Canberra, Australian Capital Territory.

Environment Australia. 2001. A Directory of Important Wetlands in Australia, Third Edition. Environment Australia. Canberra, Australian Capital Territory.

EPA. 2008. Queensland Government Environmental Offsets Policy. June. Environmental Protection Agency.

Forster P. 1997. Recovery Plans for Endangered Cycads: A Model Set of Objectives and Actions Using the Example of *Cycas megacarpa* from Queensland, Australia. Memoirs of the New York Botanical Gardens, Vol. 97: 4 – 31.

OGIA. 2012. Underground water impact report for the Surat cumulative management area. Office of Groundwater Impact Assessment. Department of Natural Resources and Mines. Brisbane, Queensland.

Parsons, S., Evans, R. and Hoban, M. 2008. Surface-groundwater connectivity assessment. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project. CSIRO, Australia, 35pp.

SEWPaC. 2012. Offsets Assessment Guide. Department of Sustainability, Environment, Water, Population and Communities. Canberra, Australian Capital Territory.

TSSC, SEWPaC. 2012. Rationale for recommendation by the Threatened Species Scientific Committee to determine that the combined koala population in Queensland, New South Wales and the Australian Capital Territory be considered a species for the purposes of the Environment Protection and Biodiversity Conservation Act (1999), Canberra, Australian Capital Territory.

# Appendix A

## Response to SEWPaC Submission on Surat Gas Project EIS MNES Attachment

## Table 1 Response to SEWPaC submission

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 1 | The draft EIS is well presented and easy to understand. It generally meets the department's requirements in respect of matters of national environmental significance (MNES), however some more detail, particularly around impacts on MNES, is required.<br>While we understand that a number of our comments below can be addressed by information, studies and reports already provided in the draft EIS, the MNES chapter must be a standalone chapter that exclusively and fully addresses MNES listed as controlling provisions for this project. Cross-referencing to other parts of the EIS can be provided in the MNES chapter, but important information (such as quantification of impacts, rationale for determinations of non-significance and assessment of cumulative impacts on MNES) must be provided in the MNES chapter. | **EIS**<br>Attachment 3<br>**SREIS**<br>Attachment 1, sections 5.5 and 9 and appendices A and C | Noted. The EIS Matters of National Environmental Significance (MNES) attachment relies on information in the EIS to provide background, context and detailed information such as survey methods. SREIS Attachment 1, Matters of National Environmental Significance, provides additional clarity on MNES including key information on the estimated quantification of impacts (Section 9 and Appendix C), the rationale for the determinations of non-significance (Section 5.5), and a review of cumulative impacts on MNES for each community/species (Appendix C). SREIS Attachment 1 addresses comments made by the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) on the EIS (Appendix A) and includes further information requested as well as specific references to sections in chapters, attachments and appendices in the SREIS. |
| 1a | The draft EIS provides a broad discussion of the threats to MNES and the mitigation measures proposed. However we require predictions of threat, impact and the benefits of any mitigation measures to be clearly stated for each individual MNES and supported by evidence and rationale to support these statements. For the listed threatened or migratory species that are believed not likely to be impacted by the action, but for which suitable habitat is present and could be impacted by the action, we require detailed information to clearly demonstrate that a likely impact on the species will not occur. | **EIS**<br>Appendix K, sections C, E and I (appendices)<br>**SREIS**<br>Attachment 1, sections 5.5, 8 and 9 and Appendix C | Profiles (dossiers) of all MNES species potentially occurring in the project development area have been compiled and are included in EIS Appendix K, Terrestrial Ecology Impact Assessment, Sections C, E and I (Appendices).<br>SREIS Attachment 1, Matters of National Environmental Significance, Appendix C provides updated dossiers for MNES species and communities prepared in accordance with the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999. Cross references to the EIS and SREIS have been provided where information already exists, as well as further explanation of the rationale to support the determination of significance supplied in SREIS Attachment 1, Section 9. This includes the discounting of any species unlikely to be present within the project development area (SREIS Attachment 1, Section 5.5).<br>General mitigation measures, inclusive of those presented in the EIS and newly developed for the SREIS that are applicable to all species are provided in SREIS Attachment 1, Section 8. Species specific mitigation measures are provided in the species specific assessments within Appendix C in each dossier, where required. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 1b | We require information on the survey methodology used, including any limitations of the methodology and data collected for each matter of MNES, as well as a justification for the survey methodology employed, including how these follow relevant Commonwealth survey guidelines where available at the time of surveying (e.g. the Survey Guidelines for Australia's Threatened Birds (SEWPaC)). We also require information around what targeted surveys were undertaken, where they were undertaken and for what species they were undertaken. Please include the justification as to why surveys were not undertaken in areas where there are known records of listed threatened species and communities and listed migratory species in the project area. | **EIS**<br>Chapter 17, Section 17.2.3 and Appendix K, Section 4.4<br>**SREIS**<br>Chapter 2, Section 2.3.1, Attachment 1, Appendix C, Attachment 2 and Appendix 9, Section 5.6 | Information on the survey methodology used is provided in the EIS, Appendix K, Terrestrial Ecology Impact Assessment, Section 4.4 and Chapter 17, Terrestrial Ecology, Section 17.2.3.<br>The size of the project development area (8,600 $km^2$ at the time of the EIS) made detailed survey for listed species and communities impractical. Consequently, Arrow developed two approaches to identify and understand the extent of MNES present within the project development area.<br>Firstly, desktop study and detailed dossiers on species identified those species and communities potentially present and potentially at risk based on habitat. Field surveys were used to validate the viability of habitat assessed as most sensitive to impacts. This information was then used to compile constraints mapping that identified no go areas and areas of high, moderate and low constraint to development.<br>The types of development that were appropriate for each level of constraint were identified as well as the appropriate level of environmental management i.e., standard or procedural, detailed and site specific controls. This approach is known as the 'environmental framework' and is designed to protect MNES through avoidance (Arrow knows what is constrained and why) and minimisation (what controls are required for each level of constraint to reduce the potential impact).<br>Areas presented in the EIS as potential facility locations have been further refined for the SREIS and have been surveyed to further refine habitat mapping and species. Detailed site assessment have been undertaken at four potential central gas processing facility locations and one potential accommodation village location with detail provided at the property scale. SREIS, Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 5.6 provides detail of each of these properties and describes MNES likely to be present on each property.<br>Used in gas field design, this approach has been supported by ecological surveys of areas of interest as part of the detailed design process, again aimed primarily at avoidance and secondarily at minimisation of impacts on listed species including MNES. Finally (i.e., if not covered by the ecological surveys), preconstruction clearance surveys will implement procedures for the management of MNES identified in areas to be cleared, such as translocation.<br>SREIS Chapter 11, Terrestrial Ecology, Section 11.5 includes an overview of Arrow's approach to site validation of environmental values, including preconstruction clearance surveys that will be undertaken. Details of survey requirements in accordance with guidelines are detailed within Appendix C of SREIS Attachment 1, Matters of National Environmental Significance. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 1b (cont'd) | | | This structured and rigorous approach while not specifically addressing the survey requirements of the EPBC Act for the entire project development area, allows for the identification, management and in some instances, protection of MNES, as part of the coal seam gas field planning, design and execution processes. |
| 1c | We require a discussion of the extent to which identified impacts can be forecast or predicted. Consistent with Section 3.01(c) of Schedule 4 of the EPBC regulations a statement whether any of the relevant impacts are likely to be unknown, unpredictable or irreversible must be provided for each individual MNES for each project. Please include, where available, common names as well as scientific names for EPBC listed species throughout the draft EIS – this will assist the public understand what species are being considered. | **SREIS** Attachment 1, Appendix C | SREIS Attachment 1, Matters of National Environmental Significance, Appendix C provides updated profiles (dossiers) for MNES prepared in accordance with the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999 and Section 3.01(c) of Schedule 4 of the Environment Protection and Biodiversity Conservation Act 1999 regulations. This includes a statement whether any of the relevant impacts are likely to be unknown, unpredictable or irreversible for MNES species and communities. Common names for each species are provided where available in the SREIS and specifically SREIS Attachment 1. |
| 1d | When discussing impacts on MNES in the MNES chapter you may wish to consider the following approach:<br>• Discuss the relevant species or community in respect of generalised known threats and those threats posed by the proposed action;<br>• Quantify and discuss likely direct, indirect and cumulative impacts from the proposed action;<br>• Describe and assess effectiveness of avoidance and mitigation measures to deal with relevant impacts and provide supporting information;<br>• Quantify and discuss residual impacts (and maximum disturbance limits, where relevant); and<br>• Make a conclusion on the level of impact and its significance, and provide a rationale for this determination. | **EIS** Attachment 3, Table 8.1 and Appendix 1<br>**SREIS** Attachment 1, Appendix C | Detailed assessments for each identified MNES are presented within SREIS Appendix 1, MNES, Appendix C. These dossiers provide an overview of known threats and those threats posed by the proposed action, potential impacts from the proposed action and avoidance and mitigation measures to reduce residual impacts.<br>Table 8.1 within EIS Attachment 3, Matters of National Environmental Significance, presents the significance of the potential impacts determined for each species identified from the EPBC Protected Matters search that potentially occur within the project development area. Discussion of the rationale for the conclusion on significance is also provided for each species or community specific MNES assessment within Appendix 1, of EIS Attachment 3.<br>The significance assessment approach adopted by Arrow for the EIS is underpinned by management measures that are effective and proven, based on industry standards where practical. The management measures set out in the EIS have been reviewed by various departments within Arrow to confirm they can be implemented from a technical feasibility and financial perspective, and that they will be effective in managing the identified impacts.<br>Consideration for the outlined approach has been given during preparation of the SREIS. |

## Table 1 Response to SEWPaC submission (cont'd)

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 2 | We require quantification of suitable habitat onsite for each EPBC listed threatened ecological community (e.g. how much of RE 11.3.1, 11.4.3, 11.4.10, 11.4.9.5 and 11.9.6 is present or potentially present onsite and the total amount of suitable habitat for Brigalow onsite). | **EIS** Chapter 17, Section 17.3.3 **SREIS** Attachment 1, Section 5.2, Appendix 9, Section 2, Section 5, Table 4 and Table 6 | An estimate of the extent of habitat in the project development area has been presented in EIS Chapter 17, Terrestrial Ecology, Section 17.3.3, as the area of regional ecosystems (vegetation classification system used by the Queensland Government). As part of the updated project description presented in SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 2, the project development area has been reduced from 8,600 $km^2$ to 6,100 $km^2$.<br>The relationship between regional ecosystems, MNES communities and habitat for MNES species is discussed within SREIS Attachment 1, Matters of National Environmental Significance, Section 5.2. This relationship has been further refined through the SREIS process to provide an estimate of the amount of each community and habitat present within the revised project development area. These estimates are based on a set of criteria and process as outlined in SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 5, Table 4 and Table 6. |
| 2a | Although maps have been provided that identify EPBC listed communities in the project area, it would assist us (and the public) if these maps clearly differentiated between each of the ecological communities. | **EIS** Attachment 3, figures 4.3 a-c **SREIS** Attachment 1, figures 5.2 a-c | Figures 4.3 a-c from EIS Attachment 3, Matters of National Environmental Significance, have been updated within SREIS Attachment 1, Matters of National Environmental Significance, Figures 5.2 a-c to differentiate between different EPBC listed ecological communities. |
| 2b | We note that the Queensland Water Commission released the Underground Water Impact Report Surat Cumulative Management Area – Consultation Draft (May 2012). Please discuss how the release of the Queensland Water Commission's report will inform the supplementary EIS in respect of MNES (if at all). | **EIS** Chapter 14 Appendix G **SREIS** Attachment 1, Section 5.5.1 | The Surat Underground Water Impact Report (QWC, 2012) prepared by the Queensland Government validates the findings of the groundwater impact assessment presented in EIS Chapter 14, Groundwater; and EIS Appendix G, Groundwater Impact Assessment, as it confirms that Arrow's assessment is conservative. The additional information within this report which was previously unavailable to Arrow and the implications of this information on MNES has been presented in SREIS Attachment 1, Matters of National Environmental Significance, Section 5.5.1. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 3 | Please provide a description of the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin (including location, distance from project area, hydrological requirements and relevant surface/groundwater systems that link the community and the project area) and an analysis of impacts on this community (in particular indirect impacts to groundwater quality and quantity). | **EIS**<br>Chapter 14, Section 14.3.3 and<br>Appendix K, Section 6.8.6<br>**SREIS**<br>Chapter 8, Chapter 11, Section 11.4.8 and Attachment 1, Section 5.5.1 | Spring complexes and groundwater dependent ecosystems were discussed in EIS Chapter 14, Groundwater as well as within EIS technical studies Appendix G, Groundwater Impact Assessment, and Appendix K, Terrestrial Ecology Impact Assessment.<br>In EIS Appendix K, Terrestrial Ecology Impact Assessment, Section 6.8.6 states that there are no known groundwater dependant ecosystems in the project development area.<br>SREIS Attachment 1, Matters of National Environmental Significance, includes a cross reference to an updated version of Figure 14.6 from the EIS titled 'Approximate location of known groundwater springs within the groundwater model extent', (Section 5.5.1) which includes data on the locations of spring complexes presented in Surat Underground Water Impact Report (OGIA, 2012).<br>New information presented in Surat Underground Water Impact Report prepared by the Queensland Government has been reviewed and acknowledged within the SREIS.<br>Initial review of the report identified further spring complex (Figure 8-2 of the OGIA report) that was not identified in the EIS. The relationship of that spring complex with potentially affected groundwater systems is provided in SREIS Chapter 8. Arrow will also continue to contribute to the Spring Impact Mitigation Strategy as detailed in SREIS, Chapter 11, Terrestrial Ecology, Section 11.4.8. |
| 3a | Please identify any listed fauna species associated with springs that may be impacted by the project, and provide a description of the species and analysis of impact (for e.g. the Queensland Water Commission's Surat Underground Water Impact Report identifies three listed flora species associated with spring complexes in the Surat Basin; *Eriocaulon carsonii* (Endangered), *Arthraxon hispidus* (Vulnerable) and *Phaius australis* (Endangered)). | **EIS**<br>Chapter 14, Section 14.3.3 and<br>Appendix K, Section 6.8.6<br>**SREIS**<br>Chapter 8, Chapter 11, Section 11.4.8 and Attachment 1, Section 5.5.1, Appendix 1, Figure 5.5 | Spring complexes and groundwater dependent ecosystems were discussed in EIS Chapter 14, Groundwater, Section 14.3.3 as well as within EIS technical studies Appendix G, Groundwater Impact Assessment, and Appendix K, Terrestrial Ecology Impact Assessment.<br>In EIS Appendix K, Terrestrial Ecology Impact Assessment, Section 6.8.6 states that there are no known groundwater dependant ecosystems in the project development area.<br>Since the EIS was finalised, additional information on groundwater dependent ecosystems has become available, as discussed in SREIS Chapter 8, Groundwater and SREIS Chapter 11, Section 11.4.8. A number of desktop studies and field investigations (hydrogeological, ecological and botanical) have been conducted within the Surat Cumulative Management Area (CMA), and used to inform the Underground Water Impact Report (UWIR) (OGIA, 2012) prepared by the Queensland Government.<br>A reduced groundwater level, and/or changes to groundwater quality in groundwater dependent ecosystem source aquifers are the primary mechanisms by which detrimental impacts can occur on MNES species associated with the ecosystem. The groundwater modelling results presented in the Surat CMA UWIR confirm that the findings of the groundwater impact assessment presented in Chapter 14 of the EIS, Groundwater; and Appendix G of the EIS, Groundwater Impact Assessment, are conservative in relation to predicted groundwater drawdown levels. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 3a (cont'd) | | | One spring complex, identified since the EIS was finalised, was assessed for the potential presence of Groundwater Dependent Communities and Species of interest under the EPBC Act and the Vegetation Management Act (VM Act). This complex is located 35 km west of the project development area and may be inter-related to the groundwater systems potentially impacted by the Surat Gas Project.<br>The spring is located outside of the project development area, and is unlikely to be directly impacted by project related activities. This area will not be exposed to Arrow's clearance activities nor any direct disturbance by Arrow. Terrestrial ecology values associated with the identified spring complex are unlikely to be impacted.<br>Groundwater dependent ecosystems are recognised in Queensland in discharge areas of the Great Artesian Basin, and not located in Tertiary aquifers (younger geological units associated with overlying fluvial and alluvial sediments), as part of regional ecosystems 2.3.39, 4.3.22 and 6.3.23 which are listed as Endangered under the VM Act. These regional ecosystems are not present in the project development area and were not found to be present during field investigations (Unpublished Report)<br>The Fitzroy River turtle (*Rheodytes leukops*) is also described within the context of a groundwater dependent ecosystem due to the potential movement between spring-fed watercourses identified in the Surat CMA.<br>The Fitzroy River turtle is only known to occur within the Fitzroy Basin, not the Murray-Darling Basin (within which the vast majority of the project development area is situated). A small portion of the project development area falls within the Dawson River catchment of the Fitzroy Basin.<br>No specimen of Fitzroy River turtle has been recorded within the project development area. Database search results did return the species as 'possibly' occurring within the small portion of the project development area occurring within the Dawson River catchment.<br>Three EPBC Act listed flora species, *Eriocaulon carsonii, Arthraxon hispidus* and *Phaius australis*, were identified as being potentially present in association with the spring complex (situated outside of the project development area) (Figure 8-2 of the QWC report) . The supplementary terrestrial ecology assessment (SREIS Appendix 8, Section 5.2.3) excludes these species from being present within the project development area. Field investigations found these species to be absent from the spring complex (Unpublished Report). |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 3a (cont'd) | | | The additional information on groundwater dependent ecosystems allows a greater understanding of potential source aquifers and the ecological communities they support. The information indicates that the following types of groundwater dependent ecosystems have the potential to occur within the project development area:<br>• Springs, spring wetlands and spring-fed watercourses.<br>• Groundwater discharge to rivers and wetlands.<br>• Ecosystems dependent on the subsurface presence of groundwater via plant roots accessing shallow groundwater.<br>This additional information was previously unavailable to Arrow. The implications of this information on the assessment of MNES in the project development area are discussed below. The approximate location of known groundwater springs, spring wetlands, and spring-fed watercourses presented in the EIS and those identified in the Surat Underground Water Impact Report are shown on SREIS, Appendix 1, Matters of National Environmental Significance, Figure 5.5.<br>Should the groundwater level and quality data collected as part of the Spring Impact Management Strategy and the Water Monitoring Strategy show significant changes in spring function or associated source aquifer groundwater levels that could potentially impact vegetation communities and associated species, Arrow will determine the required action through the periodic reporting an review obligations under the UWIR. These requirements will also determine the actions to be taken in the event that a previously unidentified groundwater dependent ecosystem is identified. Arrow is also involved in the preparation of a Joint Industry Plan for an Early Warning System for the Monitoring and Protection of EPBC Springs with other coal seam gas proponents operating within the Surat CMA. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 4 | Where suitable habitat exists within the project area please provide quantification of suitable onsite habitat for each EPBC listed threatened species. You may consider presenting this information in Table 4.2.<br>Please provide maps that clearly identify areas of suitable habitat (both on site and regionally) for each EPBC listed threatened species that identify important habitat (where known) for those species, such as habitat type and use (core breeding, foraging habitat etc.). We note that the maps currently provided (4.4a to 4.4c) only show known and possible core habitat for records of EPBC listed threatened species and do not clearly differentiate between suitable habitat onsite for each individual species. A map that identifies habitat for each key species onsite (e.g. endangered or critically endangered species, or species that are known or likely to occur onsite) provides a useful visual that allows the department to understand the landscape, available habitat and connectivity of habitat within and adjacent to the project site. We recognize some habitat for species will overlap and it should be identified for which species this overlapping habitat is suitable. | **EIS**<br>Chapter 17, Section 17.2.2, Attachment 3, figures 4.4 a-c and Appendix K<br>**SREIS**<br>Chapter 17, Section 17.2.2, Attachment 1, Appendix C, Appendix 9, Appendix A2 | Conservation-listed species records are shown on Figures 4.4a-c within EIS Attachment 3, Matters of National Environmental Significance in relation to the project development area. Many species (particularly migratory species) potentially present in the study area are generalist species and it is not possible to isolate a particular habitat type of importance to the species in question.<br>SREIS Attachment 1, Matters of National Environmental Significance, Appendix C presents a dossier for each EPBC listed community and species potentially occurring within the project development area. Individual maps are contained within each dossier with habitat displayed as per the updated mapping criteria (also found within each dossier) refined from the species dossiers found in EIS Appendix K, Terrestrial Ecology Impact Assessment.<br>The updated maps and mapping criteria are informed by the SREIS desktop assessment as described in SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Appendix A2, as well as updated regional ecosystem mapping (Version 7.0 EHP 2012d; regrowth mapping EHP 2012a) and targeted surveys of individual properties identified as potential locations for four central gas processing facilities and one temporary workers accommodation facility. Where mapping wasn't available for a species, the potential habitat preference for the individual species was analysed against known ecological niches as described in EIS Chapter 17, Terrestrial Ecology, Section 17.2.2. |
| 5 | Consistent with previous comments, these maps should state common names for all species records in addition to scientific names. | - | Figures within the SREIS show common names (where available) for all species records in addition to scientific names. |
| 6 | Consistent with previous comments, we recommended including quantification of suitable habitat available onsite for each species in this table.<br>Where it is determined that a species is unlikely they occur (such as the Red Goshawk) a logical rationale for this determination is required, including discussion of suitable habitat and whether any suitable habitat exists onsite (particularly if there are known records of a species onsite). Where suitable habitat is present onsite detailed information must be provided to demonstrate that the species is unlikely to occur, and / or that an impact on the species is unlikely. | **EIS**<br>Appendix K<br>**SREIS**<br>Attachment 1, Appendix C, Appendix 1, sections 5.2.3 and 5.3 | The assessment of the impacts upon each individual MNES followed the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999, and any species or community specific guidelines as detailed under each species or community profile. An estimate of core habitat and suitable habitat within the project development area has been presented in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C; where the species can be associated with particular regulated vegetation habitats (identified as regional ecosystems). This is largely based upon existing information on species' habitat preference and core habitat already contained in the Species Profiles attachment to EIS Appendix K, Terrestrial Ecology Impact Assessment.<br>This process included discounting species unlikely to occur, and presenting a rationale as to why this is the case and why impacts upon the species from the Surat Gas Project are likely to be non-significant. The process has been continued into SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, sections 5.2.3 and 5.3 which contain further detail on species unlikely to occur based on further desktop study and fieldwork. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
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| 6a | If a species has been recorded in the area (e.g. the Five-clawed worm skink) this must be stated, and should be included in Table 4.2.<br>If suitable habitat is deemed not to be present onsite, we require a rationale why this is the case. | **SREIS**<br>Attachment 1, Appendix C | Further clarification on species records and potential habitat use for each individual MNES species is provided in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C within the species specific dossiers. |
| 6b | For species that occur downstream of the project area, we required a detailed discussion around presence downstream and potential downstream impacts (e.g. for the Fitzroy River Turtle, Murray Cod and Bell's turtle). | **EIS**<br>Chapter 16, Section 16.6<br>**SREIS**<br>Attachment 1, Section 5.5 | Arrow's Coal Seam Gas Water and Salt Management Strategy is provided in SREIS Attachment 5. Rationale as to why downstream impacts are not expected for MNES species Fitzroy River turtle, Murray Cod and Bell's turtle is provided in SREIS Attachment 1, Matters of National Environmental Significance, Section 5.5.<br>EIS Chapter 16, Aquatic Ecology, Section 16.6 identifies a number of mitigation measures (commitments) that Arrow will implement to protect water quality and reduce the potential for downstream impacts. Commitments have been updated for the SREIS to include:<br>• Develop and implement emergency response and spill response procedures to reduce impacts that could occur as a result of releases of hazardous materials or loss of containment of storage equipment (Commitment C036).<br>• Ensure appropriate spill response equipment, including containment and recovery equipment, is available on site, or can be mobilised to the impacted site within an acceptable response time and that relevant personnel are appropriately trained (Commitment C037).<br>Arrow will develop a strategy for the discharge of coal seam gas water to watercourses in accordance with relevant legislation. The strategy will incorporate a water quality monitoring program with locations upstream and downstream of the discharge point to inform site specific water quality objectives. A detailed environmental flows assessment informed by water quality monitoring data and an aquatic ecology monitoring program will inform the discharge strategy. Periodic inspections of the physical form and hydrology of the watercourse are to be incorporated in the strategy to monitor geomorphic performance (Commitment C498).<br>The specific details of options for coal seam gas water disposal will be developed further through detailed engineering design. Chosen management options will be detailed in the coal seam gas water management plan required for the EA or EA amendment application. The management plan will include detailed coal seam gas water and brine impacts assessments and management strategies in accordance with the EHP Guideline "Application requirements for petroleum activities". |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
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| 6c | When talking about populations, particularly for species listed as vulnerable, please ensure that terms such as "significant" or "important population" are (preferably) used in the traditional EPBC Act context or (at least) clearly defined.<br>We require justification for determinations of 'possible' likelihood of occurrence for a species when it is known to occur onsite (e.g. the 'ooline' is determined to have a 'Possible' likelihood of occurrence, however there is a known population in the southern portions of the project development area). | **EIS**<br>Appendix E of Appendix K<br>**SREIS**<br>Attachment 1, Appendix C | SREIS Attachment 1, Matters of National Environmental Significance, Appendix C provides updated dossiers for MNES species and communities prepared in accordance with the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999, which includes definitions of important populations.<br>Regarding determinations of possible likelihood of occurrence for a species, and specifically ooline, Appendix E of EIS Appendix K, Terrestrial Ecology Impact Assessment states:<br>*Possible. The taxon is represented within the southwestern part of the PDA (on Kindon Station in the Wyaga Creek area) by two Herbarium collections. The records are very low precision (16000m) and dated from 1919 and 1938, however EPA (2002) identify _Wyaga-Kindon Ooline' as a Special Biodiversity Area where ooline approaches its eastern limit of distribution. It is possible that the records occurred in habitats associated with part of brigalow/belah forests along Wyaga Creek and further detailed surveys are required. The majority of ooline habitat in this area has been cleared however, there remains a possibility of isolated paddock trees and any vegetation associated with RE11.7.1. Ooline is also recorded in brigalow open forest and fragmented softwood scrub vegetation in the Stones Country Resources Reserve West Gurulmundi area located to the west of the PDA. Steep basaltic scree slopes on Captains Mountain near Millmerran are considered low potential habitat and require further survey.*<br>The above analysis provided in the technical report clearly demonstrates that the species is unlikely to be present and that evidence of its 'possible' presence is based on records dating back to 1919 and 1939. Further, threatening processes, particularly vegetation clearing, have significantly reduced the potential for the species to occur in the project development area. The ooline is provided as an example of how the EIS presents this information.<br>Information on likelihood of occurrence for each species identified in the EPBC Protected Matters search within the project development area can also be found in the EIS, Appendix K, Terrestrial Ecology, Appendix E. SREIS Attachment 1 provides an update to this assessment based on further desktop study and fieldwork at potential infrastructure locations. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 6d | We require locations, such as 'the Dalby to St George Stock Route' to be shown on maps (or where maps exist, cross references provided). | **EIS** Appendix K, Figure 13 **SREIS** Attachment 8 | EIS Appendix K, Terrestrial Ecology Impact Assessment, Figure 13 shows the location of state significant habitat within the Queensland bioregional significance framework including the Dalby – St George Road reserve (Dalby – Moonie Road).<br>The size of the project development area (8,600 sq km at the time of the EIS) made detailed mapping of locations such as the Dalby to St George Stock Route for the purposes of the EIS and SREIS impractical.<br>However, such locations were included in constraints mapping that identified no go areas and areas of high, moderate and low constraint to development, which are reflected in EIS Attachment 10, Preliminary Constraints Maps and SREIS Attachment 8, Constraints Mapping Update.<br>The types of development that were appropriate for each level of constraint were identified as well as the appropriate level of environmental management i.e., standard or procedural, detailed and site specific controls. This approach is known as the 'environmental framework' and is designed to protect MNES through avoidance and minimisation (what controls are required for each level of constraint to reduce the potential impact). |
| 7 | Consistent with other controlling provisions, if a migratory species has been recorded in the project development area please provide a map that depicts where that species has been recorded, in what type of habitat and in what numbers. Where suitable habitat is present onsite for a migratory species listed in table 4.3, include a discussion around habitat type, amount of habitat (ha) and importance for each individual species. | **SREIS** Attachment 1, Section 5.4 and Appendix C | Listed migratory species have been discussed in their representative groups of 'Migratory Shorebirds', 'Terrestrial Migratory Birds' and 'Other Migratory Wetland Birds within SREIS Attachment 1, Matters of National Environmental Significance, Section 5.4 and Appendix C.<br>Clarification on habitat type, amount of habitat (ha) and potential for use will be provided for each category where practical.<br>Listed migratory species such as the rainbow bee-eater or the great egret are likely to be widespread throughout the project development area in suitable habitat – these species are wide ranging and associated with many different habitats. No important populations of listed migratory species were identified. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 7a | It is important that the information is provided to support the rationale for your determinations of 'possible' likelihood of occurrence for a species when it is known to occur onsite (e.g. the Australian Painted Snipe has been identified as having a 'possible' likelihood of occurrence, however it has been recorded onsite (table 4.3, page 4-35)). | **EIS** Attachment 3, figures 4.4 a-c and Appendix K **SREIS** Attachment 1, Section 5.5, Attachment 1, Appendix C and Appendix 9, Section 6 | The Excluded Species list, contained within EIS Appendix K, Terrestrial Ecology Impact Assessment, outlines the excluded fauna species. This list also outlines the reasoning behind exclusions, which include a lack of recent records and/or a lack of suitable habitat. Some of the species included in this table are still addressed within EIS Attachment 3, Matters of National Environmental Significance. Further, conservation-listed species records are shown on Figures 4.4a-c of EIS Attachment 3 in relation to the project development area.<br>SREIS Attachment 1, Matters of National Environmental Significance, Appendix C presents a dossier for each EPBC listed community and species potentially occurring within the project development area. Individual maps are contained within each dossier with habitat displayed as per the updated mapping criteria (also found within each dossier) refined from the species dossiers found in EIS Appendix K, Terrestrial Ecology Impact Assessment.<br>SREIS Attachment 1, Section 5.5 and SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 6 provide an update to this assessment based on further desktop study and fieldwork at potential infrastructure locations. |
| 8 | Please provide specific cross references for the "further details of activity assessment and project phases are provided within the EIS main report" (page 5-39).<br>In respect of Section 5. Issues and Potential Impacts, provide detailed information about all potential direct, indirect, downstream and cumulative impacts (including quantification (where possible) and disturbance limits) for each listed threatened species, ecological community and migratory species. For example, we note that weed dispersal or groundwater impacts are not relevant to all species, but will be of specific concern to certain individual listed species and should be discussed in respect of species vulnerable or likely to be affected by such impacts. | **EIS** Appendix E of Appendix K **SREIS** Attachment 1, Section 6 and Appendix C | Dossiers of all MNES communities and species potentially occurring in the project development area were compiled and included in EIS Appendix K, Terrestrial Ecology Impact Assessment. The dossiers form the basis for preparing community or species specific assessments in accordance with the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999. Cross-references have been provided where information already exists.<br>General impacts and issues that are applicable to all species are discussed in SREIS Attachment 1, Matters of National Environmental Significance, Section 6. Where potential impacts and issues are of particular concern to a specific species, they are provided in the species specific assessments provided in Appendix C. |
| 9 | This section of the draft EIS talks about corridors. We require identification of which corridors are being referred to (and depict on maps where possible), which species those corridors are important for, and detail (including quantification) around impacts to those corridors in respect of listed species. | **SREIS** Attachment 1, Appendix C, Attachment 2, Section 5.4.2 and Appendix 9, Section 5.4 | Maps of suitable habitat (core, known and possible) for each EPBC listed species are provided in species dossiers within SREIS Attachment 1, Matters of National Environmental Significance, Appendix C.<br>Terrestrial, flora and fauna specialist input was sought in the preparation and discussion of these maps. Satellite imagery was used where possible to identify potential wildlife corridors, and a discussion has been provided in SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 5.4.2 on species likely to use those corridors. Desktop assessment of narrow vegetation tracts of (potential corridors) connecting vegetation stands were identified as highly constrained (to inform constraints mapping for areas of importance to MNES species). |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 9a | This section of the draft EIS states that "Arrow does not plan to construct well sites or production facilities near aquatic systems". We require clarification around what constitutes 'near' (e.g., 100 m or 1 km), and what constitutes 'aquatic systems'. Where buffer zones are intended, they should be clearly described. | **EIS** Chapter 16, Section 16.3.1 and Attachment 3, Table 7.1 | Queensland legislation prescribes buffers to environmentally sensitive areas and watercourses. The buffers are set out in conditions on environmental authorities for petroleum activities. The buffers have been included as constraints as part of the 'environmental framework' and delineated as 'no go' or highly constrained areas depending on the type of activities precluded by Queensland regulations. Aquatic ecosystems associated with environmentally sensitive areas such as Lake Broadwater are protected, as well as sensitive reaches of rivers and streams in the project development area. The environmental framework does not preclude pipeline crossings of watercourses but does preclude the development of wells and production facilities in buffers included as conditions on environmental authorities.<br>Arrow will implement agreed (conditioned) buffers in accordance with regulatory requirements at the time.<br>EIS Chapter 16, Aquatic Ecology, Section 16.3.1 defines aquatic ecosystems within the study area as diverse with permanent, semi-permanent and highly seasonal lotic (flowing water) and lentic (non-flowing water) environments.<br>The standard environmental authority (EA) conditions imposed on all mining and oil and gas developments in Queensland include buffers on watercourses according to stream order. These conditions currently regulate the Dalby Expansion Project, also operated by Arrow. The conditions describe a no-impact buffer zone (for vegetation clearance or fill placement) from the high bank of watercourses. Alternative buffer requirements exist under the Regional Vegetation Management Code for Brigalow Belt Bioregion and New England Tableland (DERM, 2009) which describe a buffer for streams of the first or second order.<br>Arrow has committed to the protection of aquatic systems and implementing appropriate buffer zones from the high bank of all watercourses within the project development area for the Surat Gas Project, in accordance with regulatory requirements at the time. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 10 | This section of the draft EIS states that "Lake Broadwater has been identified as potential habitat for MNES species". We require this section to identify for which species Lake Broadwater is potential habitat (including habitat type and use). Specific impacts to Lake Broadwater must be discussed in respect of individual listed species.<br>Vague and general statements, such as "other unmitigated impacts", should be avoided or more clearly stated (e.g. what are those unmitigated impacts in respect of listed species). | **EIS**<br>Attachment 10, Figure A10.7<br>**SREIS**<br>Attachment 1, Section 5.5.1, 5.6.1 and Appendix C | Lake Broadwater is a Category A Environmentally Sensitive Area under Queensland legislation that is protected by buffers that preclude certain types of development. Arrow will develop buffers in accordance with legislative requirements applicable at the time.<br>The buffers protecting Lake Broadwater are included in constraints mapping prepared as part of the 'environmental framework', as 'no go' and highly constrained areas. Figure A10.7 within EIS Attachment 10, Preliminary Constraints Maps, specifically shows the 'no go' and highly constrained areas that reflect the buffers on Lake Broadwater. As development activities are precluded from Lake Broadwater, project activities are unlikely to impact on habitat for MNES associated with Lake Broadwater. Arrow will implement agreed (conditioned) buffers in accordance with regulatory requirements at the time.<br>Habitat type and use will be described for individual listed species where specific habitat requirements exist. SREIS Attachment 1, Matters of National Environmental Significance, Section 5.6.1 provides further discussion about Lake Broadwater and how Arrow's management measures intend to protect species that may use Lake Broadwater as habitat. Maps of suitable habitat (core, known and possible) for each EPBC listed species are provided in SREIS Attachment 1, Appendix C, and demonstrate where Lake Broadwater is core, known or possible habitat for each MNES species. |
| 11 | Consistent with previous comments, we require information on individual species that are likely to be impacted by fauna mortality and discussion around the level of impact. | **EIS**<br>Chapter 8, Section 8.5 and Attachment 5<br>**SREIS**<br>Attachment 1, Appendix C, Attachment 2, Appendix 9, Section 11.5 and Attachment 10 | The environmental framework, as presented in EIS Chapter 8, Environmental Framework, Section 8.5, is an internal process developed by Arrow for managing impacts in the planning phase and in the construction and operation phases through the application of environmental controls that reflect the sensitivity or vulnerability of environmental values. Constraints mapping, an integral part of the environmental framework, is informed by the environmental impact assessment and guides site and route selection that seeks to avoid and reduce impacts, thereby protecting environmental values. The EIS presented preliminary constraints maps which have updated to reflect the values identified in the EIS; see SREIS, Attachment 8, Constraints Mapping Update.<br>While knowledge of species susceptible to fauna mortality would be useful information, it does not negate the primary focus of site and route selection, which is avoidance. Ecological surveys carried out as part of detailed design and/or preconstruction clearance surveys will seek to identify fauna thereby reducing the potential for mortality impacts through consideration of translocation and other measures. An outline of Arrow's management approach, inclusive of the framework, survey requirements and buffers is provided in SREIS, Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 11.5. SREIS Attachment 2, Strategic Environmental Management Plan (EMP) details the management measures required to manage the potential impacts resulting from project activities. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 11 (cont'd) | | | Potential impacts were identified for each species as part of the species specific assessments provided in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C, including the potential impacts from alteration of ecological processes. The assessment of these impacts follows the significant impact guidelines for MNES as stipulated under the Environment Protection and Biodiversity Conservation Act 1999. Revised or new mitigations for MNES in accordance with the assessment of impacts are presented in SREIS Attachment 2, Strategic Environmental Management Plan. |
| 12 | Consistent with previous comments, we require information on individual species that are likely to be impacted by edge effects, where the impacts are likely to occur and discussion around the level of impact. | **EIS** Chapter 8, Section 8.5 and Attachment 5 **SREIS** Attachment 1, Appendix C and Appendix 9, Section 11.5 | The environmental framework, as presented in EIS Chapter 8, Environmental Framework, Section 8.5, is an internal process developed by Arrow for managing impacts in the planning phase and in the construction and operation phases through the application of environmental controls that reflect the sensitivity or vulnerability of environmental values. Constraints mapping, an integral part of the environmental framework, is informed by the environmental impact assessment and guides site and route selection that seeks to avoid and reduce impacts, thereby protecting environmental values. The EIS presented preliminary constraints maps which have been updated to reflect the values identified in the EIS; see SREIS, Attachment 10, Constraints Mapping Update.<br>While knowledge of species susceptible to edge effects is useful information, it does not negate the primary focus of site and route selection which is avoidance. Ecological surveys carried out as part of detailed design and/or preconstruction clearance surveys will identify habitat/species vulnerable to edge effects and recommend appropriate responses, primarily realignment or relocation of infrastructure. An outline to Arrow's management approach, inclusive of the framework, survey requirements and buffers is provided in SREIS, Appendix 9, Supplementary Terrestrial Ecology Assessment, Section 11.5.<br>As part of the species specific assessments provided in the SREIS, Attachment 1, MNES, Appendix C, potential impacts have been identified for each species including edge effects. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 13 | Consistent with previous comments, we require information on individual species that are likely to be impacted (including indirect impacts, such as hydrological impacts from emergency discharge or changes to surface water flows) and discussion around the level of impact. | **EIS** Attachment 5 **SREIS** Attachment 1, Appendix C | Arrow's Coal Seam Gas Water and Salt Management Strategy is provided in SREIS Attachment 5.<br>As part of the species specific assessments provided in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C, potential impacts have been identified for each species including the potential impacts from alteration of ecological processes. These impacts have been provided following the significant impact guidelines for MNES as stipulated under the Environment Protection and Biodiversity Conservation Act 1999.<br>Arrow will develop a strategy for the discharge of coal seam gas water to watercourses in accordance with relevant legislation. The strategy will incorporate a water quality monitoring program with locations upstream and downstream of the discharge point to inform site specific water quality objectives. A detailed environmental flows assessment informed by water quality monitoring data and an aquatic ecology monitoring program will inform the discharge strategy. Periodic inspections of the physical form and hydrology of the watercourse are to be incorporated in the strategy to monitor geomorphic performance (Commitment C498). |
| 14 | Consistent with previous comments, we require information on individual species that are likely to be impacted from each component of the action and discussion around the level of impact, including quantification where possible. | **SREIS** Attachment 1, Appendix C | As part of the species specific assessments provided in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C; potential impacts are identified for each species as a result of each component of the proposed project activities.<br>An estimate of habitat at risk has been determined based on conceptual field layouts, RE mapping, and input from the terrestrial, flora and fauna specialist. |
| 15 | We require evidence in the MNES chapter to demonstrate the proposed mitigation methods will be effective. Note that mitigation measures that are to be relied upon to reduce the level of significance of impact must use commitment language and must not use terminology such as 'may' or 'should'. Terms such as 'where practical', 'where appropriate', 'minimise' or 'where possible' must be explained, and if relevant, other mitigation measures must be provided to ensure the level of impact will be appropriately mitigated (e.g. avoiding listed threatened communities 'where possible' is not a certain and measurable mitigation measure and cannot be relied upon to reduce the level of impact).<br>Please refer to comments about offsets below. | **EIS** Chapter 8, Section 8.5, Attachment 3 and Attachment 8 **SREIS** Chapter 2, Section 2.3.1, Chapter 11, Section 11.5.3 and Attachment 4 | The environmental framework (EIS Chapter 8, Environmental Framework) was developed by Arrow to manage the impacts of coal seam gas development where the location of infrastructure becomes progressively known over the life of the project. The identification of sites and routes for project activities is informed by the constraints imposed by environmental values including habitat and buffer requirements.<br>Constraints mapping, an integral part of the environmental framework, will guide site and route selection through the avoidance and/or minimisation of disturbance to sensitive vegetation communities and listed species during infrastructure design and layout, thereby protecting the environmental values. Where possible, Arrow will be flexible in the placement of wells and infrastructure, which will be informed by site-specific ecological surveys. SREIS, Chapter 11, Terrestrial Ecology, Section 11.5 3 outlines Arrow's approach to the identification of environmental values at proposed infrastructure sites, ecological surveys and environmental management. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 15 (cont'd) | | | The significance assessment approach adopted by Arrow for the EIS is underpinned by management measures that all available evidence suggests are effective at minimising and mitigating impacts. The management measures set out in the EIS have been reviewed by various departments within Arrow to confirm they can be implemented and will be effective in managing the identified impacts.<br>The terms 'where practicable', 'where appropriate' and 'where possible' are used to account for site specific conditions where implementation of the proposed mitigation measure may not be feasible or may result in additional impacts. They can be relied upon, as their effectiveness in reducing and managing impacts is proven, provided the site conditions permit. Where the measure cannot be implemented site specific controls will be developed and implemented by Arrow to achieve the desired outcome.<br>The mitigation measures presented in the EIS, and replicated within EIS Attachment 3, Matters of National Environmental Significance, are presented as a list of commitments in EIS Attachment 8, Commitments Summary. This list is updated in SREIS Attachment 4, Commitments Update with any amended or new commitments required as a result of additional studies undertaken for the SREIS.<br>As set out in SREIS Chapter 2, Project Approvals, environmental authority (EA) or EA amendment application(s) will be lodged in accordance with statutory requirements, including supporting technical information that contains further site-specific measures to reduce potential project impacts, where applicable. |
| 15a | Some mitigation measure specified in section 7 need to be more clearly defined (e.g,. the mitigation measure "avoid construction activities in waterbodies frequented by migratory species" (section 7.6, page 7-48) needs to provide detail around what constitutes "waterbodies frequented by migratory species". | **EIS**<br>Appendix K<br>**SREIS**<br>Appendix 9 | Listed migratory species assessed in the EIS Appendix K, Terrestrial Ecology Impact Assessment and SREIS, Appendix 9, Supplementary Terrestrial Ecology Assessment have the potential to use a range of habitats including dams, lakes, ponds, creeks, billabongs, rivers and fields. On this basis that many are transient visitors utilising a variety of habitats, mitigation measures would not be effective in managing potential impacts. However standard mitigation measures relating to works near waterbodies would afford a level of protection to any migratory species temporarily utilising that resource. No important populations were identified of any listed migratory species. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 15b | When available, please provide the statutory or policy basis for the mitigation measure, and the expected cost of the mitigation measure. Please also provide the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program. We note that this information is required under Section 4.01 of Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000. | **EIS** Chapter 2 and Attachment 5 **SREIS** Chapter 2, Attachment 1, Section 3 and Attachment 2 | The cost of mitigation will be determined through a competitive tendering process for the construction of the Surat Gas Project facilities and infrastructure. Consequently, it is not possible to provide insight into that actual cost of mitigation. It is important to note that all mitigation measures have been reviewed by various departments within Arrow to confirm they can be implemented. The review considered technical feasibility and cost.<br>EIS Chapter 2, Project Approvals provides a list of relevant legislation and expected permits, consents and licenses required by the project. EIS chapters 9 to 26 identify legislation of specific relevance to each environmental value. SREIS Chapter 2, Project Approvals, and SREIS chapters 5 to 15 provide updates to this list.<br>SREIS Attachment 2, Strategic Environmental Management Plan (EMP) provides discussion on Arrow's environmental management plans and procedures for the Surat Gas Project. The Strategic EMP provides the framework for further environmental management plans and procedures that will identify any permits or consents and the legislation and responsible agency. |
| 16 | While this table is useful and well presented, it would be appreciated if you could limit the information on proposed buffer distances in respect of MNES matters (not State matters/categories). This will be particularly helpful for the public to delineate between state and commonwealth interests. | **SREIS** Attachment 1, Section 9 and Table 9.1 | Table 9.1 has been amended in SREIS Attachment 1, Matters of National Environmental Significance, Section 9, to focus solely on Commonwealth interests. However, state interests, such as the definition of regional ecosystem types have been used to assist in defining matters of Commonwealth interests such as habitat for listed species. |
| 17 | For species with Recovery Plans, please discuss in the MNES chapter how the proposed actions identified in the EIS relate to relevant Species Recovery Plans, and if applicable, please provide a rationale as to why they are not consistent with the relevant Recovery Plans. | **EIS** Attachment 3, Section 7.7 and Appendix K **SREIS** Attachment 1, Appendix C | Relevant details from the recovery plans described in EIS Attachment 3, Matters of National Environmental Significance, Section 7.7 have been considered in the assessment of impacts and implementation of mitigation and management measures.<br>Dossiers of all species potentially occurring in the project development area were compiled and included in EIS Appendix K, Terrestrial Ecology Impact Assessment. The dossiers reference the Recovery Plans relevant to the species in discussion and have been used to inform the mitigation measures proposed.<br>These dossiers form the basis for species specific assessments in accordance with the criteria set out in the Significant Impact Guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999, presented in SREIS Attachment 1, Matters of National Environmental Significance, Appendix C. A clear statement is made up-front in each dossier as to whether a recovery plan exists for that species, and mitigation measures for that species, if required, is informed by said recovery plans. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 18 | Although the draft EIS states that offsets will be provided, we require information around what offset is proposed, what the offset compensates for, and how the offset complies with relevant Commonwealth guidelines and policies. We also require an offset strategy that specifically addresses MNES to be provided. Note that a consultation draft of the most recent EPBC Draft Environmental Offsets Policy is available (http://www.environment.gov.au/epbc/publications/consultation-draft-environmental-offsets-policy.html) and should be used as a guide for developing the offsets strategy (and referenced appropriately in the EIS).<br>We appreciate that this information will evolve as assessment progresses, but an indication of options being considered should be provided. | **EIS**<br>Chapter 8, Section 8.5<br>**SREIS**<br>Attachment 7 | Arrow has already successfully implemented the environmental framework described in EIS Chapter 8, Environmental Framework, Section 8.5.<br>It has been applied to site selection for facilities associated with approved developments, specifically the Dalby Expansion Project. In those instances, ecological surveys comprised an important part of the planning process, confirming the suitability of sites identified using constraints mapping. They also informed the design of the facility layouts to avoid habitat of MNES.<br>For the Surat Gas Project, the regional environmental constraints identified in the EIS will be used to guide field development plans across the project development area, and have informed the selection of four potential central gas processing facility locations and one temporary workers accommodation facility. Ultimately, site selection will aim to avoid constrained areas and will ensure that those areas designated as 'no go' e.g., Lake Broadwater Conservation Park, are avoided. Early identification of sensitive areas (including critical habitat) allows Arrow the best opportunity to avoid sensitivities to the greatest extent practicable.<br>Following completion of the EIS and the SREIS, the ongoing refinement of constraints maps will inform field development plans. Once additional preferred locations for project infrastructure are known, targeted ecological and preconstruction clearance surveys will be conducted. At this time, a suitably qualified person(s) will determine whether the site comprises MNES species or ecological communities, and if required, further investigation into whether they comprise important populations or additional control measures are required.<br>Arrow proposes to develop an offset strategy that incorporates a landscape approach for actual vegetation losses. An offset strategy that is based on the actual disturbance and not an estimate of disturbance based on a conceptual field development layer is considered more appropriate. Arrow's offset calculations will be developed as the field development layout is refined and further ground-truthing is undertaken. SREIS Attachment 7, Draft Environmental Offsets Strategic Management Plan, presents the results of GIS analysis to facilitate identification of potential offset sites. |
| 19 | This section is particularly important during the public consultation stage. Therefore, please ensure that the summary provided identifies all the key elements for the following aspects:<br>• All the identified impacts on MNES;<br>• Summary of the proposed mitigation measures;<br>• Residual impacts on MNES; and,<br>• The proposed offsets measures to address the residual impacts; and<br>• Conclusion on whether or not there will be significant impacts from the proposal on each of the controlling provisions. | **SREIS**<br>Chapter 4 | Public consultation for the Surat Gas Project EIS has been completed and is reported in the EIS. SREIS Chapter 4, Consultation provides an update on the latest round of consultation which presented the findings of the EIS to the communities of the Surat Basin. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 20 | While this table is a useful summary of impact assessment on MNES, this table would be provide a more useful summary (or 'snapshot') if it included information such as the quantification of pre-mitigated and residual impacts, maximum disturbance limits and identification of whether offsets will be provided for each MNES with a residual impact. We note that this information must be provided somewhere in the MNES chapter. | **SREIS** Chapter 11. Section 11.4.9 and Attachment 7 | The size of the project development area (8,600 $km^2$ at the time of the EIS) made detailed survey for listed species and communities impractical. Consequently, Arrow developed two approaches to identify and understand the extent of MNES present within the project development area.<br>Firstly, desktop study and detailed dossiers on species identified those species and communities potentially present and potentially at risk based on habitat. Field surveys were used to validate the viability of habitat assessed as most sensitive to impacts. This information was then used to compile constraints mapping that identified no go areas and areas of high, moderate and low constraint to development.<br>The types of development that were appropriate for each level of constraint were identified as well as the appropriate level of environmental management, i.e., standard or procedural, detailed and site specific controls. This approach is known as the 'environmental framework' and is designed to protect MNES through avoidance (Arrow knows what is constrained and why) and minimisation (what controls are required for each level of constraint to reduce the potential impact).<br>Areas presented in the EIS as potential facility locations have been further refined for the SREIS and have been surveyed to further refine habitat mapping and species. Detailed site assessment have been undertaken at four potential central gas processing facility locations and one potential temporary workers accommodation facility (TWAF) location with detail provided at the property scale. SREIS Chapter 11, Supplementary Terrestrial Ecology Assessment, Section 11.4.9 provides detail of each of these properties and describes MNES likely to be present on each property.<br>Used in gas field design, this approach has been supported by ecological surveys of areas of interest as part of the detailed design process, again aimed primarily at avoidance and secondarily at minimisation of impacts on listed species including MNES. Finally, (i.e., if not covered by the ecological surveys), preconstruction clearance surveys will implement procedures for the management of MNES identified in areas to be cleared, such as translocation.<br>An outline of the content of management plans is provided in SREIS Attachment 2, Strategic Environmental Management Plan. This includes measures for management of MNES species and methods for translocation of MNES species, amendments to clearing plans (in terms of methods used and/or timeframes) and offsets. Management measures are dependent on what species or habitat is identified. |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 20 (cont'd) | | | This structured and rigorous approach while not specifically addressing the survey requirements of the EPBC Act for the entire project development area ensures the identification, management and in some instances, protection of MNES, as part of the coal seam gas field planning, design and execution processes.<br>Arrow proposes to develop an offset strategy that incorporates a landscape approach for actual vegetation losses. SREIS Attachment 7, Draft Environmental Offsets Strategic Management Plan, presents the results of GIS analysis to facilitate identification of potential offset sites. |
| 20a | Consistent with previous comments, we also require a rationale for determinations of significance (why a residual impact is low, moderate or high), and a rationale why mitigation measures will be effective in reducing impacts (e.g. there is around 9,899 HA of potential Brigalow onsite, yet there is no quantification of pre-mitigated and residual impact or rationale why the 'general mitigation measures' will reduce this impact to only moderately significant). This information does not need to be provided in table 8.1 but must be provided in the MNES chapter. | **EIS**<br>Attachment 3, Table 4.1<br>**SEIS**<br>Appendix 9, Attachment A4 | EIS Chapter 17, Terrestrial Ecology, Section 17.3 set out the rationale for the determination of significance of impacts. Further desktop assessment has led to refinement of the significance assessment as presented in SREIS Appendix 9, Supplementary Terrestrial Ecology Assessment, Attachment A4.<br>The significance assessment approach adopted by Arrow for the EIS is underpinned by management measures that are effective and proven. The management measures set out in the EIS have been reviewed by various departments within Arrow to confirm they can be implemented and that they will be effective in managing the identified impacts.<br>EIS Attachment 3, Matters of National Environmental Significance states that field observations and regional ecosystem mapping suggest that Brigalow dominant and co-dominant communities are a common, although highly fragmented, ecosystem. These communities are recognised under the Vegetation Management Act as regional ecosystems (REs) 11.3.1, 11.4.3, 11.4.10, 11.9.5 and 11.9.6.<br>Arrow has made a commitment to aim to avoid Brigalow communities (REs 11.3.1, 11.4.3, 11.4.10, 11.9.5 and 11.9.6). This will be achieved through implementation of the environmental framework.<br>The Brigalow present within the project development area exists in isolated patches (as opposed to contiguous belts). The environmental framework will provide for the best opportunity in maximising the extent to which Brigalow is avoided. |
| 21 | Table 9.1 is a very useful summary of disturbance limits for listed threatened ecological communities. We require disturbance limits in this table to be completed.<br>It would be useful to have a similar table for disturbance limits for listed threatened species and listed migratory species. | **SREIS**<br>Attachment 1, Section 4.4 and Attachment 6 | Disturbance limits have been derived as part of Arrow's offset strategy, which incorporates a landscape approach for determination of actual vegetation losses. SREIS Attachment 6, Draft Environmental Offsets Strategic Management Plan, presents the results of GIS analysis to facilitate identification of potential offset sites.<br>The relationship between regional ecosystems and habitat for MNES is discussed in SREIS Attachment 1, Matters of National Environmental Significance, Section 4.4, as well as an estimate of the amount of each EPBC listed threatened ecological community and habitat present within the project development area. This information can then be tabulated as an estimate of the existing habitat present within the project development area for threatened species (and where possible, listed migratory species). |

**Table 1 Response to SEWPaC submission (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| 21a | The draft EIS states that ecological and preconstruction clearance surveys will be undertaken. We require more detail around when these surveys will be undertaken, proposed methodology and how these surveys will inform location of infrastructure to provide context around how these measures will successfully avoid and mitigate impacts. | **EIS** Attachment 3 and Attachment 5 **SREIS** Attachment 1, Appendix C and Attachment 2 | Arrow has committed to conducting preconstruction clearance surveys prior to ground disturbance works commencing (Commitment C220). An outline of Arrow's management approach is presented SREIS Chapter 11, Terrestrial Ecology, Section 11.5. Field verification of vegetation communities and habitat features will be undertaken prior to preconstruction clearance surveys to determine the level of survey effort required, appropriate to each species (as outlined in species dossiers within SREIS, Attachment 1, Appendix C).<br>Mitigation measures set out in EIS Attachment 3, Matters of National Environmental Significance, and EIS Attachment 5, draft Environmental Management Plan, have been further developed and informed by surveys undertaken for the SREIS. These documents are updated in SREIS Attachment 1, Matters of National Environmental Significance and SREIS Attachment 2, Strategic Environmental Management Plan, which provides an update to EIS Attachment 5, Environmental Management Plan.<br>SREIS Attachment 2 identifies high level management controls for the project. These controls, and any additional site-specific controls, will be set out in the statutory information requirements to support the application for an environmental authority (EA) or an EA amendment, in accordance with EHP Guideline "Application requirements for petroleum activities". This will include site specific measures for management of MNES species and methods for translocation of MNES species, amendments to clearing plans (in terms of methods used and/or timeframes) and offsets. Management measures are dependent on what species or habitat is identified.<br>SREIS Attachment 1, Matters of National Environmental Significance, Appendix C provides updated dossiers for MNES species and communities, and these dossiers contain specific management measures where applicable for each species. |
| 22 | Cumulative impacts should be identified and quantified in respect of each MNES. We note that quantification of cumulative impacts on MNES has been provided in previous coal seam gas assessments, and the Minister may consider information on cumulative impacts in making a decision on whether to approve the taking of the action under Part 9 of the EPBC Act. | **EIS** Attachment 3, Section 11 **SREIS** Attachment 1, Appendix C | EIS Attachment 3, Matters of National Environmental Significance, Section 11 described the cumulative impacts at a bioregional level and at a species level for MNES.<br>SREIS Attachment 1, Matters of National Environmental Significance, Appendix C provides an estimate of the amo1unt of each EPBC listed threatened ecological community and habitat present within the project development area. This information can be considered in light of the quantitative assessment conducted by other proponents, as a means for determining the potential cumulative impact. |

# Appendix B

## Response to Public Submissions on Surat Gas Project EIS MNES Attachment

## Table 1 Response to submissions on MNES by private submitters

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| **S145** | Managing impacts to Great Barrier Reef and other MNES should be of primary importance to the Qld and Australian Government. | **EIS**<br>Chapter 16, Section 16.6 | Arrow's Coal Seam Gas Water and Salt Management Strategy is provided in SREIS Attachment 5.<br>The Great Barrier Reef Marine Park was described in EIS Appendix I, Surface Water Part B: Water Quality Impact Assessment as receiving water from less than 1% of a catchment within the project development area. Water from this catchment has to flow approximately 700 km before discharging to the sea. Due to the distance separating the Great Barrier Reef Marine Park and the project development area, the potential for impact from the project was discounted and was therefore not assessed in the EIS.<br>EIS Chapter 16, Aquatic Ecology, Section 16.6 identifies a number of mitigation measures that Arrow will implement to protect water quality and prevent contamination entering watercourses. These include commitments to:<br>• Develop and implement emergency response and spill response procedures to reduce impacts that could occur as a result of releases of hazardous materials or loss of containment of storage equipment (Commitment C036).<br>• Ensure appropriate spill response equipment, including containment and recovery equipment, is available on site, or can be mobilised to the impacted site within an acceptable response time and that relevant personnel are appropriately trained (Commitment C037).<br>Arrow will develop a strategy for the discharge of coal seam gas water to watercourses in accordance with relevant legislation. The strategy will incorporate a water quality monitoring program with locations upstream and downstream of the discharge point to inform site specific water quality objectives. A detailed environmental flows assessment informed by water quality monitoring data and an aquatic ecology monitoring program will inform the discharge strategy. Periodic inspections of the physical form and hydrology of the watercourse are to be incorporated in the strategy to monitor geomorphic performance (Commitment C498).<br>The specific details of options for coal seam gas water disposal will be developed further through detailed engineering design. Chosen management options will be detailed in the coal seam gas water management plan required for the EA or EA amendment application. The management plan will include detailed coal seam gas water and brine impacts assessments and management strategies in accordance with the EHP Guideline "Application requirements for petroleum activities". |

**Table 1 Response to submissions on MNES by private submitters (cont'd)**

| Issue No. | Issue | Reference | Response |
|---|---|---|---|
| **S145** | General concern regarding impacts on Wetlands of National Significance and the Great Barrier Reef Marine Park. | **EIS**<br>Chapter 16, sections 16.3.7 and 16.6.2<br>**SREIS**<br>Chapter 11, sections 10.3.2 and 10.4.5 | Arrow recognises the need to protect environmentally sensitive areas (ESAs) and to identify and manage impacts on significant values of waterways in the project development areas. EIS Chapter 16, Aquatic Ecology, Section 16.3.7 identified these values, including the location of any relevant ESAs for aquatic ecology in the project development area. Arrow has committed to a range of measures to protect aquatic values, seeking as a first option to avoid impacts occurring.<br>The primary means by which avoidance is achieved is through the design of the project and associated facilities and infrastructure and the selection of sites.<br>The Great Barrier Reef Marine Park was described in EIS Appendix I, Surface Water Part B: Water Quality Impact Assessment as receiving water from less than 1% of a catchment within the project development area. The water which had to flow approximately 700 km before discharging to the sea. Due to the distance separating the Great Barrier Reef Marine Park and the project development area, the potential for impact from the project was discounted and was therefore not assessed in the EIS.<br>As identified in SREIS Chapter 10, Aquatic Ecology, Section 16.6.2, Arrow will manage potential impacts on waterways through the commitment to implement a buffer zone from the high bank of all watercourses to prevent development or clearance occurring within the buffer (other than construction of watercourse crossings for roads and pipelines, discharge infrastructure and associated stream monitoring equipment). The buffer zone distance will be determined in accordance with the legislative requirements at the time of development or through preconstruction clearance surveys (Commitment C157).<br>The SREIS Chapter 10, Aquatic Ecology, Section 10.3.2 describes the site-specific field surveys undertaken at the two proposed discharge locations for treated coal seam gas water, and Section 10.4.5 proposes additional mitigation measures to reduce the potential impacts to the identified waterways. |
| **S145** | EIS does not adequately describe and assess impacts to the Great Barrier Reef that may result from the disposal of brine and treated coal seam water via an ocean outfall pipeline. | EIS<br>Chapter 5, Section 5.6.4<br>**SREIS**<br>Attachment 5 | EIS Chapter 5, Project Description, Section 5.6.4 identifies the disposal of coal seam gas water to the sea via an ocean outfall pipeline as a feasible option undergoing evaluation as part of the detailed design of the gas field and production facilities. If the ocean outfall pipeline becomes the preferred option for coal seam gas water disposal, it will be assessed under a separate approval process.<br>Further details of the coal seam gas water management are provided in SREIS Attachment 5, Coal Seam Gas Water and Salt Management Strategy. |

# Appendix C

## MNES Community and Species Profile Dossiers

# SIGNIFICANT HABITAT, FLORA AND FAUNA SPECIES ASSESSMENTS

This appendix presents background information and impact assessment methods for the 6 ecological communities, 22 species of flora, 10 species of fauna and 33 migratory species (depicted as 3 migratory categories) of national significance that are present, or potentially present within the project development area. Information derived from literature and data review, field survey and expert input has been used to determine the habitat, distribution and threats to individual species as well as form an assessment of impact significance for MNES. This information also provides the basis for habitat mapping which has been applied to GIS datasets including an assessment of the extent or potential extent of habitat for MNES species or ecological communities.

## Habitat Mapping

Habitat descriptors used to describe flora habitat within this assessment, adapted from the Biodiversity Assessment Mapping Methodology developed by the Environmental Protection Authority (EPA) 2002 (currently known as EHP) are described below:

- 'Core Habitat Known': Identifies habitat where a spatially accurate confirmed record of a particular species exists (e.g., Herbrecs or survey record). Core habitat known is attributed to the particular habitat polygon in which it occurs, based on either regional ecosystem (RE) mapping provided by EHP or high resolution habitat mapping developed for a specific purpose. 'Core Habitat Known' also applies to a 1 km buffer around all spatially accurate (< 400 m accuracy) species records.
- 'Core Habitat Possible': Previous records of a particular species are not known to occur within a given area or habitat, although specific habitat features are present which are known to be favoured by the species and the habitat occurs within the species known geographic range.
- 'General Habitat': Where a species has not been recorded in a given location and habitat accounts for some of the features favoured by a particular species. The habitat occurs on the margins of a species known geographic range. Otherwise, the habitat is suitable for the species although has been subject to intensive survey and the species has not been recorded.
- 'Absence Suspected': The species has not been recorded in a given location and habitat features are not suitable (or sub-optimal) for survival of a given species or population.

'Essential Habitat' for NC Act listed species as regulated under the VM Act has been considered within the EIS assessment. As Essential Habitat may be drawn from a number of data sources, both verified and non-verified, is not regularly updated and does not account for all previously recorded occurrences of a species, it is considered sub-ordinate to the classification of 'Core Habitat Known' and is not shown on the species profiles. It will however generally be captured within those areas mapped as 'Core Habitat Known' for a particular species.

## Index of Confidence

The following levels of confidence are applied to habitat mapping for individual flora species:

- 'High': Habitat mapping is based on known recent (post 1980) records of a species with a high degree of precision (< 500 m). Habitat mapping has been undertaken for specific assessment purposes based on intensive field survey with mapping produced at a spatial scale of >1:25,000.

- ‘Medium’: Habitat mapping has been undertaken a spatial scale of 1: 25,000 to 1: 50,000 based on targeted field survey and assessment. Heterogeneous habitat (RE) polygons are not contained, or used extensively in the habitat mapping database.
- ‘Low’: Assessment has been undertaken broadly with limited field survey using 1:100,000 scale RE data as a basis for habitat mapping. The habitat mapping database makes extensive use of heterogeneous habitat polygons.

The following levels of confidence have been applied to habitat mapping for individual fauna species:

- ‘High’: Habitat mapping is based on known recent (post 1980) records of a species with a high degree of precision (< 500 m). The species habitat requirements are well known, and easily attributed to individual RE types.
- ‘Medium’: Habitat requirements for the species are moderately well known, but can appear in unexpected locations/habitats; and/or, particular habitat requirements of the species can be attributed, with some moderate degree of accuracy, to individual REs.
- ‘Low’: Habitat requirements of the species are relatively poorly known and patterns of occurrence are difficult to predict; and/or, particular habitat requirements cannot be easily attributed to any particular RE.

Habitat mapping confidence for fauna species does not consider inaccurate RE mapping, but rather is based on an assumption that all RE mapping is correct.

## Impact Mitigation

The mitigation and management measures (otherwise referred to as ‘commitments’) follow a tiered approach and can be generically applied across the majority of taxa and habitats. These commitments are presented in Chapter 17 of the EIS, Terrestrial Ecology, Section 17.6. A full list of commitments made within the EIS, as relevant to terrestrial ecology, is provided within Attachment 8 of the EIS, EIS Commitments Summary. Where new commitments are required which are specific to the taxa, they have been identified in the species profiles (Appendix C). Broadly, mitigations can be attributed to the various groupings listed below although in practice, these groupings may overlap considerably.

- Manage edge effects and invasive species.
- Minimise disturbance.
- Avoid sensitive areas.
- Manage mortality and entrapment.
- Manage impacts to threatened species.
- Secure habitat offsets.
- Implement monitoring programs.
- Other measures.

At this stage, the precise locations are not known for the facilities and infrastructure across the project development area. The MNES assessment therefore has taken a precautionary approach in assessing residual impacts for each MNES on the basis that avoidance may not be possible in many cases, although avoidance is the first preference in site and route selection for habitat for MNES.

The profiles also include an assessment to determine whether there is a significant impact on a community or species under EPBC guidelines within the properties that have been identified for the

development of four CGPFs and a temporary worker's accommodation facility. The assessments on MNES at the five properties follow the criteria set out in the MNES significant impact guidelines and will inform the final site selection based on identified constraints.

Activities at these sites have been identified as possibly causing localised significant impacts under the MNES criteria, although across the project development area, impacts may be assessed as being of low significance based on extensive availability of habitat and broad species distribution. The assessments have assumed complete clearance at the property level as the exact location of infrastructure on each site is not known and are therefore inherently conservative in their findings.

As with the five development areas assessed in the profiles, further areas identified for development will be surveyed and assessed prior to construction for potential impacts to MNES ecological communities, flora and fauna species habitat and individuals. Communities and habitat for MNES species will be avoided where possible.

## Specific Recommendations for Ecological Survey Effort

Existing and prescribed (e.g., MNES guidelines (DEWHA, 2009a)) survey methods were reviewed to determine their adequacy for identifying species in the context of the predominantly linear and spatially distributed project infrastructure. Recommendations on revised methods are presented within species profiles in Appendix C. Compliance with relevant aspects of the survey guidelines will be achieved through the implementation of the recommendations, which consider the isolation of communities, extent to which species can be detected in various habitats and the risk of disturbance and adverse impacts.

Recommendations for survey effort will be reviewed and incorporated where appropriate into preconstruction clearance survey procedures for site assessment and management as presented in Chapter 11, Terrestrial Ecology, Section 11.5. These survey procedures will be based on standard survey methodology and refined to target listed species and communities based on the risk of disturbance at individual sites.

# MNES Assessments- Threatened Ecological Communities

**Brigalow** (*Acacia harpophylla* dominant and co-dominant)

**EPBC Act Status:** Endangered

**VM Act Status:** Endangered

**Biodiversity Status*:*** Endangered

**Sensitivity:** High

***Recovery Plan:*** A nation wide recovery plan has not been prepared for the Brigalow (*Acacia harpophylla)* dominant and co-dominant ecological community, herein referred to as the Brigalow TEC.

***Relevant REs:*** The following REs associated with the Brigalow TEC, have been recorded within the project development area (Index of confidence 'low' when applied to EHP 1: 100 000 scale RE dataset of EHP 2012a; 'moderate' index of confidence when applied to project 1: 40 000 scale RE mapping):

- RE11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains)
- RE11.4.3 (*Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains)
- RE11.9.5 (*Acacia harpophylla* and/or Casuarina cristata open forest on fine-grained sedimentary rocks)
- RE11.4.10 (*Eucalyptus populnea* or *Eucalyptus pilligaensis*, Acacia harpophylla, Casuarina cristata open forest to woodland on margins of Cainozoic clay plains)
- RE11.9.6 (*Acacia melvillei* ± *Acacia harpophylla* open forest on fine-grained sedimentary rocks).

The following REs associated with the Brigalow TEC have been recorded within survey area targeted for the SREIS:

- RE11.4.3 (survey area 9 and survey area F assessed with biocondition site No. GB71 and secondary survey site GB97 respectively) (index of confidence 'high').

***Other relevant habitats:***

- Mature regrowth habitats derived from REs listed above are included within the Brigalow TEC as sourced from the mature regrowth Database (EHP2012b) (index of confidence 'low' applied to mapping at 1:100 000 scale).

- Brigalow regrowth >15 yrs old (Index of confidence 'moderate' when applied to project 1: 40 000 scale RE mapping with index of confidence 'high' when applied to site specific RE mapping at 1: 10 000 scale).

***Total number of survey sites across project development area:*** RE11.3.1 - 3 Secondary (AS77, AS138, AS158), 8 Quaternary; RE11.4.3 - 5 Secondary including 1 biocondition (AS77, AS138, AS158, GB71 and GB97), 6 Quaternary; Brigalow regrowth . 15 yrs – (9 Quaternary). Summary site data and floristic descriptions for these sites are included within **Appendix H** and **Appendix I**.

**Overview of the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC**

The Brigalow TEC is represented by REs described below as occurring within the project development area.

***Regional Ecosystem 11.3.1:*** The ecosystem has been highly fragmented throughout its range, generally existing as linear remnants within roadside reserves and stock routes. The most extensive occurrences are located on the floodplain of the Condamine River and Wilkie Creek to the west of Dalby with scattered occurrences occurring throughout the broader project development area. Typical canopy heights range from 15 to 23 m in better preserved examples where projected canopy covers range 30 to 60%. Whilst *Acacia harpophylla* generally forms the dominant canopy, *Casuarina cristata* predominates in some locations. Typical sub-canopy trees include *Acacia harpophylla,* and *Casuarina cristata* with shrubby layers often dominated by *Geijera parviflora, Pittosporum angustifolium, Melaleuca bracteata, Alectryon oleofolious* subsp*. elongatus, Alectryon diversifolius, Elaeodendron australe* var*. integrifolium, Ehretia membranifolium,* and *Optuntia stricta*.* Ground cover percentage is variable with typical species being *Paspalidium caespitosum, Ancistrachne uncinulata, Aristida* spp., *Enychleana tomentosa, Rhagodia spinescens, Einadia hastata,* and *Solanum parvifolium,* although *Harissia martinii** and *Bryophyllum delagoense** may be typically abundant.

Community condition is typically poor, a testament to edge effects created by massive fragmentation. The class 2 declared weed species prickly pear (*Opuntia stricta),* velvet pear (*Opuntia tomentosa)* and harissa cactus (*Harissia martini)* are highly prominent in shrub and ground layers and frequent canopy gaps, caused by canopy dieback and senescence in the absence of recruitment is a compounding problem.

The spatial representation of the ecosystem provided in the certified RE (DERM 2009b) mapping is often inaccurate, incorporating areas of cypress regrowth and frequently mis-representing RE11.3.17. Updated mapping provided in this exercise is intended to provide a more realistic representation of the ecosystems distribution.

**Plate 1.** Tall brigalow woodland on the alluvial plain of Wilkie Creek (Site AS138). This occurrence is represented as RE11.3.17 in DERM (2009b).

***Regional Ecosystem 11.4.3:*** The distinction between RE11.3.1 and RE11.4.3 is based largely on landscape position rather than any recognisable floristic expression. RE11.3.1 by definition, occupies alluvial landforms, and as such is associated with flood plains, river terraces and associated drainage depressions and swamps. The heavy clay soils associated with land zone (LZ) 4 are raised above the influence of current river systems and in the majority cases, this provides the only basis for distinction. Both ecosystems occupy heavy clay soils with shrink and swell properties (vertosols) and gilgai micro-topography.

The productivity of the associated soil types has resulted in extensive fragmentation of this ecosystem and remaining occurrences are generally highly fragmented and isolated. Intact examples are generally associated with with stock routes where the remnants, although linear, are generally continuous with adjacent ecosystems. The Chinchilla Sporting Shooters Club (which is located on the Chinchilla Sands Local Fossil Fauna Site) hosts one of the better preserved and more extensive examples observed with the project development area. In this location *Acacia harpopylla* forms the dominant canopy to 25 m, mixed to varying degrees with *Casuarina cristata* with a predominant canopy cover ranging from 30% to 60% dependant largely on habitat condition. The sub-canopy is typically formed by *Acacia harpophylla* and *Casuarina cristata* mixed with a range of vine thicket shrubs and trees including *Geijera parviflora, Ehretia membranifolia, Alectryon oleofolia* subsp*. elongatus* and *Carissa ovata.*

The classification also includes RE11.4.3a, a wetland community formed by *Eucalyptus woolsiana* with a sub-canopy formed by *Melaleuca bracteata* (Site AQ163). A relatively extensive area is mapped within PL 253 (in the Linc-Energy operational area) although this area was assessed remotely and requires ground truthing to confirm the true nature of the habitafor confirmation. The concerned area is currently mapped as RE11.5.1 in certified RE mapping (EHP 2012a).

The community is degraded throughout much of its range with sub-canopy layers often dominated by *Opuntia spp.* and *Harissia martini.* Canopy dieback, although a natural feature of the brigalow

community, is severe in some locations. Excessive light penetration through a dramatically reduced canopy cover has further promoted the invasion of exotic species into the ground cover and shrub layers.

**Plate 2.** Well developed woodland of *Acacia harpophylla* and *Casuarina cristata* in the Chinchilla Sporting Shooters Club (Site AS 170).

***Regional Ecosystem 11.9.5:*** This ecosystem was not sampled during field surveys for the EIS or SREISs. Certified RE mapping (EHP 2012a) indicates the community becomes increasingly prominent to the south and west of Millmerran in the south-western portion of the project development area. Scattered examples are also indicated in the northern portions of the project development area to the north of Chinchilla.

***Regional Ecosystem 11.4.10:*** The ecosystem was not observed during field surveys for the EIS or SREIS. Certified RE mapping (EHP 2012a) represents minor scattered occurrences scattered in the north of the project development area. The ecosystem is indicated as occurring on the margins of clay plains (LZ4) in association with REs 11.4.3, 11.3.18, 11.3.14, 11.3.25, 11.5.4 and 11.5.1a. Although unconfirmed, this ecosystem is considered likely to occur in the vicinity of currently mapped locations.

***Regional Ecosystem 11.9.6:*** The ecosystem was not observed during the field surveys for the EIS or SREIS. Certified RE mapping (EHP 2012a) represents the ecosystem as occurring as numerous scattered fragments across the project development area, almost universally mapped as sub-dominant components of heterogeneous polygons associated with other brigalow ecosystems (RE11.9.5 and RE11.3.1).

***Mature Brigalow Regrowth / Brigalow Regrowth > 15 yrs:*** The EPBC brigalow ecological community includes advanced brigalow regrowth which is represented in the mature regrowth Mapping (EHP 2012b) as heterogeneous components of much larger regrowth polygons where they are mixed with a range of woodland and open forest communities. Due the the heterogeneous mapping of polygons, a ‘low’ index of confidence is applied to the mapping of brigalow regrowth ecosystems within the mature regrowth Mapping database (EHP 2012b).

Within revised RE mapping completed at 1: 40 000 scale, the ecological community was defined to include brigalow regrowth with > 60% canopy cover, >0.5 ha in size, a width of >10 m for linear communities and determined as greater than 15 years old as per guidelines of Environment Australia (2001b). The age of the regrowth was assessed through analysis of historical aerial photography, coupled with an assessment of the structural development of the habitat observed during field survey. The minimum size of 0.5 ha is the minimum area that can be practically delineated on 1:40 000 scale aerial photograph. Patches below this size with linear width of <10 m generally suffer severely from edge effects and structural development is of poor quality and as such are not included with the Brigalow TEC. Regrowth brigalow is prominent throughout the heavily utilised portions of the project development area where it commonly manifests as linear fringes along fencelines, and road reserves. The community may include areas dominated by *Casuarina cristata* (belah).

**Plate 3.** Small non-remnant area of brigalow regrowth of approximately 0.5 ha in size (Site AQ081).

**Threats :** The major risks to the Brigalow TEC are listed as:

- Vegetation clearing through failure to correctly identify habitat prior to activity.
- Failure to account for and identify areas of regrowth vegetation developed structurally to a degree that they form EPBC siginificant values.
- Unavoidable impacts to the ecosystem through necessity to clear for infrastructure or facility placement.

**Potential project-related impacts (unmitigated):** Activities and processes which threaten this community include:

- Direct impacts due to vegetation clearing associated with placement of facilities or infrastructure (e.g. gathering lines for water and gas, gas processing facilities, road widening and road maintenance).
- Edge effects associated with increased habitat and landscape fragmentation including loss of native ground covers, exotic species invasion, changes to surface water flow and sedimentation that affect ecosystem function. Dust may also be a significant contributor to degradation of this habitat.

**Occurrence in the project development area and extent of habitat:** The Brigalow TEC is known to occur in the project development area. The extent of the Brigalow TEC in the project development area is provided in **Table A10** with distribution shown in **Figure A1.** The Brigalow TEC was recorded within survey area 9 and survey area F. Small, highly disturbed fragments also occur within survey area 7 with 0.8 ha of advanced regrowth (regrowth >15yrs old) being recorded and 2.1 ha of advanced regrowth recorded in survey area 8. The Brigalow TEC is not identified in survey area 8.). Details within specific survey areas is provided below.

- ***Survey area F:*** One small remnant area of approximately 0.75 ha was assessed during the field survey. In this location *Acacia harpophylla* forms the dominant canopy at 14 to 18 m with up to 50% projected canopy cover (PCC). Sub-canopy and shrub layers are typically sparse with scattered *Acacia harpophylla* and *Geijera parviflora*. Ground cover is also sparse, degraded by cattle grazing, with harissa cactus (*Harissia martini*) and prickly pear (*Opuntia stricta*)* forming < 5% ground cover. The community occupies the gently sloping apron surrounding a residual escarment, forming an isolated pocket amongst more extensive ironbark woodlands. Soils are heavy clays with well developed gilgai.
- ***Survey area 9:*** A single area of 1.75 ha was identified and assessed during the field survey and is represented by biocondition site GB71. At this location, the habitat formed an open forest with 55 % canopy cover (T1) with a height range of 15 to 22 m. Scattered *Eucalyptus woolsiana* also form a component of the canopy and sub-canopy although cover is typically < 5%. The shrub layers comprise *Eremophila mitchellii, Capparis sp* and scattered *Acacia harpophylla.* The ground cover is heavily disturbed with a dominant cover of wandering jew (*Commelina ensifolia)* and native grasses including brigalow grass (*Eriochloa procera).* Soils are heavy clay with gilgai development, although natural soil structure has been compacted by sheep.

**Plate 4.** Occurrence of RE11.4.3 on survey area 9.

**Table A10.** Extent of the Brigalow TEC within the project development area and associated areas of assessment.

| | RE11.3.1 | RE11.4.3 | RE11.4.10 | RE11.9.5 | RE11.9.6 | Mature Regrowth[5] | Total (ha) |
|---|---|---|---|---|---|---|---|
| Project development area[1] | 444 | 669 | 67 | 3152 | 117 | 2534 | 6982 |
| 3D detailed mapping area[2] | 189 | 509 | 0 | 0 | 0 | 572 | 1307 |
| 3D detailed mapping area based on EHP (2012)[3] | 352 | 290 | 0 | 19 | 3 | 238 | 902 |
| Project development area[4] | 281 | 888 | 67 | 3133 | 114 | 2868 | 7387 |
| Survey area 9* | 0 | 5.4 | 0 | 0 | 0 | 0 | 5.4 |
| Survey area F* | 0 | 1.1 | 0 | 0 | 0 | 0 | 1.1 |
| Survey area 8* | 0 | 0 | 0 | 0 | 0 | 2.13 | 2.13 |
| Survey area 7* | 0 | 0 | 0 | 0 | 0 | 0.9 | 0.9 |
| Survey area 2* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1 Based on regional ecosystem mapping of EHP (2012a). Level of confidence = ***Low***

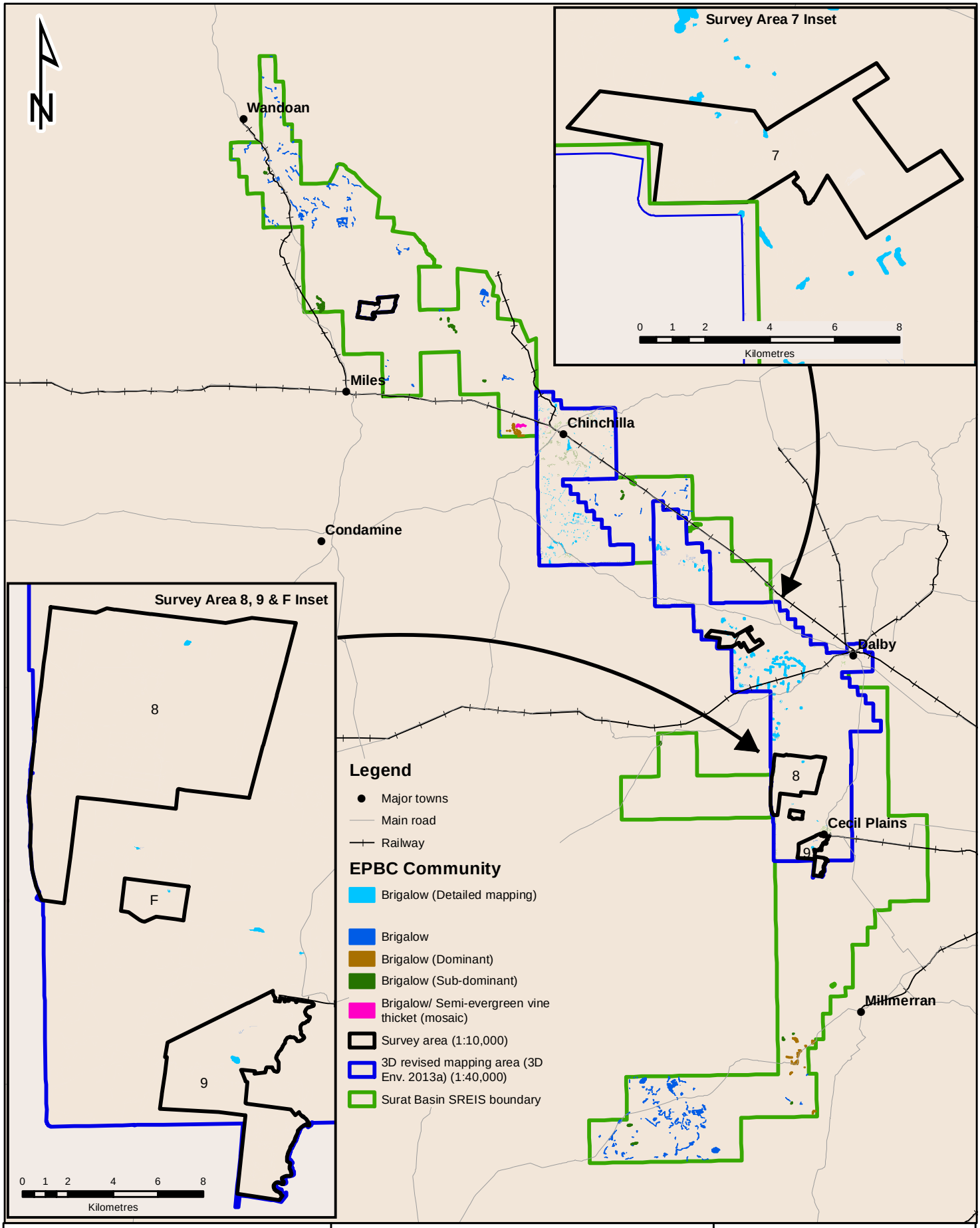
2 Based on 1: 40 000 scale RE mapping undertaken for the EIS within PL areas by 3D Environmental, 2103. Level of Confidence = ***Moderate***

3 Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

4 Based on regional ecosystem mapping of EHP (2012a) and 3D RE mapping (3D Environmental).

5. Mapped as Brigalow regrowth (>15yrs age) in 3D Environmental datasets (3D Environmental 2013).

*Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).

**Figure A1.** Distribution of Brigalow ecological community

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,084,632 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_Append_A4P.mxd | 5/05/2013 | A4 |

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**Rule(s) for Ecological Community Mapping:**

1. EHP RE mapping database (EHP 2012a);. The Brigalow TEC is applied to RE11.3.1, 11.4.3, 11.4.10, 11.9.5. 11.9.6. Where these REs contribute <50% to the total area of a heterogeous polygon, they are mapped as 'Brigalow sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Brigalow dominant'. Where these REs contribute 100% to the total area of a polygon, they are mapped singularly as 'Brigalow'.
2. EHP mature regrowth database (EHP 2012b): As applied to EHP 2012a.
3. 3D Environmental database (3D Environmental 2013); The Brigalow TEC is applied to RE11.3.1, 11.4.3, 11.4.3a, 11.4.10, 11.9.5. 11.9.6 and Brigalow regrowth (>15yrs old). Brigalow patches <0.5 ha and <15 years old are excluded from the mapping.
4. The 3D Environmental database takes precedence for mapping purposes although this is subject to refinement following detailed field survey.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The Brigalow TEC refers only to that part of the polygon where applicable REs are present.

**Significance of project-related impacts:** Brigalow has an extensive root system which is capable of developing adventitious buds in response to disturbance of aerial plant proportions. Hence, disturbance will often result in massive suckering response (Collard 2007). As such, the mechanism to profusely regenerate naturally means that the ability of this ecosystem to recover from disturbance (in the absence of intervening factors such as exotic species invasion) is relatively robust. The susceptibility of the ecosystem to edge effects including invasion of exotic species (in particular prickly pear -*Opuntia* spp. and harrisa cactus -*Harissia martini*) the noted tendency for heavily fragmented communities to suffer from canopy dieback in the absence of recruitment, does have implications for the long term integrity and viability of both fragmented and intact remnants. Unmitigated activities in the vicinity of sensitive areas (in the absence of direct impact) do have considerable potential to accelerate edge effects and hence affect the long term viability of the community on a project scale. The sensitivity of this habitat is considered to be ***High.***

An estimated 804 264 ha of this ecosystem occurs nationally (TSSC 2001a) with 586 049 ha of this ecosystem present in the bio-region including 50394 ha occurring within Queensland National Park Reserves based on data provided by Accad *et al*. (2012). This does not include areas mapped as mature regrowth (EHP 2012b) as release of the mature regrowth data postdates these assessments. Based on analysis of government RE and mature regrowth Mapping (EHP 2012a and EHP 2012b) 4450 ha of remnant brigalow and 2534 ha of regrowth brigalow are present in the project development area with a combined total of 6984 ha. Individually, the small disturbed fragments that are common across the landscape present poor type examples, although some much better preserved examples are present in the project development area, typically within historic stock routes. As the Brigalow

TEC consists largely as fragmented remnants within the project development area representing 0.86% of the national extent, the impact magnitude in terms of direct habitat loss is considered to be ***Moderate*** and the unmitigated impact significance is considered to be ***Moderate (17).***

**Proposed management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to this ecological community.

Summary residual impact assessment: Whilst avoidance is the only feasible method of eliminating direct impact to the ecosystem, the measure alone will not eliminate processes of degredation. The increase in land use and access pressure facilitated by construction and production activities will, in the absence of strict management measures, promote edge effects including weed infestation and potential loss of canopy vigour (through dust, weed infestation and hydrological changes). A combination of various mitigation measures including habitat avoidance where possible and habitat offset under requirements of SEWPaC (2012b) will mostly mitigate against impacts. The residual impact significance assessment is therefore considered to be ***Moderate (12).***

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| **Avoidance*** | | | **Others#** | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| High | NA | NA | Low | Moderate (12) |

*Includes application of appropriate management buffers
# Clearing of the Brigalow TEC is avoided.
NA - Not applicable as the area will not be subject to impacts.

**Evaluation under MNES referral guidelines**

**Table A11** presents an assessment of Brigalow (*Acacia harpophylla* dominant and co-dominant) under the MNES referral guidelines. This assessment assumes that all vegetation associated with these survey areas occurs within the development footprint and will be 100% cleared.

**Table A11**. Significance of impact to the Brigalow TEC under MNES referral guidelines.

| **Criteria** | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | Within survey areas 7, 8, 9 and F, 9.5 ha of the Brigalow TEC will be cleared for project development activities. Total anticipated clearing represents <0.001% of the national extent of the ecological community.<br><br>No impact will be incurred within survey areas 2 as it was not found to be present.<br><br>In accordance with Criteria 1, a significant impact is expected due to reduction in extent of the Brigalow TEC. |

| **Criteria** | Evaluation |
|---|---|
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Where the Brigalow TEC occurs in survey areas 7, 8, 9 and F, these habitats represent remnants that have been previously subject to landscape fragmentation and represent poor examples of the community. If direct clearing of these fragmented remnants occurs, it will not lead to further degradation and fragmentation of the Brigalow TEC in the adjacent landscape or broader project development area.<br><br>Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present.<br><br>In accordance with **Criteria 2**, no significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | The occurrences subject to clearance are small isolated remnants that are heavily degraded. These habitats are not considered critical to the survival of the ecological community.<br><br>Development of survey areas 2 will not result in impact to the Brigalow TEC as it was not found to be present.<br><br>In accordance with **Criteria 3**, no significant impact is expected. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | It is assumed that all brigalow habitats within survey areas 7, 8, 9 and F will be cleared during development.<br><br>If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent modification or destruction of abiotic factors critical to the survival of the ecological community.<br><br>Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present.<br><br>In accordance with **Criteria 4**, no significant impact is expected. |
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting. | It is assumed that all brigalow habitats within survey areas 7, 8, 9, and F will be cleared during development.<br><br>If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent loss of a functionally important species.<br><br>Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present.<br><br>In accordance with **Criteria 5**, no significant impact is expected. |
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to | It is assumed that all brigalow habitats within survey areas 7, 8, 9 and F will be cleared during development.<br><br>If these habitats can be avoided through modification of |

| **Criteria** | Evaluation |
|---|---|
| the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent the loss in quality or integrity of an occurrence of an ecological community. It should be noted that these habitats exist in a degraded condition.<br><br>Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present.<br><br>In accordance with **Criteria 6**, no significant impact is expected. |
| **Criteria 7:** Interfere with the recovery of an ecological community. | The ecological community is not in state of recovery within survey areas 7, 8, 9 and F and are being degraded by ongoing processes of attrition through weed invasion and canopy senescence.<br><br>Development of survey areas 2 will not result in impact to the Brigalow TEC as it was not found to be present<br><br>In accordance with **Criteria 7**, no significant impact is expected. |

* Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence **= *High***.

**Conclusions:** For the Brigalow (TEC) the potential impacts are known with 9.5 ha likely to be cleared. This assumes the entirety of the survey areas are cleared of vegetation within Survey Areas 7, 8, 9 and F. These impacts are considered significant under MNES guidelines, Criteria 1 and 2. Impacts can be mitigated and are considered reversible by appropriate application of biodiversity offsets according to EPBC Act Environmental Offsets Policy (SEWPaC 2012). Project related activities will contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS.

No impact to the Brigalow Ecological Community will be incurred within survey area 2.

**Rule(s) for survey effort required in accordance with survey guidelines:** Current survey guidelines as contained within Nelder et al 2012 for REs in Queensland are appropriate to allow identification of this ecological community.

**Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland**

**EPBC Act Status:** Critically Endangered

**Relevant REs:** 11.3.21 (*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils): 11.3.24 (*Themeda avenacea* grassland on alluvial plains. Basalt derived soils).

**VM Act Status:** Endangered

**Biodiversity Status:** Endangered

**Sensitivity:** Extremely high

***Recovery plan:*** A draft national recovery plan (Butler 2007) has been prepared for the Natural grassland and fine textured alluvial plains of northern New South Wales and southern Queensland Ecological Community, herein referred to as the Natural Grasslands TEC.

***Other relevant habitats:*** RE11.3.21 and RE11.3.24 is represented within the mature regrowth mapping database (EHP 2012b) although it is uncertain as to how regrowth grassland ecosystems manifest in the project development area. Due to a lack of information concerning habitat condition, regrowth grassland habitats represented in mature regrowth datasets (EHP 2012b) are not included within the Natural Grassland TEC.

Non-remnant derived grasslands have been represented in the project RE mapping undertaken at 1: 40 000 scale. Although these habitats present a floristic expression that is similar to natural grasslands, they are not included within the TEC due to their derivation from clearing of prior woodland habitat.

***No of survey sites:*** 8 Secondary (AS121, AS355, AS365, AS366, AS368, AS370, AS372), 1 Quaternary. Summary site data is provided in Appendix A, Arrow Enery - Surat Gas Terrestrial Ecology EIS (3D Environmental 2011).

**Overview of the Natural Grassland TEC**

Native grassland is one of the more difficult communities to map and assess, due largely to the difficulties in determining whether the community is a natural treeless area, or derived from historical clearing of the original woodland. Whilst historical photographs provide some evidence on which to make an assessment, the earliest photography (1960's) may predate settlement by up to 100 years. Hence landscape context and landuse type (in the absence of historical survey reports) are often the most reliable means on which to base a determination.

In the project development area, field survey determined that naturally grassed areas, with the exception of a few minor occurrences, are confined almost entirely to designated stock routes which have been largely protected from land clearing. The community is largely restricted to narrow linear fragments in the area between Cecil Plains and Dalby with scattered examples to the north between Dalby and Chinchilla. Heavy clay soils with vertic properties (gilgai) form the underlying substrate in all examples of this TEC that were examined during field survey.

The ecosystem was sampled on a seasonal basis with surveys completed in October/November 2009. Methods utilised in additional surveys in May 2010 were consistent with those necassary to determine threshold condition according to the EPBC listing advice. Four sites were placed within grasslands along the Dalby-Kogan Road and another four along the Dalby-Cecil Plains Road. Species were grouped into broad life form categories with calculations of mean cover values and species richness utilised.

On the basis of the data collected in May 2010 the grasslands on the Dalby-Kogan Road exhibit high integrity and are consistent with the 'best quality' EPBC endangered classification on the basis that they: a) have a minimum patch size at least 0.5 ha; b) support at least four native perennial grass species from the indicator species list; c) support at least 200 native perennial grass tussocks per plot of 0.1 ha; d) have a total projected canopy cover of shrubs less than 30%; and e) perennial non-woody introduced weed species are less than 5% of the total projected crown cover.

Whilst the Dalby-Cecil Plains Road grasslands also meet EPBC criteria they are assessed as 'good quality' grasslands under the EPBC threshold criteria. They exhibit a higher incidence of weeds (i.e. perennial non-woody introduced weed species are less than 30% of the total projected crown cover), however this is heaviy influenced by the widespread occurrence of lippia rather than widespread infestations of exotic grasses. Exotic grasses such as Rhodes grass (*Chloris gayana*), African love grass (*Eragrostis curvula*), and paspalum (*Paspalum notatum*) are more prolific on roadside margins and along disturbance associated with drainage works, fence lines and other linear infrastructure.

The results of the condition survey are broadly consistent with the findings of Goodland (2000) who notes the overall high integrity of grasslands within the Dalby-Kogan stockroute, and the lower signficance of the Dalby-Cecil Plains stock route. Goodland (2000) also notes that the influence of lippia is more pronounced along the Dalby-Cecil Plains sites. It is likely that the widespread flooding events of 2011 will have facilitated its further dispersal of lippia adding to increased modification of the groundcover through displacement of native herbs in inter-tussock spaces.

One EVNT species *Solanum papaverifolium,* was recorded within the Dalby-Kogan Road grasslands habitats. Habitat is suitable for the potential occurrence of lobed blue grass (*Bothriochloa biloba),* finger panic grass (*Digitaria porrecta),* king blue grass (*Dichanthium queenslandicum),* plains picris (*Picris evae),* Australe cornflower (*Rhaponticum australe), Solanum stenopterum,* and Austral toadflax (*Thesium australe).*

The certified RE mapping (EHP 2012a) does not necessarily present an accurate spatial representation of the community, and includes many areas of derived grassland where the evidence of the original woodland in the form of ringbarked trees, log piles and inappropriate soil types is clearly evident both in field inspection and through stereoscopic examination of recent aerial photography. The best preserved example located within a stock route to the north of Dalby (Site AS121) is not recognised in the certified RE mapping, being represented as a mosaic of RE11.3.2 and 11.3.25. It is intended that the detailed mapping undertaken in this exercise provide a more accurate representation of the community distribution and reduce the risk of direct impact.

It should also be noted that two minor areas of RE11.3.24 (*Themeda avenacea* grassland on alluvial plains. Basalt derived soils.) are indicated to the northeast of Cecil Plains. In this location, the ecosystem is represented in association with grassland ecosystem 11.3.21. Access restrictions to private property prevented confirmation although it is considered unlikely however that small areas of basalt derived alluvial soil could be differentiated from within a broader alluvial landform. Hence this ecosystem has been merged with the broader RE11.3.21 ecosystem for the purpose of impact assessment.

**Threats:** The major threats to native grassland habitats are listed as mining, weed invasion, heavy grazing regimes, inappropriate management such as mowing, burning and tree regeneration (SEWPAC 2012a, TSSC 2008r)

**Plate 5.** Remnant native grassland within a stockroute to the north of Dalby (Site AS121). The ecosystem forms a mosaic with woodland RE11.3.2 which is clearly visible in the background.

**Plate 6.** Derived grassland at site AQ88 is mapped as RE11.3.21 in certified DERM RE mapping. Log piles from stick raking are clearly visible in foreground.

**Project-related impacts (unmitigated):** Activities and processes which threaten this ecological community include:

- Direct impacts due to vegetation clearing associated with placement of facilities or infrastructure (e.g. gathering lines for water and gas, gas processing facilities, road widening and road maintenance).
- Accelerated fragmentation of linear habitats adjacent to roadsides or within stock routes through placement of access tracks and petroleum related infrastructure.
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers, exotic species invasion, changes to surface water flow and sedimentation that affect ecosystem function.
- Salt scalding through saline groundwater discharge from production well heads.

**Occurrence in the project development area and extent of habitat:** The Natural Grassland TEC is known to occur in the project development area with the majority of occurrences in the region between Dalby and Millmerran and scattered occurrences northwards to Chinchilla. Its extent in the project development area is provided in **Table A12**. The distribution of the Natural Grassland TEC is shown in **Figure A2**. The Natural Grassland TEC is not recorded within properties subject to examination during the SREIS (i.e., survey areas 2, 7, 8, 9 F).

**Table A12**. Extent of the Natural Grassland TEC within the project development area and associated areas of assessment.

| | **RE11.3.21** | **RE11.3.24** | **Mature Regrowth** | **Total (ha)** |
|---|---|---|---|---|
| Project development area* | 676 | 101 | Not assessed | 777 |
| 3D detailed mapping area** | 200 | 0 | 0 | 200 |
| 3D detailed mapping area based on EHP (2012a)*** | 290 | 9 | Not assessed | 299 |
| Based on regional ecosystem mapping of EHP (2012a) and 3D RE mapping (3D Environmental)**** | 586 | 92 | Not Assessed | 678 |
| Survey areas 2, 7, 8, 9 and F ***** | 0 | 0 | 0 | 0 |

* Based on regional ecosystem mapping of EHP (2012a). Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Project-related impact significance (unmitigated):** Whilst mechanical disturbance is implicated as a means of effecting the spread of exotic plants, Fensham (1998) indicates that relatively few exotic species have the capacity to displace native species without mechanical disturbance, with the exception of lippia (*Phyla canescens)* a weed which is a pervasive groundcover in many habitats

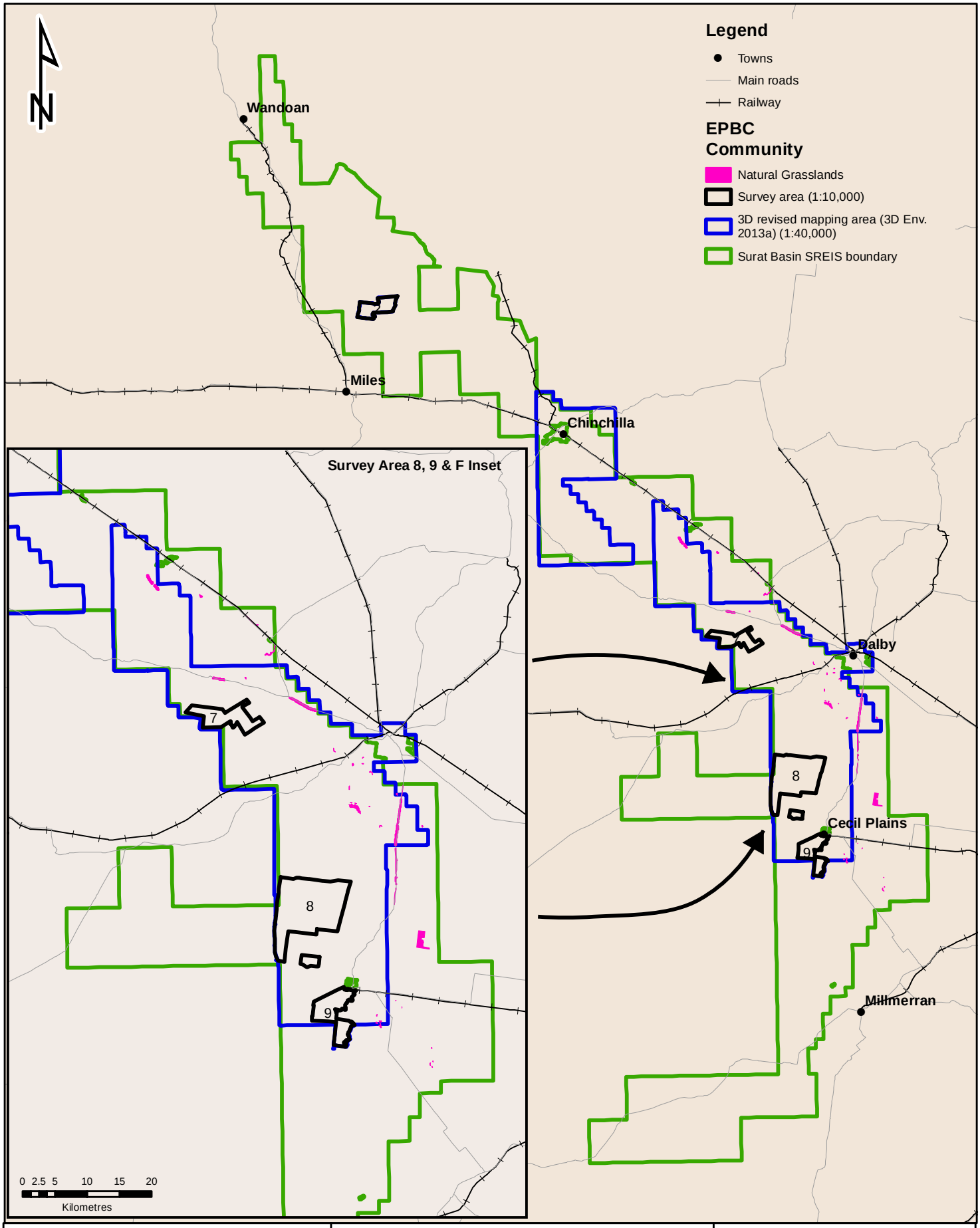
within the project development area. Due to the susceptibility of the habitat to edge effects and invasive species, plus the highly specific edaphic controls, the Natural Grassland TEC is attributed as having ***Extremely High*** sensitivity. Of the 54 584 ha of this ecosystem present in the bio-region, 777 ha (1.4 %) occurs within the project development area as linear fragments within stock routes based on certified RE mapping (EHP 2012a). The community is poorly represented in the conservation estate with only 150 ha preserved within National Parks (Accad *et al*. 2012). Whilst the potential for direct loss of habitat resulting from this project is relatively low, the listing as a 'critically endangered' ecological community underwrites the historical broadscale habitat loss that has been imparted on this community. Grasslands originally extended for 390 000 ha across the Darling Downs with poplar box (*Eucalyptus populnea*) grassy woodlands making up 100 000 ha of the 920 000 ha. Extensive land use in the form of cropping and grazing of the fertile alluvial soils of the Condamine valley has drastically reduced grasslands to some 1.25% of the original extent (Fensham and Fairfax 1997). In Queensland, natural grassland ecosystems in the Darling Downs have been cleared to less than 1% of their original extent (Butler 2007 cited in TSSC 2008r). It is considered important to address the cumulative impacts of projects running concurrently in the bioregion with potential to result in further incremental loss of habitat. Any impact to the Natural Grassland TEC the project development area can be considered to be of ***Extremely High*** magnitude and ***Major (25)*** significance.

**Proposed management / mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impact to this ecological community.

**Summary residual impact assessment:** Avoidance is the only feasible method to mitigate direct impact to the ecosystem. This measure alone will not eliminate all impacts. The increase in land use and access pressure facilitated by construction and production activities will, in the absence of strict management measures, promote edge effects including weed infestation, changes to the natural composition and floristic structure of natural grassland habitats. A combination of all measures will be required to eliminate the risk of impact. In this regard, maintenance of management buffers around identified grassland areas will be particularly important and unnecessary activity within these buffer zones should be avoided. Without any mitigation,impact significance will be ***Major*** **(25)** and application of other measures will not reduce impact significance substantially. Commitment to avoid this habitat (C217) will result in no impact being incurred.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| **Avoidance*** | | | **Others**[#] | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| Extremely High | NA | NA | High | Major (25) |

*Includes application of appropriate management buffers.
[#] Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).

**Figure A2.** Distribution of natural grasslands ecological community

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for Ecological Community Mapping:**

1. EHP RE mapping database (EHP 2012a); The Natural Grassland TEC is applied to RE11.3.21, and 11.3.24. Where these REs contribute <50% to the total area of a heterogeous polygon, they are mapped as 'Natural Grassland sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Natural Grassland sub-dominant'.
2. EHP mature regrowth dataset (EHP 2012b): The Natural Grassland TEC is not applied to the nature regrowth dataset (EHP 2012b).
3. 3D Environmental database (3D Environmental 2013); The Natural Grassland TEC is applied to RE11.3.21 only. RE 11.3.24 has not been mapped. Refer to SEWPAC 2012a for mapping and floristic thresholds.
4. The 3D Environmental database takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The Natural Grassland TEC refers only to that part of the polygon where applicable REs are present.

**Evaluation under MNES referral guidelines**

**Table A13**. Significance of impact to the Natural Grassland TEC under MNES referral guidelines.

| Criteria | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | The Natural Grassland TEC does not occur within survey areas 2, 7, 8, 9 and F and no reduction in the extent of this ecological community will result from project development activities in these locations.<br><br>In accordance with **Criteria 1**, no significant impact is expected. |
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Will not fragment or increase fragmentation of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 2**, no significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | Will not adversely affect habitat critical to the survival of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 3**, no significant impact is expected. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | Will not modify or destroy abiotic (non-living) factors necessary for an ecological communities survival based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 4**, no significant impact is expected. |

| Criteria | Evaluation |
|---|---|
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting. | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 5**, no significant impact is expected. |
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 6**, no significant impact is expected. |
| **Criteria 7:** Interfere with the recovery of an ecological community. | Will not interfere with the recovery of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 7**, no significant impact is expected. |

**Conclusions:** Based on the preceding information, impacts on the Natural Grasslands TEC will not be incurred and are not expected to be unknown, unpredictable or irreversible during development of survey areas 2, 7, 8, 9 and F when assessed under MNES referral guidelines. Project related activities will not contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS. The Natural Grassland TEC will be avoided during development activities and no impacts are expected across the broader project development area.

**Rule(s) for survey effort required in accordance with survey guidelines:** The Natural Grasslands TEC requires survey in the optimal growing season for the assessment of MNES values to be valid. This period typically occurs from February to May although may extend later in the season if significant late season rainfall occurs. Threshold criteria for the Natural Grassland TEC is detailed in SEWPAC 2012a. Survey methods as detailed in Neldner et al (2012) for vegetion in Queensland are otherwise sufficient to identify this ecological community.

**Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions**

**EPBC Act Status**: Endangered

**VM Act Status:** Endangered

**Biodiversity Status:** Endangered

**Sensitivity:** High

***Recovery plan:*** A national recovery plan (McDonald, W. J. F., 2010) has been prepared for the Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions, herein referred to as the Semi-evergreen Vine Thickets TEC.

.***Relevant REs:*** 11.9.4a (Semi-evergreen vine thicket or *Acacia harpophylla* with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks). RE11.9.4a is also represented within the mature regrowth dataset (EHP 2012b) and this has been included with the TEC, although condition of these regrowth habitats is not known.

***No of survey sites:*** The ecological community was not observed during field survey.

**Overview of the Semi-evergreen Vine Thicket TEC**

The ecological community comprises REs 11.11.18, 11.3.11, 11.4.1, 11.5.15, 11.8.3, 11.8.13 and 11.9.4a (TSSC 2001b). RE 11.9.4a, and a single mapped occurrence of RE11.8.3 provides the only example of these ecosystems in the project development area that is represented in certified ecosystem mapping (EHP 2012a).

RE 11.9.4a occurs to the west of Chinchilla where it is mapped as a sub-dominant component of heterogeneous polygons (11.9.5/11.9.4a). Examination of a number of these small occurrences of brigalow in the vicinity indicates vine forest elements are generally suppressed and brigalow-belah comprises the dominant canopy. There is some potential for this ecological community to occur in association with small patches of brigalow (RE 11.9.5) and the two ecosystems area likely to merge and be difficult to differentiate. Hence it is possible that small areas of this community are included with mapping of the brigalow ecological community.

It should be noted that no minimum patch size for the ecological community is defined in the EPBC advice listing (TSSC 2001b). Considering that the natural patch size may be extremely small, it is feasible to recognise fragments with intact canopy down to 0.25 ha as being representative. It should be noted that isolated remnants of < 2 ha may not be represented in certified RE mapping. As such, it is possible that the presently defined extent is a considerable under estimate.

**Threats:** Fragmentation, lack of connectivity, continued clearing, inappropriate fire regimes, invasion by introduced pasture species and increased grazing by domestic stock and native animals are

considered to be general threats to semi-evergreen vine thicket remnants (TSSC 2008s). Within the project development area, major identified threats include:

- Degradation of habitat through fragmentation.
- Edge effects associated with clearing and fragmentation. Of greatest concern is the acceleration of the invasion of exotic species including Opuntia spp. Lantana and pasture grasses, buffel grass (*Pennisetum ciliaris*) in particular, which increases sensitivity to fire.

**Potential project-related impacts (unmitigated):** Project related activities and processes which threaten this ecological community include:

- Direct impacts due to vegetation clearing. Major threats are associated with exploration related activities (e.g., drill pad, access tracks).
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers, exotic species invasion and promotion of inappropriate fire regimes.

**Occurrence in the project development area and extent of habitat:** The Semi-evergreen Vine Thicket TEC is known to occur in the project development area with the majority of occurrences in the region to the north of Chinchilla. Its extent in the project development area is provided in **Table A14**. The distribution of the Semi-evergreen Vine Thicket TEC is shown in **Figure A3**. The Semi-evergreen Vine Thicket TEC has not been recorded within properties subject to examination during the SREIS (i.e., survey areas 2, 7, 8, 9 and F).

**Table A14.** Extent of the Semi-evergreen Vine Thicket TEC within the project development area and associated areas of assessment.

| | **RE11.9.4a** | **Mature Regrowth (RE11.9.4a)** | **Total (ha)** |
|---|---|---|---|
| Project development area* | 22 | 27 | 49 |
| 3D Detailed Mapping Area** | 0 | 0 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 8 | 6 | 14 |
| Project development area**** | 14 | 21 | 35 |
| Survey areas 9, 7, 2, 8 and F ***** | 0 | 0 | 0 |

* Based on regional ecosystem mapping of EHP (2012a ad 2012b). Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Based on regional ecosystem mapping of EHP (2012a) and 3D RE mapping (3D Environmental).

***** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Significance of project-related impacts:** Less than 150 000 ha of this ecological community exists nationally (McDonald 2010). Based on certified ecosystem mapping (EHP 2012a) 22 ha of RE11.9.4a is represented in the project development area. This is represented in a number of scattered occurrences and isolated remnants (typically of <1.7 ha) which, due to the large edge to area ratios, are likely to be severely degraded and provide poor representation of the Semi-evergreen vine thickets TEC. The habitat comprises an abundance of perennial plant and shrub species which seed irregularly and soils are conducive to establishment of exotic species. Hence, the sensitivity considered to be ***High***. The potential for direct loss of habitat resulting from this project is relatively low, and due to current fragmentation of the community within the project development area, the loss of high quality examples of the ecosystem is considered unlikely. The potential magnitude of unmitigated impact is considered to be ***Moderate*** with the project related impact significance considered to be ***Moderate (17).***

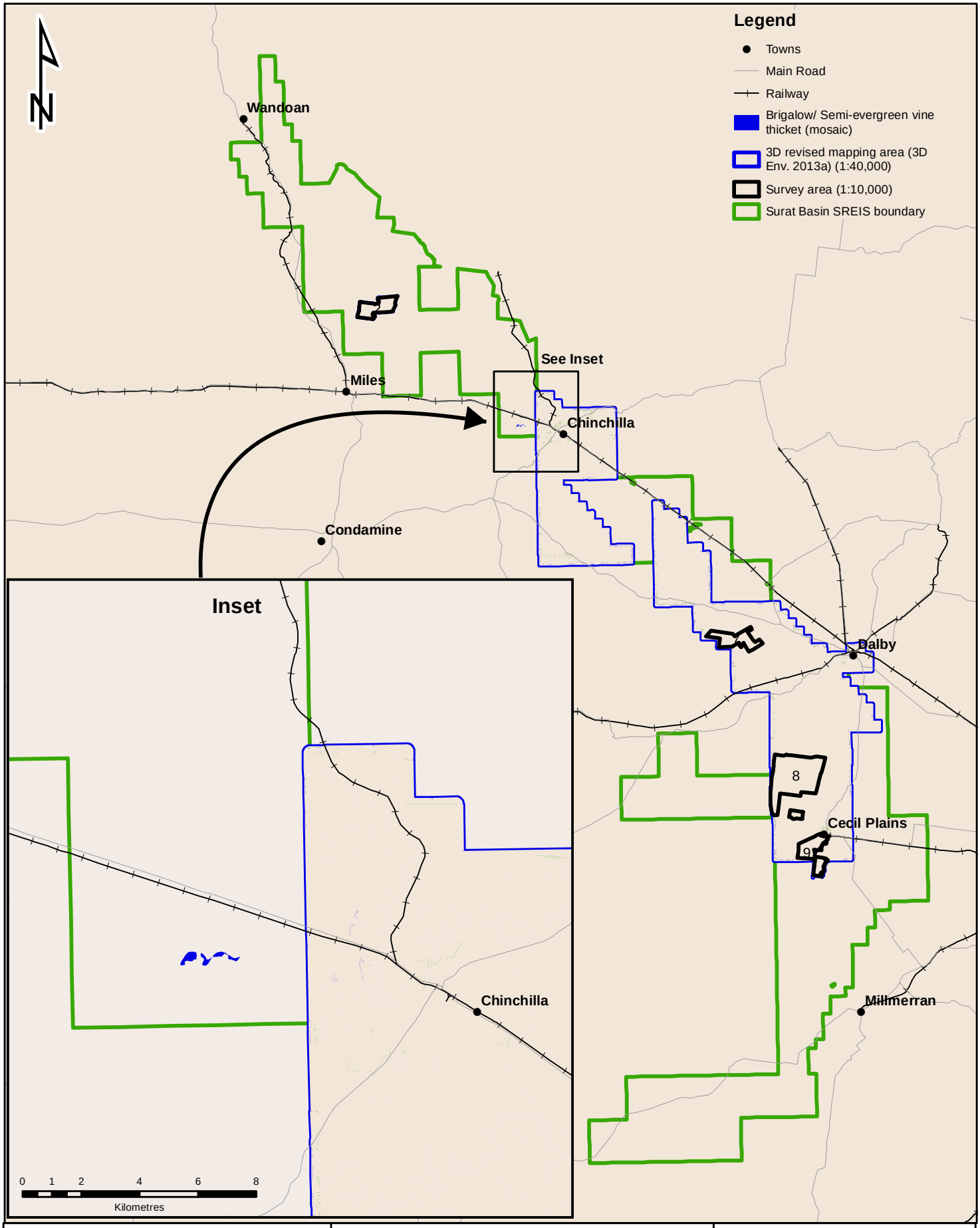
**Proposed management / mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impact to this ecological community.

**Summary residual impact assessment:** Because the Semi-evergreen Vine Thicket TEC comprises small isolated fragments, avoidance of the ecosystem should be easily managed. The highly fragmented nature of the habitat suggests that edge effects are likely to have already significantly reduced the habitat integrity. Habitat re-construction may be difficult to implement and maintain in the long term and little detailed information is available on the reproduction of semi-evergreen vine thicket plants. Observations suggest that few seedlings and young plants establish in undisturbed thickets although recovery potential for some species could be robust (Kahn and Lawrie, 1987 cited in TSSC, 2001b). Hence, rehabilitation is likely to be moderately successful.

If habitats are not avoided, alternative management measures and well managed rehabilitation to disturbed areas will mostly be able to mitigate impacts and the impact significance will be ***Moderate (12)***. Total habitat avoidance with management buffers in place will totally mitigate against impact.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| **Avoidance*** | | | **Others#** | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).

**Figure A3.** Distribution of semi-evergreen vine thicket ecological community.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for Ecological Community Mapping:**

1. EHP RE mapping database (EHP 2012a); The Semi-evergreen Vine Thicket TEC is applied to RE11.8.3, 11.9.4a. Where these REs contribute <50% to the total area of a heterogeous polygon, they are mapped as 'Semi-evergreen Vine Thicket Sub-dominant). Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Semi-Evergreen Vine Thicket Dominant'.
2. EHP mature regrowth dataset (EHP 2012b): As applied to EHP (2012a).
3. 3D Environmental database (3D Environmental 2013); The Semi-Evergreen Vine Thicket TEC is not applied in the 3D Environmental Dataset (3D Environmental 2013) as the ecological community has not been identified. Refer to TSSC (2001b) for mapping and floristic thresholds.
4. The 3D Environmental database takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

**Evaluation under MNES referral guidelines**

**Table A15.** Significance of impact to the Semi-evergreen Vine Thicket TEC under MNES referral guidelines.

| Criteria | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | The Semi-evergreen Vine Thicket TEC does not occur within survey areas 2, 7, 8, 9 or F and no reduction in the extent of this ecological community will result from project development activities in these locations.<br><br>In accordance with **Criteria 1**, no significant impact is expected. |
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Will not fragment or increase fragmentation of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 2**, no significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | Will not adversely affect habitat critical to the survival of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 3**, no significant impact is expected. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | Will not modify or destroy abiotic (non-living) factors necessary for an ecological communities survival based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 4**, no significant impact is expected. |
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting. | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 5**, no significant impact is expected. |

| Criteria | Evaluation |
|---|---|
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.** Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed.<br><br>In accordance with **Criteria 6**, no significant impact is expected. |
| **Criteria 7:** Interfere with the recovery of an ecological community. | Will not interfere with the recovery of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 7**, no significant impact is expected. |

**Conclusions:** Based on the preceding information, there will be no impact to the Semi-evergreen Vine Thicket TEC incurred during development of survey areas 2, 7, 8, 9 and F and when assessed under MNES referral guidelines. Impacts are considered known and predictable (no impact) and reversibility is not relevant. Project related activities will not contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS.

There is potential for the TEC to be impacted during survey works more broadly within the project development area although more likely close to Chinchilla. Survey works to identify areas of Semi-evergreen vine thicket should be undertaken prior to project development activities and habitat avoided wheren indicated. Assuming pre-clearance surveys are undertaken and habitat is avoid, impacts will not be significant under MNES guidelines.

**Rule(s) for survey effort required in accordance with survey guidelines:** Standard survey floristic survey guidelines for vegetation in Queensland (Neldner etal 2012) will be sufficient to identify this ecological community during field survey regardless of seasonal timing when working more broadly in the project development area.

**Weeping Myall Woodlands**

**EPBC Status:** Endangered

**VMA Status:** Not Represented

**Biodiversity Status:** Not Represented

**Sensitivity:** High

**No of survey sites:** 1 Secondary (GB82).

***Recovery Plan:*** A nation wide recovery plan has not been prepared for the Weeping Myall Woodlands Ecological Community, herein referred to as the Weeping Myall Woodlands TEC.

***Regional Ecosystems:*** Not represented

**Overview of the Weeping Myall Woodlands TEC**

In Queensland, the Weeping Myall Woodlands TEC is known to occur as small patches within REs 11.3.2 and 11.3.28 (DEWHA, 2009), although the latter ecosystem is not known to occur in the project development area. The best preserved examples are typically associated with road reserves and stock routes although the community is not considered to form woodland communities of sufficient extent to be consistently separated as an ecosystem. As such, the community is not recognised as an individual ecosystem within the framework of Queensland's VM Act. The patchy nature of the community also makes delineation difficult,hence the ecological community may be easily overlooked. Based on descriptions provided by DEWHA (2009a) and TSSC (2008t), the following applies to the Weeping Myall Woodlands TEC:

- The Weeping Myall Woodlands TEC range from open woodlands to woodlands, generally 4 to 12m high. The overstorey is dominated by weeping myall (Acacia pendula) trees and in some cases this species may be the only tree canopy species. Other common names for weeping myall include myall, boree, balaar, nilyah, bastard gidgee, and silver leaf boree.
- Other woodland species may also form part of the overstorey of the ecological community. These include: western rosewood (*Alectryon oleifolius subsp. elongatus*); poplar box (*Eucalyptus populnea*); or black box (*Eucalyptus largiflorens*). Grey mistletoe (*Amyema quandang*) commonly occurs on the branches of weeping myall trees throughout the ecological community's range.
- The Weeping Myall Woodlands ecological community can naturally occur either as a grassy or a shrubby woodland. However, the understorey often includes an open layer of shrubs over a ground layer which includes a diversity of grasses and forbs. The ground layers can vary in species composition and cover depending on past and current grazing regimes, and the occurrence of recent rain.

The following condition thresholds for the Weeping Myall Ecological Community apply based on DEWHA (2009):

- The patch of woodland must be at least 0.5 ha (5000 m²) in size.
- The overstorey must have at least 5 per cent tree canopy cover or at least 25 dead or defoliated mature weeping myall trees per hectare.
- The tree canopy must be dominated (at least 50% of trees present) by living, dead or defoliated weeping myall trees.
- The patch has more than two layers of regenerating weeping myall present.

**Threats:** DEWHA (2009) lists the major threats to the community as being land clearing and modification; heavy grazing, lopping for drought fodder; invasive plant species, and; fertiliser and herbicide application. Major threats imposed by the project include:

- Vegetation clearing through failure to correctly identify the ecological community prior to activity.
- Degradation of habitat through fragmentation.
- Edge effects associated with clearing and fragmentation. Of greatest concern is the acceleration of the invasion of exotic species including Opuntia spp., lantana and pasture grasses (buffel grass in particular) which increase the sensitivity of the community to fire.
- The typical chenopod shrub and forb cover of the ground layer is particularly susceptible to displacement by exotic species through heavy grazing and changed fire regimes.

**Project-related impacts (unmitigated):** Activities and processes which threaten this ecological community include:

- Direct impacts due to vegetation clearing.
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.

**Occurrence in the project development area and extent of habitat:** A single occurrence of the Weeping Myall Ecological Community was observed within survey area 7, although the habitat was was not recorded within any other location within the project development area. The observed community formed a low open woodland with canopy heights ranging from 6 m to 10 m with a lower shrub layer at 3 m to 6 m merging with a lower shrub layer. The projected canopy cover of the community was formed by 55 % cover of weeping myall (*Acacia pendula)* with scattered eucalypts including poplar box (*Eucalyptus populnea)* forming less than four % of the upper strata. Ground cover was formed by predominantly native graminoids and soils were moist, becoming saturated in depressions. The community was fringed by regrowth woodland of poplar box and red gum (*Eucalyptus tereticornis)* although there is no clear indication that the ecological community originally occurred within RE 11.3.2. The extent of the ecological community at this location was 0.85 ha, well within patch size thresholds. Regional distribution mapping provided by DEWHA (2009) indicates the

greatest likelihood for occurence is in a band that stretches from Roma to Blackall, west of the project development area meaning that any occurrences are highly significant, representing the eastern limits of the ecological communities distribution.

**Plate 7.** The Weeping Myall TEC within survey area 7, site GB82.

The mapped extent of the ecological community in the project development area is 0.85 ha which was recorded withinsurvey area 7. As the ecological community is not represented in RE mapping, no attempt has been made to estimate its occurrence based on RE associations due to limitations in the accuracy of existing RE mapping databases (EHP 2012a). The location of the only recorded occurrence of the Weeping Myall Woodland TEC in the project development area did not correspond to REs 11.3.2 or 11.3.28, hence mapping these REs as an indication of potential distribution may be misleading. The location of the patch in survey area 7 is shown in **Figure A4** relative to the broader project development area and associated components.

**Significance of project-related impacts:** Current indications are that the community is capable of regeneration following removal of disturbance regimes (DEWHA 2009c) although information relating to the success of rehabilitation efforts from past examples is lacking. The groundcover, dominated by graminoids and herbs is highly sensitive to disturbance and was observed to be subject to infestation

by lippia in patches. The habitat sensitivity is therefore considered to be ***High.*** A total of 31 000 ha of the community is estimated to occur in Queensland (DEWHA, 2009). This is however based on available RE mapping (EHP 2012a) which is poorly constrained due to the prevalence of heterogeneous polygons and coarse spatial accuracy ( ± 100 m) which does not provide a sound basis for accurately assessing the extent of the Weeping Myall TEC within the project development area. Given that the project development area occurs at the eastern limit of the ecological communities distribution, the potential magnitude of impact is considered to be ***Moderate (17)*****.**

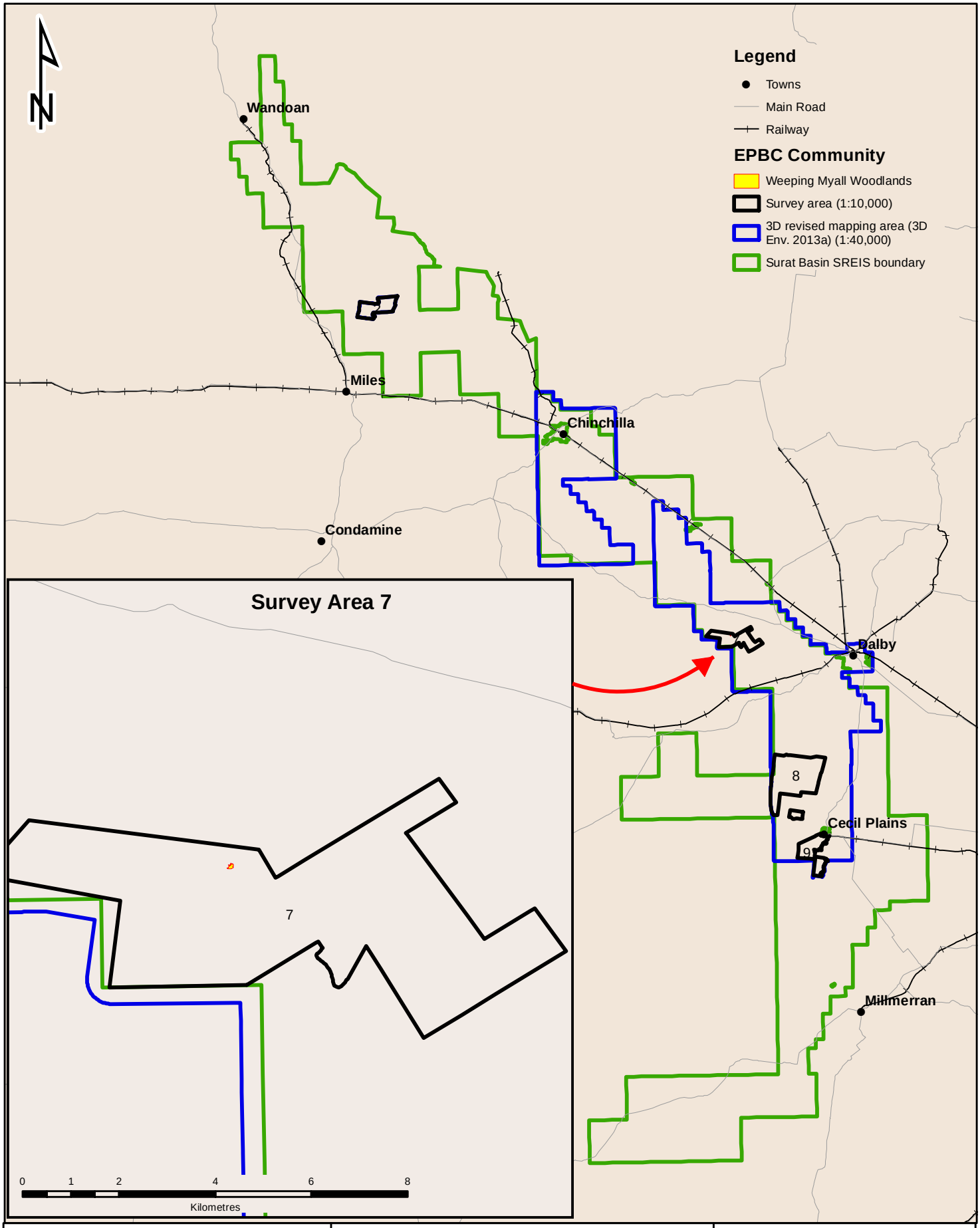
**Proposed management / mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impact to this ecological community.

**Summary residual impact assessment:** Because the Weeping Myall Woodland Ecological Community comprises small isolated fragments, avoidance of the ecosystem should be easily managed although will require careful on site inspection prior to disturbance. Following removal of disturbance, indications are that the community will regenerate successfully (DEWHA, 2009a).

Without any mitigation, impact significance will be ***Moderate*** **(17)*.*** Avoidance with strict protocols to manage edge effects through appropriate application of buffers will completely mitigate impacts potentially incurred through Arrow activities and there will be no residual impact. The application of other mitigation measures (rehabilitation and ecological offsets etc) will mostly mitigate impacts and project related residual impact significance will be ***Moderate (12).***

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| **Avoidance*** | | | **Others#** | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).

**Figure A4.** Distribution of weeping myall ecological community (known distribution only).

**Client** Arrow

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**Rule(s) for Ecological Community Mapping:**

1. The Weeping Myall TEC is not recorded in the EHP RE mapping database (EHP 2012a) nor mature regrowth mapping database (EHP 2012b).
2. 3D Environmental database (3D Environmental 2013); The Weeping Myall Woodland TEC is mapped down to threshold limits of 0.5 ha. Further condtion thresholds are described within TSSC 2008t.

**Evaluation under MNES referral Guidelines**

**Table A16.** Significance of impact to the Weeping Myall Woodland TEC under MNES referral guidelines.

| Criteria | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | Within survey area 7, 0.85 ha of the Weeping Myall Woodland Ecological Community will be cleared for project development activities. This assessment assumes that all vegetation associated with survey area 7 will be cleared.<br><br>Development of survey areas 2, 7, 8, 9 and F will not result in impact to the the ecological community.<br><br>No impact will be incurred within survey areas 2 as it was not found to be present.<br><br>In accordance with Criteria 1, a significant impact is expected due to reduction in extent of the Weeping Myall Woodlands TEC. |
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Clearing associated with development activities on survey area will increase fragmentation of an ecological community based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 2**, a significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | The occurrences subject to clearance are small isolated remnants that occur in a heavily fragmented landscape. The habitat associated with survey area 7 should not be considered critical to the survival of the ecological community.<br><br>In accordance with **Criteria 3**, impact to the Weeping Myall TEC in survey area 7 will not adversely affect habitat critical to the survival of an ecological community.<br><br>It should be noted however that the ecological community in survey area 7 occurs at the eastern limits of distribution and provides a good type example of the habitat in relatively good condition. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | It is assumed that the entirety of Weeping Myall Woodland TEC within survey area 7 will be cleared during development.<br><br>If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent modification or destruction of |

| Criteria | Evaluation |
|---|---|
| | abiotic factors critical to the survival of the ecological community and no impact in accordance with **Criteria 4** is expected. |
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting. | Clearing associated with development activities on survey area 7 will destroy the occurrence of Weeping Myall TEC and cause substantial change in species composition in accordance with **Criteria 5**.<br><br>If the Weeping Myall Woodland TEC within survey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent loss of a functionally important species. |
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | Clearing associated with development activities on survey area 7 will destroy the occurrence of Weeping Myall TEC and cause substantial reduction in the quality and integrity of an occurrence of and ecological community in accordance with **Criteria 6**.<br><br>If the Weeping Myall Woodland TEC within survey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to mitigate impacts described in association with **Criteria 6.** |
| **Criteria 7:** Interfere with the recovery of an ecological community. | The ecological community is not in state of recovery within survey area 7. Hence project development activities with survey area 7 will not have an impact in accordance with **Criteria 7**. |

**Conclusions:** For the Weeping Myall Woodlands TEC the potential impacts are known with 0.85 ha impacted assuming the entirety survey area 7 is cleared of vegetation. This impact is considered significant under MNES referral guidelines, Criteria 1 and Criteria 2. Although significant, these impacts are predictable and can be reversed by appropriate application of biodiversity offsets according to EPBC Act Environmental Offsets Policy (SEWPaC, 2012). Project related activities will contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS.

No significant impacts are expected for the Weeping Myall TEC for survey areas 2, 8, 9 and F although the habitat may occur more broadly in the project development area. Survey works to identify areas of Weeping Myall Woodlands TEC should be undertaken prior to project development activities and habitat avoided wheren indicated. Assuming pre-clearance surveys are undertaken and habitat is avoid, impacts will not be significant under MNES guidelines.

**Rule(s) for survey effort required in accordance with survey guidelines:** Guidelines for survey of vegetation in Queensland, prepared by Nelder et al, are sufficient to identify this ecological community during field surveys. Conditions thresholds for classification of this TEC contained within DEWHA

(2009) should be referenced during survey to ascertain ecological community size and condition thresholds.

**White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland**

**EPBC Status:** Critically Endangered

**VM Act Status:** Least Concern

**Biodiversity Status:** No Concern at Present

**Sensitivity:** High

***Recovery Plan:*** A nation wide recovery plan has not been prepared for the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, herein referred to as the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC.

***Regional Ecosystems:*** 11.8.2a

***Other relevant habitats:*** RE11.8.2a is represented in mature regrowth databases (EHP 2012b) although due to condition thresholds applicable to groundcover, it is not included within the Weeping Myall Woodlands TEC.

***No. of survey sites:*** The ecological community was not observed during survey.

**Overview of the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC**

Box – gum grassy woodlands and derived grasslands are characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs, and the dominance, or prior dominance, of White Box, Yellow Box or Blakely's Red Gum trees (TSSC 2008v, TSSC 2006).

A relatively extensive occurrence of RE11.8.2a (*Eucalyptus tereticornis* + *Eucalyptus melliodora* woodland) are represented in the certified RE mapping (EHP, 2012a) on steep basalt landforms in the Captains Mountain area to the south of Millmerran. The ecological community forms a primary component of this RE (TSSC, 2006a). These sites could not be accessed during the field survey to allow habitat confirmation, although the occurrence of white box (*Eucalyptus melliodora)* in roadside regrowth vegetation suggests that the RE is likely to be accurately represented. However, the nature of the shrub layer requires consideration and only those remnants with a significant cover of native tussock grasses and a patchy shrub layer are consistent with classification of the ecological community. Remnant patches with consistently dense shrub layers are excluded from the classification. In the absence of detailed field survey, it should be assumed that areas of mapped RE11.8.2a provide representation for the White Box – Yellow Box Blakely's Red Gum Grassy Woodland Ecological Community. The community should therefore be considered likely to occur in basalt landscapes to the southern portion of the project development area.

**Threats:** TSSC (2008v) indicates major threats to the community as including grazing, land clearing, weed invasion plus a range of other degrading processes including salinity, nutrient enrichment, altered fire regimes and fragmentation. Major threats imposed by the project are likely include:

- Vegetation clearing through failure to correctly identify the ecological community prior to activity.
- Degradation of habitat through fragmentation.
- Edge effects associated with clearing and fragmentation including invasion of exotic weeds. Of particular concern would be those that displace native grass covers such as Lantana camara*, a process that might occur relatively rapidly in the long term absence of fire.

**Project-related impacts (unmitigated):** Activities and processes which threaten this community, include:

- Direct impacts due to vegetation clearing. The most extensive areas currently mapped occur on steep basalt escarpments and hill slopes where access for exploration would be extremely limited.
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.
- Interruption of fire regimes which are responsible for maintenance of native grass cover. This would likely occur with increasing fragmentation of the landscape through construction of exploration infrastructure.

**Occurrence in the project development area and extent of habitat:** The White Box – Yellow Box Grassy Woodland Ecological Community possibly occurs in the project development area in the vicinity of Millmerran. Its likely extent in the project development area is provided in **Table A17** with distribution shown in **Figure A5**. The ecological community has not been recorded within properties subject to examination during the SREIS (i.e., survey area 2, 7, 8, 9 and F).

**Table A17.** White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC within the project development area and associated areas of assessment.

| | **RE11.8.2a** | **Mature Regrowth (RE11.8.2a)** | **Total (ha)** |
|---|---|---|---|
| Project development area* | 260 | 126***** | 260 |
| 3D Detailed Mapping Area** | 0 | 0 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 0 | 0 |
| Survey area 9, survey area 7, survey area 2, survey area 8, survey area F **** | 0 | 0 | 0 |

* Based on regional ecosystem mapping of EHP (2012a ad 2012b). Level of confidence = ***Low***
** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***
*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***
**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

***** Not Considered in the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC.

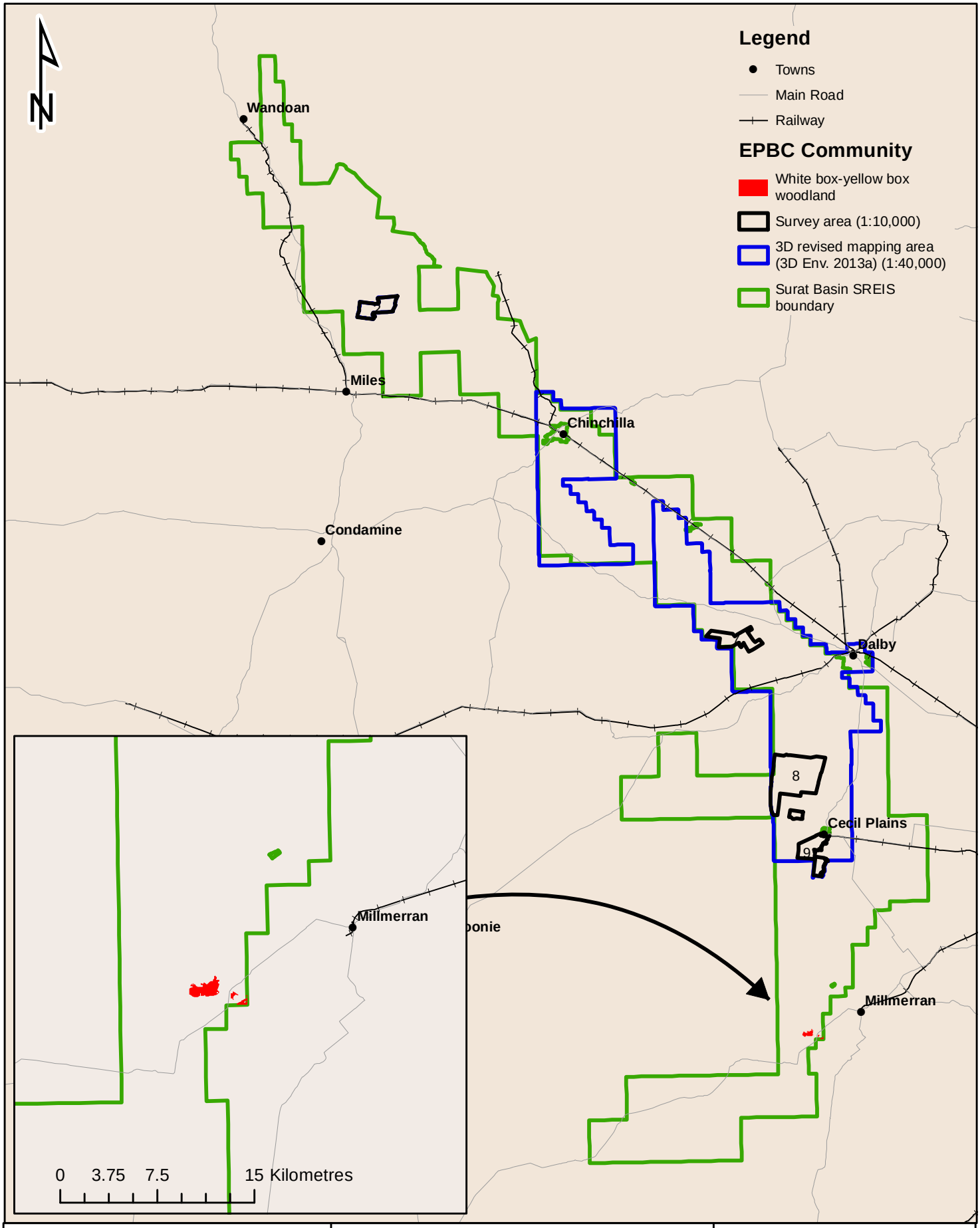
**Significance of project-related impacts:** Given the fragile nature of the ground cover which comprises a number of perennial grass species which are susceptible to degredation, coupled with the fact that the community is at the northern limit of its ecological range, the sensitivity of this habitat is considered ***Extremely High***. The Brigalow Belt bioregion hosts of 67 574 ha (16%) of the ecological community out of a total of 416 325 ha at a national level (TSSC 2008v). Approximately 260 ha of the community is potentially present within the project development area, 1.5% of the total bioregional representation of the ecological community. The magnitude of potential unmitigated impact to this habitat is considered ***High***. A total loss of the representation of this ecological community within the project development area would be considered an impact of ***Major (23)*** significance. With consideration given to the inaccessible nature of the occurrence, on a steep basalt escarpment, any major loss incurred by direct impact is however unlikely.

**Proposed management / mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impact to this ecological community.

**Summary Residual Impact Assessment:** Avoidance is the only feasible method to mitigate direct impact to this ecosystem. Because the ecosystem occurs largely on inaccessible terrain, there is unlikely to be any direct impact to the community during exploration activity and avoidance is easily managed. Without any mitigation, impact of ***Major (23)*** significance may occur. Avoidance of the habitat (commitment C217) with strict protocols to manage edge effects will completely mitigate impacts and residual impacts will not be incurred**.** A combination of avoidance and other compensatory measures will partially mitigate impact and impact significance will remain ***High*** **(20).**

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| **Avoidance*** | | | **Others#** | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| Extremely High | NA | NA | Moderate | High (20) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);

**Figure A5.** Distribution of white box - yellow box woodlands ecological eommunity in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for Habitat Mapping:**

1. EHP RE mapping database (EHP 2012a); The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland TEC is applied to RE11.8.2a. Where this RE contributes <50% to the total area of a heterogeous polygon, it is mapped as White Box – Yellow Box, Blakely's Red Gum, TEC). Where this RE contributes >50% but less than 100% to the total area of a polygon, it is mapped as 'Semi-Evergreen Vine Thicket Dominant'.
2. The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland TEC is not applied to the Nature Regrowth dataset (EHP 2012b.
3. 3D Environmental database (3D Environmental 2013); The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland TEC is not applied in the 3D Environmental Dataset (3D Environmental 2013) as the ecological community has not been identified
4. The 3D Environmental database takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

**Evaluation under MNES referral guidelines**

**Table A18.** Significance of impact to the White Box – Yellow Box, Blakely's Red Gum Ecological Community under MNES referral guidelines.

| Criteria | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland does not occur within any survey area. No reduction in the extent of this ecological community will result from project development activities in these locations.<br><br>In accordance with **Criteria 1**, no significant impact is expected. |
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Will not fragment or increase fragmentation of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 2**, no significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | Will not adversely affect habitat critical to the survival of the ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 3**, no significant impact is expected. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | Will not modify or destroy abiotic (non-living) factors necessary for an ecological communities survival based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 4**, no significant impact is expected. |
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria** |

| Criteria | Evaluation |
|---|---|
| functionally important species, for example through regular burning or flora or fauna harvesting. | **1.**<br><br>In accordance with **Criteria 5**, no significant impact is expected. |
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 6**, no significant impact is expected. |
| **Criteria 7:** Interfere with the recovery of an ecological community. | Will not interfere with the recovery of an ecological community based on information provided in **Criteria 1.**<br><br>In accordance with **Criteria 7**, no significant impact is expected. |

**Conclusions:** For the The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland TEC no impact is expected from development activities within survey areas. Impact is considered known and predictable (no impact) and reversibility is not relevant. Project related activities will not contribute to the cumulative impact incurred to this community.

Survey works to identify areas of the White Box – Yellow Box, Blakely's Red Gum Grassy Woodland TEC should be undertaken prior to project development activities and habitat avoided where it is indicated. Assuming pre-clearance surveys are undertaken and habitat is avoided, impacts will not be significant under MNES guidelines.

Survey guidelines should be followed when working more broadly within the project development area to ensure the TEC is identified during field survey.

**Rule(s) for survey effort required in accordance with survey guidelines:** Guidelines for survey of vegetation in Queensland, prepared by Nelder et al, will be sufficient to identify this ecological community during field survey. Conditions thresholds for classification of this TEC contained within TSSC (2006) should be referenced during survey.

**Coolibah – Black Box Woodlands of the Darling Riverine Plains and Bigalow Belt South Bioregions**

**EPBC Status:** Endangered

**VM Act Status:** Of Concern

**Biodiversity Status:** Of Concern

**Sensitivity:** High

***Recovery plan:*** A nation wide recovery plan has not been prepared for the Black Box Woodlands of the Darling Riverine Plains and Bigalow Belt South Bioregions, herein referred to as the Coolibah – Black Box Woodlands TEC

***Relevant REs:*** 11.3.3

***Total number of survey sites across the project development area:*** 2 Secondary (GB74, GB77)

**Overview of the Coolibah – Black Box Woodlands TEC**

The Coolibah – Black Box Woodlands TEC represents occurrences of one type of eucalypt woodland where *Eucalyptus coolabah* subsp. *coolabah* (coolibah) and/or *Eucalyptus largiflorens* (black box) are the dominant canopy species and where the understory tends to be grassy (TSSC 2011a). The condition thresholds to identify the ecological community are provided below (from TSSC 2011b):

- Patch size: The minimum patch size is 5 ha which may include areas of native vegetation that may be naturally open or contain regrowth.
- The crown cover of trees must be > 8 %.
- Coolibah and coolibah and/or black box in the tree canopy must be present in the patch that are either mature trees with a DBH > 30cm; are coppiced trees with a main stem > 20cm or; hollow bearing trees.
- The ecological community must have a ground-cover in which 10% or more contains native graminoids, herbs or shrubs.

**Threats:** TSSC (2011a) indicates major threats to the community as including land clearing and fragmentation, Hydrological changes to river flow, innappropriate grazing regimes and weed invasion. Major threats imposed by the project are likely to include:

- Vegetation clearing and fragmentation.
- Edge effects associated with clearing and fragmentation.
- Potential changes to hydrology or water quality associated with gas field development including construction of brine ponds, causeways and river crossings and dams.

**Project-related impacts (unmitigated):** Project related activities and processes that threaten this ecological community include:

- Direct impacts due to vegetation clearing for gas facilities, pipelines and well pads.
- Edge effects associated with increased land use pressure, habitat and landscape fragmentation including loss of native ground covers and exotic species invasion.
- Changes to hydrology which may decrease (or increase) the period of seasonal wetting to affect integrity of ground covers or canopy health.

**Occurrence in the project development area and extent of habitat:** The The Coolibah – Black Box Woodlands TEC ecological community is mapped by EHP (2012a) as occurring in the Chinchilla region where it is occurrence is focused on the Charlie Creek Flood Plain and other tributaries of the Condamine River which occur in the vicinity. The community is mapped in these areas as a sub-dominant component of a flood plain woodland mosaics containing REs 11.3.25 and RE11.3.4. Field survey of flood plain vegetation in the area did not confirm the presence of the ecological community where it is currently mapped. Although coolabah (*Eucalyptus coolabah)* was identified as a component of riparian open forest vegetation in the locality of Charlies Creek, it was in no case observed to be a dominant species, mixing with Queensland blue gum (*Eucalyptus camaldulensis, Eucalyptus tereticornis)* and river oak (*Casuarina cunninghamiana)* within RE11.3.25.

A relatively extensive occurrence was however identified in survey area 7 where it occupies an area of approximately 10 ha. In this locality, the habitat forms a low woodland of 10 – 15m height and up to 40 % projected canopy cover. Ground layers are dominated by native species (> 60 %) including a range of native graminoids and forbs (*Eleacharis spp. Walwhelleya subxerophila* and *Marsilea drummondii* predominate). Exotic species, which form < 20% of the ground cover are dominated by lippia *(Phyla canescens).* The habitat occupies a broad, swampy drainage depression and associated black clay soils were saturated at the time of survey. A number of minor occurences of coolibah woodland were also identified as fringing communities to Wilkie Creek where they have been mapped as RE11.3.3. The limited extent of these fringing habitats however, typically < 2 ha, precludes their inclusion within the ecological community. The extent of the ecological community within the project development area based on EHP (2012a and 2012b) and detailed vegetation mapping is provided in **Table A19** with distribution shown in **Figure A6**.

**Table A19.** Extent of the Coolibah – Black Box woodlands TEC within the project development area and associated areas of assessment.

| | **RE11.3.3*** | **Mature Regrowth (RE11.3.3)*** | **Total (ha)** |
|---|---|---|---|
| Project development area* | 259 | 225 | 484 |
| 3D Detailed Mapping Area** | 11.7 | 0 | 11.7 |

| | RE11.3.3* | Mature Regrowth (RE11.3.3)* | Total (ha) |
|---|---|---|---|
| 3D Detailed Mapping Area based on EHP (2012a and 2012b)*** | 127 | 163 | 290 |
| Project development area**** | 144 | 62 | 206 |
| Survey area 7***** | 11.7 | 0 | 11.7 |
| Survey areas 28, 9 and F ***** | 0 | 0 | 0 |

* Based on regional ecosystem mapping of EHP (2012a ad 2012b). Level of confidence = ***Low***

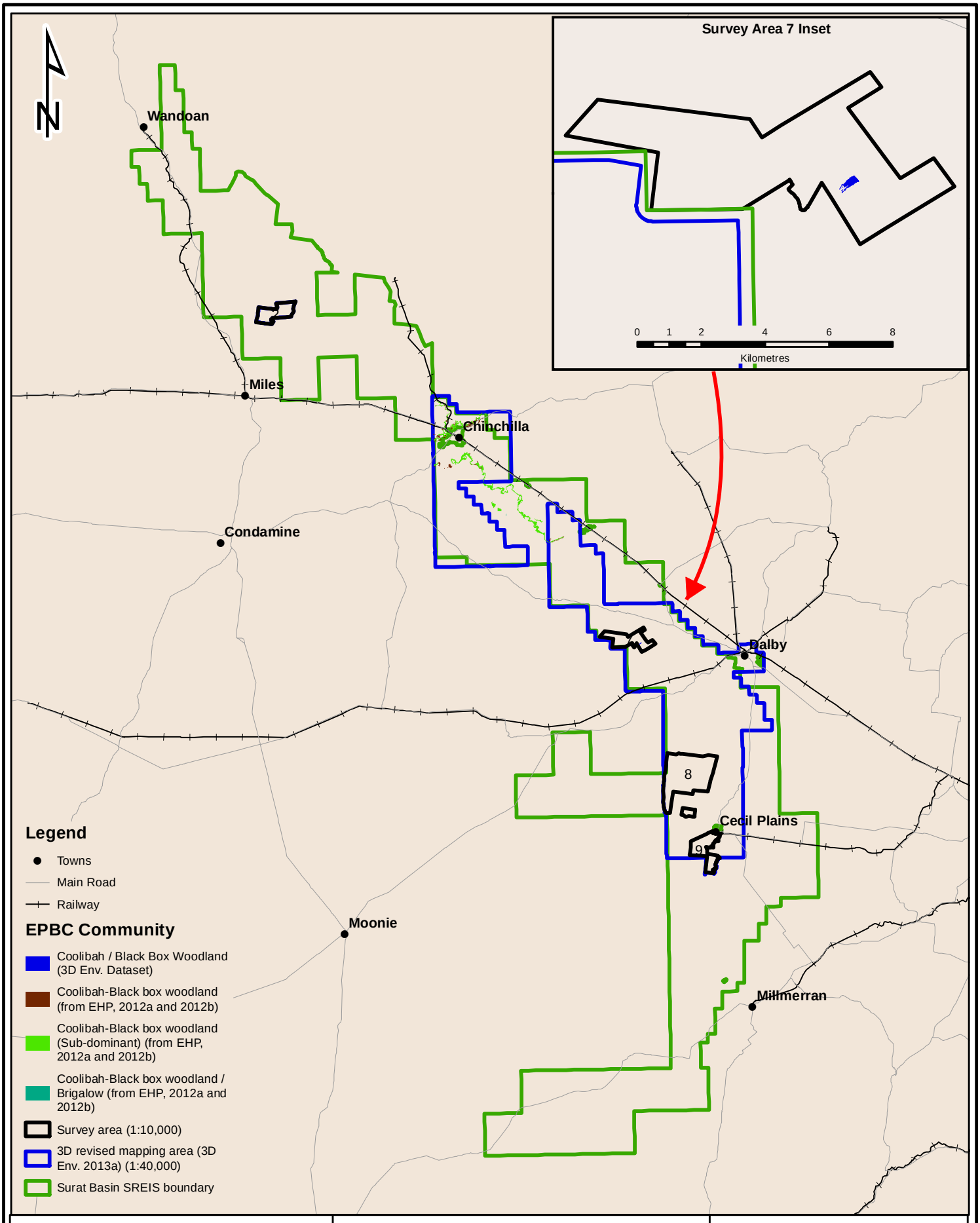
** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate*** (excludes patch sizes < 5ha).

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low.***

**** Based on regional ecosystem mapping of EHP (2012a) and 3D RE mapping (3D Environmental).

***** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High*** (excludes patch sizes < 5 ha)

**Plate 8.** The Coolibah / Black Box Woodland Ecological Community expressed as RE11.3.3 on survey area 7 (site GB77).




NOTES:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).

**Figure A6.** Distribution of coolibah-black box ecological community.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for Ecological Community Mapping:**

1. EHP RE mapping database (EHP 2012a); The Coolibah – Black Box Woodlands TEC is applied to RE11.3.3, and 11.3.3c. Where these REs contribute <50% to the total area of a heterogeous polygon, they are mapped as 'Coolibah – Black Box sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Coolibah – Black Box dominant'.
2. EHP mature regrowth dataset (EHP 2012b): The Coolibah – Black Box Woodland TEC is applied to the mature regrowth dataset (EHP 2012b) as per EHP 2012a.
3. 3D Environmental database (3D Environmental 2013); The The Coolibah – Black Box Woodland TEC is applied to RE11.3.3 where it occurs in patch sizes > 5 ha. Refer to TSSC (2011b) for mapping and floristic thresholds.
4. The 3D Environmental database (3D Environmental 2013) takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The The Coolibah – Black Box Woodlands TEC refers only to that part of the polygon where applicable REs are present.

**Significance of project-related impacts :** The habitat is highly sensitive to altered hydrological regimes which may modify and cause irreversible changes in ground cover composition and integrity. Hence the sensitivity to disturbance of this ecological community is considered ***High***. The Brigalow Belt South bioregion hosts 181 173 (13%) of the ecological community out of a total of 1 321 103 ha at a national level (TSSC, 2011a). Approximately 386 ha of the community is inferred to be present in the project development area (based on EHP 2012a), 0.14% of the total bioregional representation. The magnitude of potential unmitigated impact to this habitat is considered ***Moderate*** with the significance of unmitigated impact considered to be ***Moderate (17).***

**Proposed management / mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impact to this ecological community.

**Summary residual impact assessment:** Without any mitigation, impacts of moderate significance will possibly happen and impact significance will be ***Moderate (17).*** Total habitat avoidance will completely mitigate against impact and residual impact will not be incurred Alternative management measures and well managed rehabilitation in disturbed areas will mostly mitigate impacts. The residual impacts in this case will be of ***Low (4)***.

| Residual Significance Assessment | | | | |
|---|---|---|---|---|
| **Avoidance** | | | **Others** | |
| **Sensitivity Ranking** | **Magnitude Ranking** | **Significance Ranking** | **Magnitude Ranking** | **Significance Ranking** |
| High | NA | NA | Extremely Low | Low (4) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.

### Evaluation under MNES referral Guidelines

**Table A20**. Significance of impact to the Coolibah - Black Box Woodlands TEC under MNES referral guidelines.

| **Criteria** | Evaluation |
|---|---|
| **Criteria 1:** Reduce the extent of an ecological community | Within survey area 7, 11.7 ha of the Coolibah / Black Box Woodlands TE will be cleared for project development activities. This assessment assumes that all vegetation associated with survey area 7 will be cleared.<br><br>In accordance with **Criteria 1**, a significant impact is expected.<br><br>Development of survey areas 7, 8, 9, 2 and F will not result in impact to the the ecological community. |
| **Criteria 2:** Fragment or increase fragmentation of an ecological community | Clearing associated with development activities onsurvey area 7 will increase fragmentation of an ecological community based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 2**, a significant impact is expected. |
| **Criteria 3:** Adversely affect habitat critical to the survival of an ecological community. | The occurrences subject to clearance are small isolated remnants that occur in a heavily fragmented landscape. The habitat associated within survey area 7 should not be considered critical to the survival of the ecological community.<br><br>In accordance with **Criteria 3**, no significant impact is expected through this mechanism. |
| **Criteria 4:** Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns. | It is assumed that the all Coolibah - Black Box Woodlands within survey area 7 will be cleared during development.<br><br>If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent modification or destruction of abiotic factors critical to the survival of the ecological |

| **Criteria** | Evaluation |
|---|---|
| | community.<br><br>In accordance with **Criteria 4**, no significant impact is expected through this mechanism. |
| **Criteria 5:** Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting. | If the Coolibah - Black Box Woodlands Ecological Community withinsurvey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (Attachment 4, Commitments Update of the SREIS) will be sufficient to prevent loss of a functionally important species.<br><br>In accordance with **Criteria 5**, no significant impact is expected through this mechanism. |
| **Criteria 6:** Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:<br>• Assisting invasive species, that are harmful to the listed ecological community, to become established; or<br>• Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community. | As per information provided within Criteria 4 and Criteria 5. In accordance with **Criteria 6**, no significant impact is expected through this mechanism. |
| **Criteria 7:** Interfere with the recovery of an ecological community. | The ecological community is not in state of recovery within survey area 7. In accordance with **Criteria 7**, no significant impact is expected through this mechanism. |

**Conclusions:** For the Coolibah – Black Box Woodlands TEC the potential impacts are known with 11.7 ha cleared on survey area 7 assuming the entirety of the survey areas are cleared of vegetation. This impact is significant under MNES referral guidelines, Criteria 1 and Criteria 2. These impacts are hoawever predictable and can be reversed by appropriate application of biodiversity offsets according to EPBC Act Environmental Offsets Policy (SEWPaC, 2012). Project related activities will contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS.

There is potential for the Coolibah – Black Box Woodlands TEC to be impacted within the project development area although more likely close to Chinchilla. Survey works to identify areas of this TEC should be undertaken prior to project development activities and habitat avoided wheren indicated. Assuming pre-clearance surveys are undertaken and habitat is avoid, impacts will not be significant under MNES guidelines.

**Rule(s) for survey effort required in accordance with survey guidelines:** Guidelines for survey of vegetation in Queensland, prepared by Nelder et al, will be sufficient to identify this ecological community during field survey. Thresholds for classification of this TEC contained within TSSC (2011b) should be referenced during survey.

# MNES Assessments - Flora Species

## Shrubs and Trees

### Curly-bark wattle (*Acacia curranii*)

**Family:** Mimosaceae

**Status: EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT**: Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A recovery plan has been prepared by the Australian Nature Conservancy (Pickard 1995a) although this document could not be sourced.

### Overview of curly-bark wattle

**Description** (based on Pedley 1978 & 1987; Maslin 2001): An erect or spreading multi-stemmed shrub, up to 3 m tall, with distinctive red curling (minni-ritchi) bark. Phyllodes (i.e. leaves) are up to 18 cm long, needle-like in shape, though slightly flattened with longitudinal striations. Flowers are clustered into small yellow spikes, < 1.5 cm long. Pods are narrow, up to 3 mm wide.

**Plate 9.** Curly-bark wattle (*Acacia curranii).* Photograph M. Fagg, Australian National Botanical Gardens

**Ecology:** The typical life span of curly-bark wattle is unknown, but it is probably similar to many other shrubby *Acacia* species in being a moderately long-lived shrub of 10 to 30 years. It has been recorded flowering during August and September, with pods maturing several months later (Pedley 1987). As a hard-seeded legume, the soil-stored seed reserves of *A. curranii* are likely to be long lived (i.e. > 10 years).

The response to fire by curly-bark wattle may vary depending on the intensity and timing of the burn. In New South Wales populations, plants have been observed to survive fire through vegetative regeneration from root suckers (DECC 1995), yet Cohn (1995) considered that post-fire regeneration at different sites was most likely the result of seed germination, with pre-fire plants apparently killed. There is consistency in reports that curly-bark wattle is capable of post-fire germination, which can be quite dense (Cohn 1995; DECC 1995). Abundant post-fire seed germination probably explains the high stem density of some curly-bark wattle populations. The age at which curly-bark wattle seedlings mature to begin producing seed is an unknown but critical issue influencing appropriate fire intervals. Seedlings of the closely related fire-killed *Acacia tenuissima* begin seed production when 4 years old (Williams *et al*. 2006).

The abundant regeneration via seedlings after fire suggests *Acacia curranii* will also germinate seedlings following mechanical disturbance of the topsoil, although repeated soil disturbance would kill the seedlings that germinate after any initial disturbance. The impact of stock grazing is unknown, but damage from grazing by feral goats has been observed (Cohn 1995).

**Habitat:** Plants are known to occur in shrubby heaths, dry sclerophyll forests and semi-arid woodlands where they can occur as widely scattered thickets in very species-rich heathy scrub with emergent eucalypts (Pickard 1995c, Threatened Species Scientific Committee 2008). Curly-bark wattle grows on sandy clay soils that are poorly drained on weathered sandstone (Pedley 1987; Pickard 1995c). The Queensland population at Gurlumundi has been reported as growing in dense “groves” (Pedley 1987). Queensland collections of curly-bark wattle, recorded in Herbrecs (EHP 2013), mostly occur within areas mapped by the Queensland Herbarium as Regional Ecosystem 11.7.5; shrubland with *Calytrix* spp., *Hakea* spp., *Kunzea* spp., *Micromyrtus* spp., *Acacia* spp., *Melaleuca* spp. and a spinifex grass layer, on natural scalds on deeply weathered sedimentary rocks.

Herbrecs collections (EHP 2013) indicate that a population of curly-bark wattle has been collected on the north-west boundary of the project development area occuring within the mapped regional ecosystem 11.7.6, which is Lemon scented gum (*Corymbia citriodora*) or ironbark (*Eucalyptus crebra*) woodland on lateritic duricrust. An additional curly-bark wattle plant has also been collected in an adjacent area mapped as a mixture of regional ecosystems 11.7.7, 11.7.4 and 11.5.1. These ecosystems are various eucalypt woodlands (e.g. *Eucalyptus fibrosa* subsp. *nubile, Corymbia citriodora, Eucalyptus decorticans* or *Eucalyptus crebra*) woodland on lateritic duricrust or Cainozoic sand plains. The consistent factor in these ecosystems is their association with lateritic duricrust or sand plains.

**Distribution:** The species has a disjunct distribution in NSW and Queensland, with populations separated by several hundred kilometres. The NSW populations occur in the south west plains of western NSW, in the Lake Cargelligo area and on the Gunderbooka Range near Bourke (Pickard 1995c, Orchard & Wilson 2001a). The only Queensland population occurs in and adjacent to the Gurulmundi State Forest area of the Darling Downs, approximately 65 km north-west of Chinchilla (Pedley 1987; Maslin 2001). The Gurulmundi population, which is adjacent to the project development area and restricted to an area of less than 20 km diameter (EHP 2013), represents a highly disjunct northern limit of distribution. It is considered that the three main populations are too broadly separated to facilitate gene flow between populations.

**Likelihood of occurrence in the project development area and extent of habitat:** The species is is shown to occur from existing Herbrecs collections on the north-west boundary of the project development area, approximately 65 km north of Chinchilla, and further west towards and within Gurulmundi State Forest. These records are all attributed with 'low' precision (±16 km) and hence the occurrence of curly-bark wattle should only be considered 'possible' within the project development area. The Gurulmundi area is reported to support two populations with approximately 200 individuals (Pickard 1995c). The species was not detected during field surveys within the project development area, not being recorded in any of the sites proposed for development (i.e., survey area 2, 7, 8, 9 and F). The Gurulmundi population including the collection within the project development area is associated with a broad east-west trending bioregional wildlife corridor that spans the northern portion of the study area. This wildlife corridor encompasses both Barakula and Gurulmundi State Forests.

**Figure A7** indicates the location of Herbrecs collections of the species (EHP 2013) as well as providing representation of the distribution of habitat (including 'core habitat known' and 'core habitat possible) within the project development area. The extent of habitat within specific areas of the project development area is summarised within **Table A21.**

**Threats:** The main threats to the local populations of curly-bark wattle are:

- Grazing, browsing and trampling of adult and seedling plants by feral goats and rabbits (and to less an extent by stock, and macropods). This may be facilitated installation of well ponds which artificially increases watering points for feral animals.
- Clearing of vegetation, including for road widening, gravel extraction and mining;
- Habitat erosion and associated sedimentation of habitat.
- Inappropriate fire regimes, including too frequent fires that do not allow seedlings to mature to produce seed; or fires that are too intense and extensive, which do not leave any mature plants unburnt and limit vegetative survival from root suckers. Alternatively, a long absence of fire, required to promote seedling establishment, for such a period that the soil seed reserves begin to senesce (Lithgow 1997, DECC 2005a, TSSC 2008a). Fires may also be ignited accidentally during construction and operation.

**Table A21.** Extent of habitat for curly-bark wattle within the project development area and associated areas of assessment.

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 74666 | 0 |
| 3D Detailed Mapping Area** | 0 | 0 | 1479 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 1315 | 0 |
| Survey area 2**** | 0 | 0 | 1249 |
| Survey area 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

Of the threats listed above, removal of the shrubs through mechanical clearing, damage from feral animals, especially goats and rabbits, and inappropriate fire regimes are likely to be the most significant for the Gurulmundi population. Damage to curly-bark wattle populations from grazing by goats has been recorded by several observers of NSW populations (Cohn 1995; Martin 2011). For example, in 2011, a group of naturalists were unable to find a NSW population of curly bark wattle on Mt Gundabooka, which in 2005 had been reported to have 150 mature plants across two small areas (Martin 2011). It was also suggested that damage from goats or changed fire regimes may be the cause of this localised decline. Fire regimes that are too frequent will not allow sufficient post-fire seedlings to mature to seed production, and very infrequent fires may lead to the absence of seedlings to replace plants that senesce after a decade or more.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, influencing the success of pollen and seed dispersal.

- Changed fire regimes, such as complete fire exclusion, or repeated, frequent unplanned fires that occur before seedlings can begin producing seed. Changes to fire regimes may be associated with landscape fragmentation that may occur during development of linear infrastructure and gathering lines.

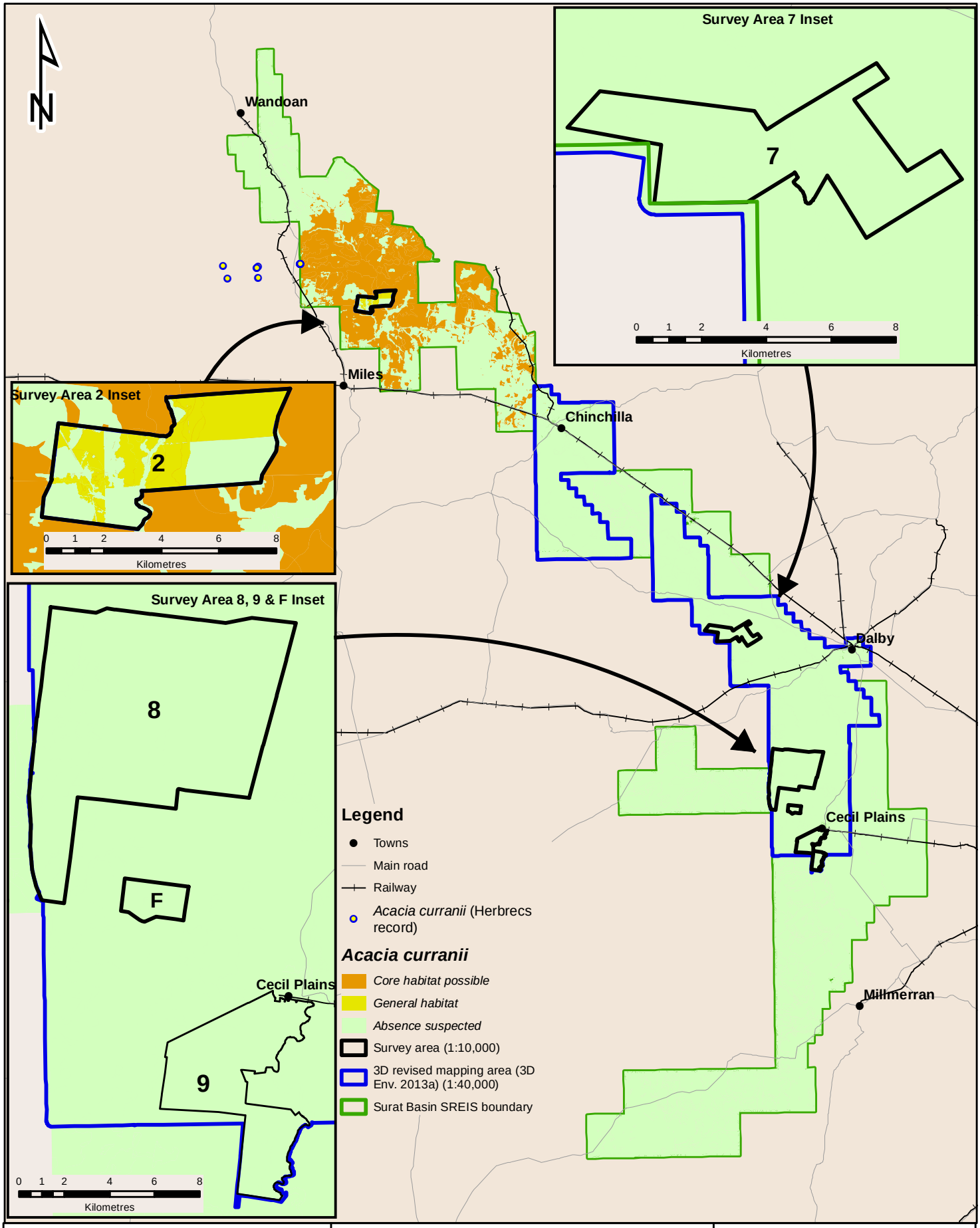
**Significance of project related impacts (unmitigated):** The sensitivity of curly-bark wattle disturbance is considered ***Moderate.*** This is based on the fact that curly-bark wattle is a perennial plant with the ability to generate abundantly from seed following a disturbance such as fire, with some capacity for survival through vegetative suckering; and due to the likelihood of a long lived soil seed reserves.

The potential magnitude of unmitigated impact to curly-bark wattle is considered ***High.*** This is because, based on attribution of the government generated RE and mature regrowth mapping databases (EHP 2013a and 2013b), approximately 20% of the local population occurs within the project development area, and an estimated 12% of the project development area contains possible habitat ( 'core habitat possible').

The only known core habitat for curly-bark wattle in Queensland occurs within a 20 km area, with part of this local population occurring on the north-western boundary of the project development area. Core habitat also occurs outside of project development area in Gurulmundi SF, which is known to be contained within non-Arrow controlled petroleum leases. It has a low abundance both locally and regionally. Core habitat within state forest areas and adjoining land is subject to disturbance by logging. Without mitigation measures, project impacts to restricted areas of core habitat are expected to occur over the life of the project causing decline in local populations although never extinction. It is possible, though not certain, that natural recruitment following disturbance will be able to replace or restore the population density within several generations. It is unlikely to affect the long-term integrity of the entire species which is also known in NSW from two populations.

**Specific management / mitigation for curly-bark wattle populations:** Management of this species is covered in Arrow committments made within Attachment 4, Commitments Update of the SREIS**.** Infrastructure design and site selection that seeks to avoid core habitat known of curly bark wattle will be prioritised. In addition, the following mitigations should be applied specifically to curly-bark wattle:

- Salvage seed from threatened flora species unavoidably disturbed for use in rehabilitation as propagation material or natural regeneration. [C541].




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A7.** Curly bark wattle *(Acacia curranii)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for Habitat Mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as "core habitat known" ('high' confidence levels apply).
2. RE polygons with confirmed records ( ≤ 500 m precision) should be treated as "core habitat known":
3. The following regional ecosystems occurring to the north of Chinchilla (-27.75) should be classed as "core habitat possible":
    - RE 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 ('low'confidence is applied to EHP 2012a with 'high' confidence applied to 3D Environmental dataset (3D Environmental 2013).
    - Where these REs have been subject to intensive survey and the species was not found, they can be downgraded to 'general habitat'.
4. The EHP mature regrowth dataset (EHP 2013) is not included in the attribution as the species is known only from intact habitats.
5. All other remnant and non-remnant vegetation, including cleared grazing land within the project development area should be treated as "absence suspected" ('high' confidence is applied).

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Summary residual impact assessment:** Unmitigated project related activities may result in a residual impact of ***Moderate*** **(18**) significance to curly-bark wattle populations within the project development area. Where avoidance of habitat or populations is not possible, the identified impact management measures of minimising disturbance, and rehabilitation are considered to be mostly effective. Curly-bark wattle is known to germinate abundant seedlings and is likely to be successfully rehabilitated, with a new population maturing within several years. These may mitigate impacts to a large degree, to the extent that minor loss in a local population occurs. If infrastructure avoids core habitat, no impact to the ecological community is expected. If not avoided, but other mitigation measures are implemented, impacts of ***Moderate (13)*** significance may be expected in consideration to the expected success of rehabilitation, particularly if some undisturbed plant clusters can be retained within disturbance footprint.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts.

**Evaluation under MNES referral guidelines**

**Table A22**. Evaluation of impact significance for curly bark wattle under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge a single record of the species occurs within the project development area with further records occurring within the Gurulmundi State Forest 10 km west of the project development area boundary. The record within the project development area should be considered a component of the Gurulmundi population which forms the only population of the species known from Queensland. Curly bark wattle populations are highly disjunct and all should be considered 'important populations'.<br><br>The proposed facility site survey area 2 contains general habitat for the species and although extensive site survey not locate a population of curly-bark wattle, there remains potential for the species to exist. Pre-construction surveys will be required to totally discount its occurrence. No other property considered for development in the near future contains potential habitat for the species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive field survey failed to locate this species within potentially suitable habitats. It is not possible however to totally discount occurrence of the species within these properties and pre-clearance survey will be required once final project footprints have been identified.<br><br>Based on current knowledge an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact to the species is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not adversely affect habitat critical to survival of the species based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 4**, a significant impact to the species is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not the breeding cycle of an important population based on detail provided in Criteria 1.<br>In accordance with **Criteria 5**, a significant impact to the species is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Whilst broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of survey area 2 will not introduce landscape scale processes that have potential to modify, destroy, remove or isolate or decrease habitat leading to decline of the species. Development within other subject properties will not impact wildlife corridors.<br><br>In accordance with **Criteria 6**, a significant impact to the species is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not result in establishment of an invasive species based on detail provided in Criteria 5. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed.<br><br>In accordance with **Criteria 7**, a significant impact to the species is not expected. |
| Criteria 8: introduce a disease | Diseases which impact acacia species are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact to the species is not expected. |
| Criteria 9: interfere with the recovery of the species | The species currently exists within an intact population in vicinity of the project development area. From current knowledge, this population is stable and not in the process of recovery from prior disturbance.<br><br>In accordance with **Criteria 9**, a significant impact to the species is not expected. |

**Conclusions:** For curly-bark wattle (*Acacia curranii)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F ) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development

actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

**Rule(s) for survey effort required in accordance with survey guidelines:** Curly-bark wattle is a perennial shrub species that, due largely to the nature of its distinctive bark, should be readily identified throughout all seasons. Hence no specific survey timing is required to effectively detect the species.

**Hando's Wattle *(Acacia handonis)***

**Family:** Mimosaceae

**Status: EPBC Act**: Vulnerable; **NC Act**: Vulnerable **BoT:** Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A formal recovery plan has not been prepared although Halford (1995b) has prepared advice in regard to species management.

**Overview of Hando's wattle**

**Description** (based on Pedley 1981; Maslin 2001; Hando 2007): Hando's wattle is a small shrub of 1 to 2 m in height. It is resinous, with ribbed branchlets. The phyllodes (i.e., leaves) are spirally arranged, less than 2 cm long and 5 mm wide, and with a small recurved mucro point at the apex. Flowers are grouped together into bright yellow globular heads, with a single head arising from a phyllode axil. Pods are up to 4 cm long and 4 mm wide, which are thickened along the edges of the suture and have a coating resembling sawdust.

**Plate 10.** Hando's wattle (*Acacia handonis).* Photograph M. Fagg, Australian National Botanical Gardens.

**Ecology:** The life span of Hando's wattle plants in the wild is unknown, but they live for about 10 years in cultivation (Hando 2007). Plants have been collected in flower in July, August and

September, and with pods in August, September and November (EHP 2013). As a hard-seeded legume, the soil-stored seed reserves of Hando's wattle are likely to be long lived (i.e. > 10 years).

The response to fire by Hando's wattle has not been well studied. However, it is suggested that it regenerates well from seed following burning (DNR 2000). Hando (2007) reported the value of treating seeds with boiling to promote germination – a treatment typically used to mimic the heat of a fire. (Halford 1995b) observed a few plants re-sprouting from the base of the stems after a fire, suggesting Hando's wattle is mainly fire killed, regenerating via seedlings, but that a minor number can survive where the fire is a low intensity fire.

Acacia species with fire-promoted germination often have quite dense clumping of plants and this has been observed by botanists while collecting samples of Hando's wattle (e.g. with clumps of several hundred plants noted in a 2003 collection (AVH 2013a). Halford (1995b) recorded plant density varied across the known population, from one to 16 plants every 100 $m^2$, estimating that approximately 60% of the population were juveniles, < 10 cm tall. Twelve years later, Hando (2007) reported that the population had declined. Barakula State Forest is capable of fuelling intense fires, the most recent of which occurred in November 2012 (ABC 2012). Fires burnt through most of the known population area in Barukula State Forest in 1990 and 1991, though the fires were patchy enough so that some plants were not burnt (Halford 1995b).

The information from various reports reveal a population dominated by juveniles in 1995, four or five years after fires, and a decline in plant density by 2007. This reflects a typical boom and bust cycle of a short-lived, fire-promoted wattle. The age at which Hando's wattle seedlings begin producing seed is a critical unknown issue that is an important to determine to assist the management of the species.

**Habitat:** Hando's wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest (Maslin 2001, Orchard & Wilson 2001). The vegetation it grows within is a shrubby woodland of *Eucalyptus fibrosa* subsp. *nubila*, *Eucalyptus watsoniana* subsp. *watsoniana, Lysicarpus angustifolius,* and *Allocasuarina inophloia* (Halford 1995). The descriptions of the habitat from which it has been collected are consistent with the regional ecosystem mapping for its locations. This is, primarily RE11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. One collection is also recorded in RE11.7.6: *Corymbia citriodora* or *Eucalyptus crebra* woodland on lateritic duricrust. Although in the wild, Hando's wattle is restricted to lateritic sandstone ridges, Hando (2007) found that they could be grown successfully in sandy loam soil and required very little watering, which is important information for potential translocation and rehabilitation.

**Distribution:** Hando's wattle has an extremely restricted occurrence, being known only from the Barakula State Forest, approximately 40 km north of Chinchilla (Maslin 2001). This population of Hando's wattle was considered to occur in three adjacent areas and was estimated in 1994 to contain around 10 080 individuals over approximately 28 ha (Halford 1995b). The extent of population was considered to have broadened within the Barakula State Forest between the initial collections in 1978

and 1997 (Lithgow, 1997). Although Hando (2007) reported that the population had declined in the years prior to 2007, suggesting dry years may have caused some death.

**Likelihood of occurrence and extent of habitat in the project development area:** This species possibly occurs although has not been recorded in the project development area to date. All currently known populations occur in Barakula State Forest in a cluster approximately 25 km to the east of the project development area boundary. One collection locality is mapped by Herbrecs (EHP 2013) only nine km east of the project development area margins. This outlying sample is the original 1978 collection by Val Hando, which has less precise details (record precision ± 16km) of the collection point than later collections (i.e. was simply recorded as "Barakula SF"). Hando (2007) wrote that the plants collected were to the east of the Auburn Road-Chinchilla road, and all of her subsequent collection localities in 1981 were recorded to the east of the Auburn Road-Chinchilla road, amongst the cluster of all other plant collections, 25 km to the east of the project development area. The population has consistently been considered a single locality encompassing three areas totalling 28 ha to the east of Auburn-Chinchilla Rd (Halford 1995b; Lithgow 1997, DNR 2000).Therefore it is almost certain that the closest known Hando's wattle plants to the project development area are 25 km to the east, well within Barakula State Forest. **Figure A8** indicates the location of Hando's wattle records and distribution of potential habitat whilst **Table A23** provides a summary of the extent of potential species habitat within the project development area.

There is the potential that additional, as yet unknown populations occur within the northern part of the project development area in suitable habitat adjoining Barakula State Forest. Gurulmundi State Forest should also be considered to host possible habitat for *Acacia handonis*. However, the species was not detected during field surveys.

**Table A23**. Extent of habitat for Hando's wattle within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 74666 | 0 |
| 3D Detailed Mapping Area** | 0 | 0 | 1479 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 1315 | 0 |
| Survey area 2 | 0 | 0 | 1288 |
| Survey area 7, 8, 9 and F. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** Inappropriate fire regimes, habitat destruction, disturbance from timber harvesting, inappropriate grazing regimes (DNR 2000) are considered the major threats to *Acacia handonis* populations. Halford (1995b) suggested the main threat to Hando's wattle was inappropriate fire regimes. That is, fires that are too frequent, intense fires, or complete fire exclusion.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

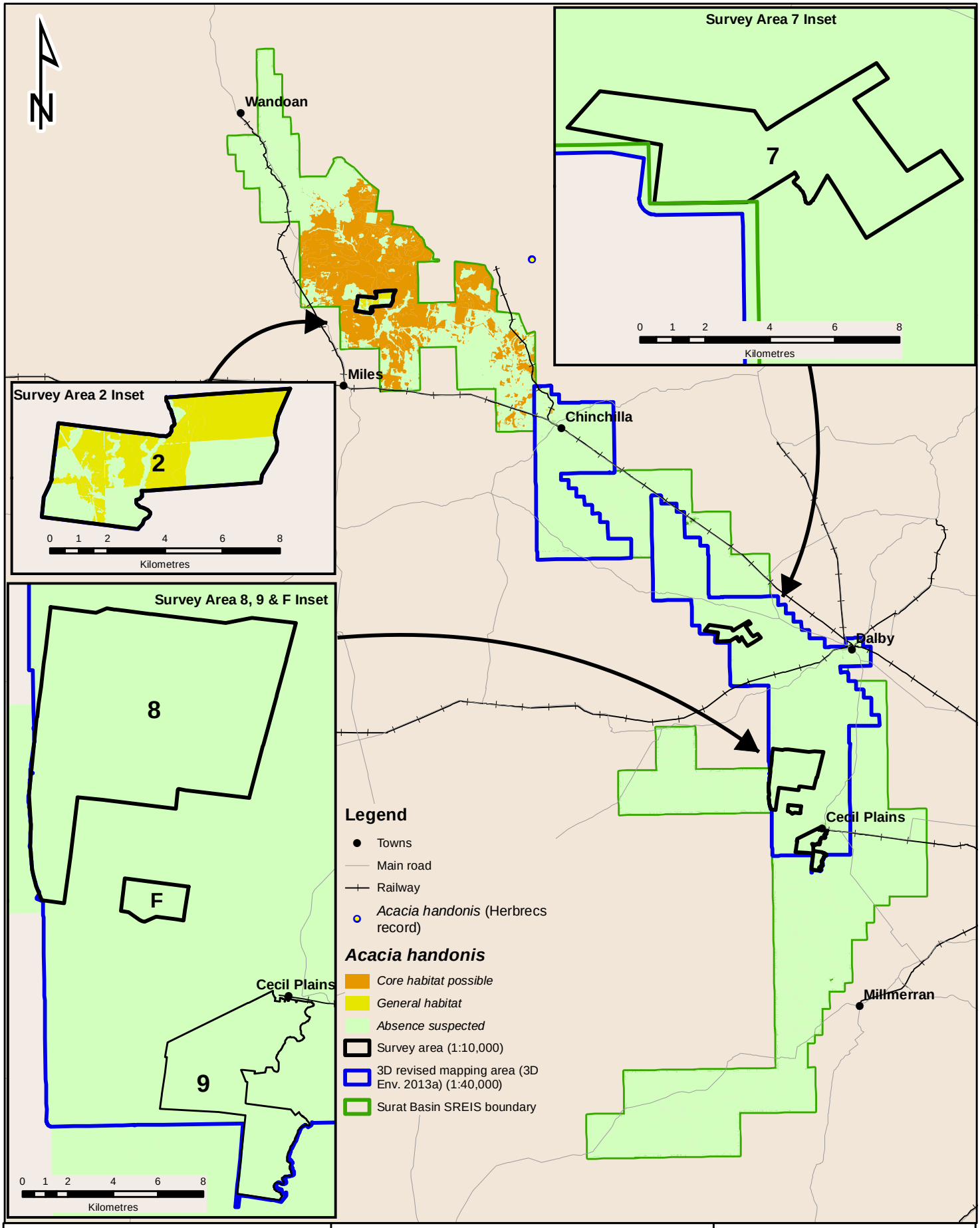
- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, reducing the success of pollen and seed dispersal.
- Changed fire regimes, such as complete fire exclusion that may result from fragmentation, or repeated, frequent unplanned fires that occur before seedlings can begin producing seed.

**Significance of project related impacts (unmitigated):** The sensitivity of populations of Hando's wattle to unmitigated impacts within the project development area is considered ***Moderate.*** This is because it is a perennial species with the ability to generate abundantly from seed following a disturbance such as fire, with some capacity for survival through vegetative suckering observed. Also, Hando's wattle is likely to have a long lived soil seed reserves due to the hard seeds.

The potential magnitude of unmitigated impact is considered ***Moderate.*** This is because no plants are currently known from within the project development area, despite being a well search-for species; and around 10% of the project development area contains known or possible core habitat based on mapping produced by EHP (2012a). The species is reported to propagate readily from seed and is therefore likely be able to be rehabilitated successfully.

**Specific management / mitigation measures:** Management of this species is covered in Arrow committments made within Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Hando's wattle will be prioritised

In addition commitments C224 and C303 within Attachment 4 of the SREIS relating to site specific management for threatened species, will consider fire management in relation to this species where appropriate.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A8.** Hando's wattle *(Acacia handonis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for Habitat Mapping**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. RE polygons with confirmed records ( ≤ 500 m precision) should be treated as “core habitat known”.
3. The following regional ecosystems occurring to the north of Chinchilla (-27.75) should be classed as “core habitat possible”:
    - RE 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 (‘low’confidence is applied to EHP 2012a with ‘high’ confidence applied to 3D Environmental dataset (3D Environmental 2013).
    - Where these REs have been subject to intensive survey and the species was not found, they can be downgraded to ‘general habitat’.
4. The EHP mature regrowth dataset (EHP 2013) is not included in the attribution as the species is known only from intact habitats.
5. All other remnant and non-remnant vegetation, including cleared grazing land within the project development area should be treated as “absence suspected” (‘high’ confidence is applied).

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Summary residual impact assessment:** Where avoidance is not possible, the unmitigated project related impacts to any populations of Hando’s wattle that are found within the project development area are considered ***Moderate* (17)**. Rehabilitation, from seed collection and propagation, will likely facilitate recovery over several to many years. Hando’s wattle regenerates from seedlings after burning. As such, the burning of grass across a disturbed site may provide some rehabilitation, as long as the topsoil containing seed reserves is maintained or stock-piled. If the project disturbance avoids core habitat, impact is not expected.

Where avoidance is not possible, the identified impact management measures of minimising disturbance (including leaving some clusters of undisturbed plants within the footprint), and rehabilitation are considered to be mostly effective, because of Hando’s wattle documented success in propagation. These measures may mitigate impact to a large degree, to the extent that a minor loss in a local population occurs. Therefore, if core habitat can’t be avoided, but other mitigation measures are implemented, project activities may result in impacts of ***Moderate* (13)** significance.

| Residual Impact Assessment | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.

### Evaluation under MNES referral guidelines

**Table A24**. Evaluation of impact significance for Handoo's wattle under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge the only known population of Handoo's wattle occurs in the Barakula State Forest, approximately 25 km east of the project development area. Three sub-populations exist within this locality and all are considered 'important populations'<br><br>The proposed facility site survey area 2 contains general habitat for the species although extensive site survey not locate a population of Handoo's wattle. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount its occurrence. No other property considered for development in the near future contains potential habitat for the species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive field survey within survey area 2 failed to locate this species within suitable habitat. It is however not possible to totally discount occurrence of the Handoo's wattle within the property and pre-clearance survey will be required once project footprints have been identified.<br><br>Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is |

| Criteria | Evaluation |
|---|---|
| | not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Whilst broadscale clearing of propertlysurvey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of survey area 2 will not introduce landscape scale processes that have potential to modify, destroy, remove or isolate or decrease habitat leading to decline of the species. Development within other subject properties will not impact wildlife corridors.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact acacia species are not known to occur.<br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | The species currently exists within an intact population vicinity 25 km east of the project development area. From current knowledge, this population is stable and not in the process of recovery from prior disturbance.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Hando's wattle (*Acacia handonis)* no impact is expected from project development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development

actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

**Rule(s) for survey effort required in accordance with survey guidelines:** Hando's wattle is a perennial shrub species that should be readily identified throughout all seasons. Although no specific survey timing is suggested, surveys completed during the optimal season period ( July to November) would add confidence to the assessment.

**Wardell's wattle (*Acacia wardellii*)**

**Family:** Mimosaceae

**Status: NC Act**: Vulnerable; **EPBC Act**: Vulnerable; **BoT:** Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A recovery plan has not been prepared for Wardell's wattle.

**Overview of Wardell's wattle**

**Description** (based on Maslin 2001): Wardell's wattle is a slender shrub or tree 5 to 7 m high with smooth, silvery-grey or white bark, developing into a rough trunk base on older plants. Branchlets often have a whitish waxy bloom. Phyllodes (i.e., leaves) are 10 to 18 cm long by 1.5 to 3 cm wide, shiny, curved, with two raised main veins that merge together near the phyllode base. The outer phyllode margin often has several gland-tipped teeth. Flowers are clustered into pale yellow globular heads. Seed pods are up to 12 cm long, 6 mm wide and indented between each seed.

**Plate 11.** Wardell's wattle (*Acacia wardellii).* Photograph Copyright © Boobook

**Ecology:** Apparently a short-lived wattle, possibly only living 5 years or so and susceptible to borer attack (Eddie 2007; Lester 2008). Its response to fire is unrecorded. However the closely related *Acacia binervata* is fire-killed (Benson & McDougall 1996).

SEWPAC (2013) suggest that "research by Taylor (1989) and House (1995) showed that frequent burning is detrimental for this species". However the research by Taylor (1989) and House (1995) refers to other acacia species in a different section of south-east Queensland, so do not provide any direct evidence of the fire ecology of Wardell's wattle. However, based on closely related acacia species, and the short life span of Wardell's wattle, it remains likely that that it would be a fire-killed species requiring several fire-free years for post-fire seedlings to mature. It is known to have been cultivated in the region and reported to grow in disturbed areas, such as road sides and pipelines (Eddie 2007; L. Pedley's 1984 collection label and Pollock's 2001 collection notes viewed at AVH (2013b)).

**Habitat:** The species inhabits gravelly soils on shallow weathered sandstone in eucalypt woodland (Pedley, 1978). Herbrecs data (EHP 2013) indicates habitat in Condamine State Forest which includes; woodland of *Eucalyptus decorticans* (RE 11.7.4); RE 11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. It is also likely to grow within RE 11.7.5: Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks

Wardell's wattle has been collected in non-remnant areas including previously cleared land, especially along roadsides and on a hillside with *Acacia jucunda,* a former a brigalow-belah dominant habitat.

**Distribution:** The species is known from south of Roma, south-west of Chinchilla and the Thomby Range in south-east Queensland (Maslin 2001). On the Thomby Range, the species has been collected near Rocky Glen Homestead, Glenmore in the Silver Springs Gas Field and closer to the project development area, within an area ranging from 15 km east-north-east to 15 km east-south-east of Condamine (TSSC 2008c). Herbrecs records (EHP 2013) indicate habitat 36 km south-west of Chinchilla, approximately 16 km west of the nearest point of the project development area. Populations have been recorded on a gas pipeline easement east of Condamine (QGC Ltd 2009). Qld Herbarium records (EHP 2013) in the Condamine State Forest indicate robust populations of 10 to 20 plants at the collection site.

**Likelihood of occurrence and extent of habitat in the project development area:** The species possibly occurs within the project development area although has not been previously recorded. It has potential to occur in suitable remnant and regrowth habitat on the western margins of the project development area south of the Condamine-Kogan Rd. It was not recorded during field survey. Herbrecs records of Wardell's wattle in the project development area with extent of potential habitat is shown in **Figure A9**.

**Table A25**. Extent of habitat for Wardell's wattle within the project development area and associated areas of assessment

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 32226 | 21768 |
| 3D Detailed Mapping Area** | 0 | 1646 | 6062 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 14994 | 7543 |
| Survey area 2****. | 0 | 0 | 2076 |
| Survey area 7, 8, 9 and F | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Known Threats:** The main identified threats are clearing for agriculture, grazing, infrastructure or mining; and inappropriate fire regimes (SEWPaC 2013).

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, reducing the success of pollen and seed dispersal, and
- Changed fire regimes, such as complete fire exclusion, or repetitive unplanned fires that occur before seedlings can begin producing seed.

**Significance of project related impacts (Unmitigated):** The sensitivity of populations of Wardell's wattle to unmitigated project related impact is considered ***Moderate.*** The basis for this assessment is that it is a perennial species with a demonstrated ability to regenerate abundantly from seed following disturbance and it is likely to be amenable to rehabilitation based on its records within disturbed areas, such as along roadsides. Also, Wardell's wattle is likely to have a long lived soil seed reserves, due to the hard nature of the seeds.

The magnitude of potential of unmitigated impact is also considered ***Moderate.*** This is because no plants are currently known from within the project development area and approximately 10% of the project development area contains known or possible core habitat based on RE mapping provided by EHP (2012a).

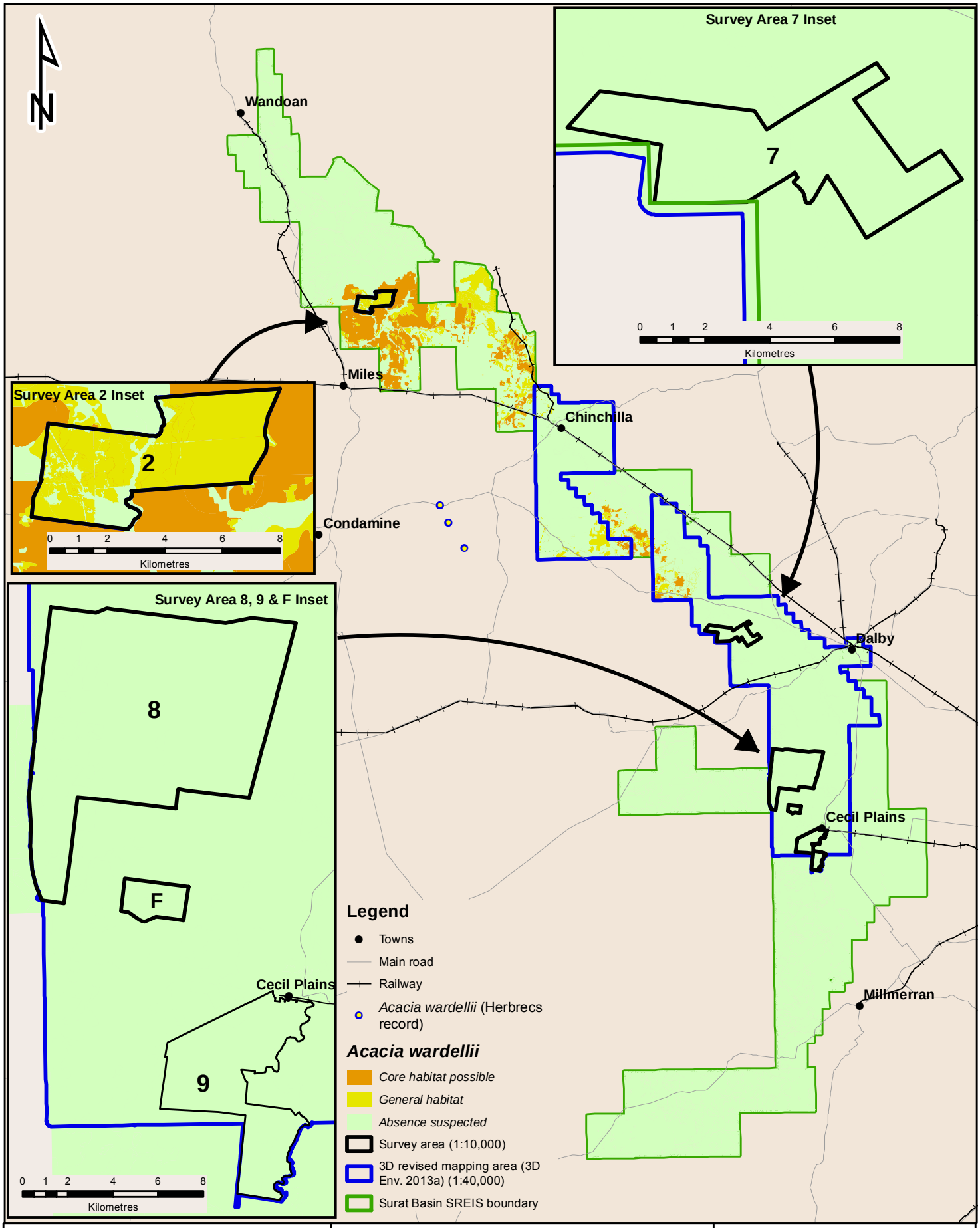
**Specific management / mitigation measures:** Management of individuals of this species is covered by commitments made within Attachment 4 Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Wardell's wattle will be prioritised.

**Summary Residual Impact Assessment:** Rehabilitation, from seed collection and propagation, will likely facilitate recovery over several to many years. If the project disturbance avoids core habitat, no impact would be incurred.

Where avoidance is not possible, the identified impact management measures of minimizing disturbance (including leaving some clusters of undisturbed plants within the footprint), and rehabilitation are considered to be mostly effective, because of Wardell's wattle documented ability to grow in disturbed areas. These may mitigate impact to a large degree, to the extent that minor loss in a local population occurs. Therefore, if core habitat can't be avoided, but other mitigation measures are implemented, project related activities may result in impacts of ***Moderate*** **(13)** significance.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A9.** Wardell's wattle *(Acacia wardellii)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |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**Rule(s) for Habitat Mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant REs within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. RE polygons with confirmed records ( ≤ 500 m precision) should be treated as “core habitat known” (Confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by EHP).
3. The following regional ecosystems should be classed as “core habitat possible” within 50 km of previous records:
   - RE11.7.4, RE11.7.7, RE11.7.5, RE11.7.6
4. RE11.5.1/ 11.5.1a within 50km of prior records should be considered “general habitat” (‘low’ confidence levels apply).
5. Mature regrowth of ‘core habitat possible’ and ‘general habitat’ REs should be classified as ‘general habitat’.
6. All other remnant vegetation in the project development area and non-remnant and cleared agricultural and grazing land outside of the species known distribution outside these areas should be treated as “absence suspected”.

**Evaluation under MNES Referral Guidelines**

**Table A26**. Evaluation of impact significance for Wardell's wattle under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, Wardell's wattle occurs in a number of discrete populations near, Roma, south west of Chinchilla and in the Thomby Range area near Surat. The nearest population occurs 36 km southwest of Chinchilla, 16 km south-west of the project development area. Any newly identified population occurring within the project development area should be considered an 'Important Population' as it would represent an extension of the species range.<br><br>General habitat for the species is indicated in survey area 2 although field survey in these localities did not locate the plant. Pre-construction surveys will be required to totally discount occurrence of the species in associated suitable habitats. Based on mapping rules for the species, there is limited potential for the species to occur with survey areas 7, 8, 9 and F and all habitats within these properties are mapped 'Absence Suspected'. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. Habitats within survey area 7, 8, 9 and F are not considered suitable for Wardell's wattle. It is not possible to totally discount occurrence of the Wardell's wattle within survey area 2 and pre-clearance survey will be required once project footprints have been identified.<br><br>Based on current knowledge an 'Important Population' is not contained within properties subject to development and hence no long term decrease in population size will be incurred.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in **Criteria 1**.<br><br>Known populations occur in association with a major north-east / south-west trending wildlife corridor that lies to the west of the project development area. This wildlife corridor will not be impacted during project development.<br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1 and 6. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact acacia species are not known to occur. Eddie (2007) suggest *Acacia wardellii* is susceptible to borer attack although there is no indication that increased borer attack will be facilitated by project development activities.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1 and Criteria 6.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Wardell's wattle (*Acacia Wardellii)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development

actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant

**Rule(s) for survey effort required in accordance with survey guidelines:** Wardell's wattle is a perennial shrub species that has distinctive leaf shape with the outer phyllode margin having several gland-tipped teeth. This should allow the species to be identified throughout all seasons regardless of whether fertile material is available. Hence no specific survey timing is required to effectively detect the species.

**Ooline / Scrub Myrtle (*Cadellia pentastylis*)**

**Family:** Surianaceae

**Status: EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT:** Critical

**Sensitivity:** Extremely High

**Recovery plan:** A recovery plan has not been prepared for ooline. DECC (2005b) has identified 12 priority actions for management of ooline populations.

**Overview of Ooline**

**Description** (based on Stanley & Ross 1983; Flora of NSW; Harden *et al*. 2006): Ooline is a tree, typically growing to 10 m but occasionally up to 25 m tall, with hard fissured bark. Leaves are simple, alternatively arranged along the branchlet and broadest in the middle or upper half of the leaf. Leaves are usually 2 to 5 cm long, but can be up to 7 cm long. The leaf venation is distinct and slightly raised on the upper leaf surface. The edge of the leaf is smooth to wavy but not toothed. The flowers occur singularly, or with a few flowers clustered together. There are five petals, which are white and 5 to 7 mm long. The fruit resemble dried flowers, with up to five small, 5 mm long, inflated-looking segments (drupes) clustered together in the centre, surrounded by five papery, reddish sepals up to 10 mm long, making the fruit resemble flowers.

**Plate 12.** Ooline foliage and bark (Photograph provided by Paul Williams, Vegetation Management Science)

**Ecology:** Ooline is a long lived tree. Flowering is concentrated in October to December, but can extend to April, with fruit recorded in November and December (Pollock 1997a). Curran and Curran (2005) observed that while flowering and fruiting of ooline is sporadic, fruit is most often seen in dry years. Although their survey occurred during a year with abundant fruiting, it did not find any seedlings, however, root coppicing appears to occur (Curran & Curran 2005). As a tree of dry rainforest and brigalow scrub, ooline is likely to be damaged, or even killed, by fires that are intense enough to burn up to the base of trees.

**Habitat:** Ooline grows in semi-evergreen vine thickets, brigalow and occasionally in adjacent eucalypt woodland, where it maybe locally dominant in the canopy layer or occur as an emergent (TSSC 2008e). It is also known to occur as isolated trees in cleared non-remnant grazing lands. Ooline tends to grow on soils of low to medium fertility, often with sandy clay or clay consistencies (DECC 2005b). Substrates include clay plains, sandstone and residual ridges (Santos 2007).

**Distribution:** A large proportion of ooline habitat has been cleared for cropping or grazing in the past (Benson 1993). Ooline is known to occur on the western edge of the NSW north-west slopes, extending into Carnarvon Range, Blackwater and the Callide Valley, south and west of Rockhampton (Harden *et al*., 2006) within Queensland. Its habitat is now restricted to a few scattered sites and is conserved within the Tregole National Park (NP), Sundown NP, and Carnarvon Gorge NP (DNR 2000). It is also known from the area to the west of Gurulmundi State Forest.

**Likelihood of occurrence and extent of habitat in the project development area:** The species possibly occurs although populations are unlikely to be extensive. Ooline has been collected within the south-western part of the project development area (on Kindon Station in the Wyaga Creek area). However, these collections were made in 1919 and 1938 and the imprecise localities ( $\pm$ 16 km accuracy) provided in those early collections mean that an exact location is not available. Therefore there is no certainty that these trees and their habitat remain uncleared. Pollock (1997) considers that "the status of virtually all populations collected before 1962 is unknown". However EPA (2002) describe 'Wyaga-Kindon ooline population' as a special biodiversity area where ooline approaches its eastern limit of distribution. It is possible that the records occurred in habitats associated with brigalow/belah forests along Wyaga Creek. Further surveys are required in the south-western portion of the project development area to confirm that these records still exist.

The majority of ooline habitat within the project development area has been cleared. There is the possibility that isolated paddock trees remain in the project development area, or the tree may be associated with small unmapped pockets of vine thicket on laterite (RE11.7.1).

Ooline has been recorded as very common in brigalow open forest and fragmented softwood scrub vegetation in the Stones Country Resources Reserve in the west Gurulmundi area located approximately 15 km west of the project development area, and the Moonie Range 25 km west of the project development area (DHP 2013). Steep basaltic scree slopes on Captains Mountain near Millmerran are considered marginal habitat and require further survey. The extent of ooline habitat in

the project development area is provided in **Table A27** with spatial reference to areas of potential habitat provided in **Figure A10.**

**Table A27.** Extent of habitat for ooline within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 0 | 1412 |
| 3d Detailed Mapping Area** | 0 | 0 | 0 |
| 3d Detailed Mapping Area based on EHP (2012)*** | 0 | 0 | 0 |
| Survey areas 2, 7, 8, 9 and F | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** Threats to ooline are broad scale tree clearing, inappropriate fire regimes, and inappropriate grazing regimes (DNR 2000). Other threats include localised extinction due to small and scattered populations; inbreeding which threatens genetic diversity in small populations; low seed viability which threatens breeding success; feral goats and pigs; invasion of habitat by weeds; frequent fires; tunnel and sheet erosion; damage to roadside populations during roadworks; and high insect attack (Fletcher 2002, DECC 2005b in Threatened Species Scientific Committee 2008e). The species is thought to be undergoing slow decline with occurrences in regrowth threatened by re-clearing and fire (EPA 2002).

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing; and
- Habitat edge effects such as promoting conditions for invasion of weeds and exotic grasses which induce altered habitat structure along gathering lines, tracks and clearing zones.
- Altered fire regimes, particularly introduction of fire promoting weeds (grasses) into the margins of ooline habitat. Such changes may dramatically increase the intensity of fires which is a particular threat to ooline.

**Significance of project related impacts (Unmitigated):**

The sensitivity of the species to project related impacts is considered ***Extremely High*** because it is a long lived perennial that is damaged by fires and mechanical disturbance, but with only erratic recruitment. Any seedlings will take more than 10 years to mature. While ooline has been recorded as an isolated tree within paddocks, the ability of post-disturbance juvenile ooline plants to grow to maturity in a disturbed environment (e.g., through a densely grassed or weedy habitat) is limited.

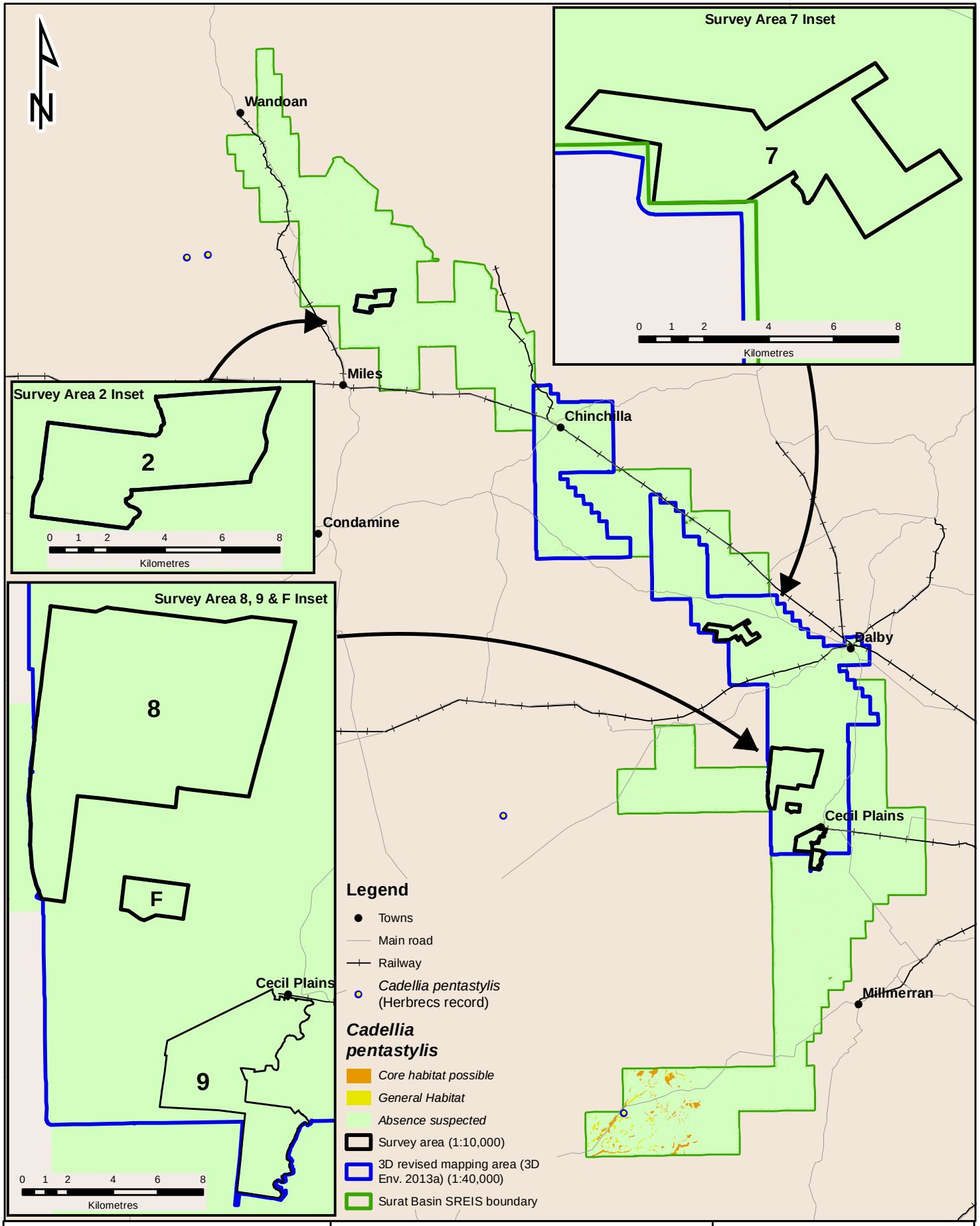
Because of the absence of any confirmed populations of ooline in the project development area and the presence of an intact population to the west, project related activities may result in impacts of ***Moderate*** magnitude to ooline. The unmitigated significance of impact is considered ***High (20)***. The possibility of the species occurring in the Wyaga area area is unknown given the age of the Herbarium records (1919, 1938) and the extent of clearing that has occurred in that area. Any remaining occurrences in the Wyaga locality represents the eastern limit of distribution for the species. These occurrences may occur as scattered individual trees within cleared paddocks and/or non-remnant vegetation. Isolated trees in cleared land have the potential to be cleared by project works. Targeted ground truthing of the development footprint in high-risk locations and avoidance of trees will considerably reduce the risk of impact.

**Species specific management/ mitigation measures**: Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of ooline will be prioritised.

**Summary residual impact assessment:** Project related activities may result in impacts of ***High (20)*** significance to potential ooline populations within the project development area. Avoiding habitat and undertaking further survey work within areas of historical populations to ensure impact to individual trees is avoided will result in no impact being incurred. Where avoidance is not possible, the identified impact management measures are considered to be only partially effective with rehabilitation and species translocation being untested. Given that fruit fall is known to be sporadic and successful propagation techniques limited, if avoidance is not possible but other mitigation measures are implemented, project activities may result in impacts of ***Moderate*** magnitude, providing a significance ranking of ***High (20)***.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | Moderate | High (20) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A10.** Ooline *(Cadellia pentastylis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |

**3D Environmental**
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**Rule(s) for Habitat Mapping:**

1. Areas of remnant vegetation associated with Land Zone 3 (REs 11.3.2, 11.3.25, 11.3.4) and Land Zone 9 (RE11.9.5) in the Kindon Station and Wyaga Creek areas (west of 150.91 and south of -28.00) should be classed as 'core habitat possible' subject to further field survey ('low' confidence applies to mapping produced by EHP 2012a).
2. Areas of mature regrowth (EHP 2012b) of the same REs as EHP 2012a should be considered 'general habitat'.

**Evaluation under MNES Referral Guidelines**

**Table A28**. Evaluation of impact significance for ooline under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area | Based on current knowledge, historical records in the Wyaga area provide the only evidence for occurrence of the species in the project development area. The status of the Wyaga population has not been confirmed and it is unknown as to whether this population still exists. Given that the Wyaga population would represent the eastern geographic limits of ooline in Queensland, it would be considered an 'Important Population' if its persistence in the project development area could be verified. Individual trees in highly disturbed landscapes are however not likely to be viable in the long term and hence their importance is somewhat diminished. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** These properties are not considered to host potential habitat for ooline. Hence no long term decrease in the size of an ooline population is anticipated from development at these locations.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | **Survey areas 2, 7, 8, 9 and F:** Diseases specific to ooline are not known. The species is susceptible to insect attack although it is not considered that this would be facilitated by development activities.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1. If works are to be undertaken in the Wyaga area, pre-clearance surveys will be required to determine the presence of the species and erect exclusion buffers around individual trees to assist possible recovery of the population.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For ooline (*Cadellia pentastylis)* no impact is expected from project development activities. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact).

**Rule(s) for survey effort required in accordance with survey guidelines:** Ooline is a distinctive tree that would be readily identified throughout the year without the requirement for seasonal consideration.

**Gurulmundi fringe myrtle (*Calytrix gurulmundensis)***

**Family:** Myrtaceae

**Status: EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT**: Not Listed

**Sensitivity:** Extremely High

**Recovery plan:** A recovery plan has not been prepared for Gurulmundi fringe myrtle.

**Overview of Gurulmundi fringe mytle**

**Description** (based on Williams 1979 as "*Calytrix* sp."; Stanley & Ross1986 as "*Calytrix* sp.1"; Craven 1986 as *Calytrix gurulmundensis*): An attractive, well branched shrub to 2 m tall. The leaves are 4 to 11 mm long and up to 1 mm wide, alternate or crowded together, slightly 3-angled or flat with a point at the apex, and are aromatic when crushed. The flowers are tubular and clustered at the ends of branches, with narrow cream petals that are yellow at their base, and many long yellow stamen. The fruit are dry, with the sepals form the flowers remaining attached.

**Plate 13.** Gurulmundi fringe myrtle (*Calytrix gurulmundensis)* foliage and flower. Copyright © Boobook

**Ecology:** The life span of Gurulmundi fringe myrtle is unknown, but it is likely to live for at least a decade. Flowers have been recorded from June to October (Craven 1986; Halford 1996). Plants as small as 15 cm tall have been observed to flower (Williams 1979). Gurulmundi fringe myrtle can be quite common at sites where it grows, being described in several collection labels as abundant or co-dominant at the collection site (AVH 2013c).

**Habitat:** Gurulmundi fringe myrtle has been recorded growing in patches of shrubland on very shallow soils (EPA 2002). Soils are lateritic sandstone ridges, which contain yellow sandy-clay that retains moisture (Williams 1979). Vegetation is predominately eucalypt, acacia, casuarina dense shrublands with spinifex, and spinifex grassland with scattered shrubs. This habitat description is consistent with RE11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks).

The coordinates of Gurulmundi fringe myrtle collections derived from Herbrecs (EHP 2013) place them in areas mapped by as RE11.7.5; RE11.10.1/11.7.2; RE11.7.6; and RE11.7.7/11.7.4/11.5.1 based on RE mapping provided by EHP (2012a).

**Distribution:** The species is endemic to the Gurulmundi and Barakula areas north of Chinchilla (Halford 1996).#

**Likelihood of occurrence and extent of habitat in the project development area:** The species has not been recorded in the project development area although possibly occurs based on suitable habitat and known distribution range. The species is known from the Barakula and Gurulmundi State Forests to the east and west of the project development area respectively.

A 1961 collection by M.E. Phillips is held in the Australian National Herbarium (AVH 2013c) which gives the locality as simply Gurulmundi, and has subsequently been given the coordinates of the locality of Gurulmundi by the Australian National Herbarium. This places the coordinates for the collection within the project development area, however, the absence of a more detailed locality description in the 1961 collection notes, including the absence of any coordinates, suggests this collection was made in the general Gurulmundi area, most likely Gurulumundi State Forest 10 km to the west.

Additional populations have the potential to occur in tracts of remnant vegetation and on disturbed roadsides on lateritic duricrusts (land zone 7). In the project development area, suitable habitat occurs to the north of the Leichhardt Highway where the where it overlaps with the continuous remnant vegetation of the Gurulmundi and Barakula State Forests. There is suitable habitat within the northern parts of the project development area in the Binkey State Forest, east of the Leichhardt Highway near Gurulmundi.

Survey area 2, which is approximately 30 km east of the Gurulmundi population, hosts 10 ha of RE11.7.5, based on detailed vegetation mapping and survey undertaken specifically for the SREIS (3D Environmental 2013). Despite suitability of habitat and intensive survey effort within the property, the species was not recorded. Within survey area 2, RE11.7.5 should be considered ‘general habitat’ and subject to pre-clearance survey once project footprints have been determined. A summary of

potential habitat is provided in **Table A29** with spatial representation of habitats provided within **Figure A11.**

**Table A29.** Extent of habitat for *Calytrix gurulmundensis* within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 61713 | 0 |
| 3D Detailed Mapping Area** | 0 | 0 | 359 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 1175 | 0 |
| Survey area 2**** | 0 | 0 | 359 |
| Survey area 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** The main threats to the local populations of *C. gurulmundensis* are (based on Halford 1996):

- Destruction of habitat due to clearing or timber harvesting.
- Degradation of habitat due to road construction and maintenance, potentially allowing weed invasion and erosion.
- Inappropriate fire regimes.

Of these, clearing, disturbance for track creation and maintenance and inappropriate fire regimes are the key threats related to this project. At least one population is identified as having been damaged in the past due to gravel extraction (Williams 1979). Due to the absence of any information relating to fire ecology, no data exists as a basis to identify appropriate fire regimes, although it is probable that fire frequency is a key issue, requiring many years between fires for regrowth to mature.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.

- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Inappropriate fire regimes, particularly escaped unplanned fires.

**Significance of project related impacts (unmitigated):** There is limited known of the ecology of Gurulmundi fringe myrtle including a lack of detailed information on its germination, response to fire and life span. One population is known to have been damaged in the past due to gravel extraction (Williams 1979). Its response to disturbances such as habitat fragmentation, changed fire regimes and edge effects requires further detailed study, and its ease and success of translocation and rehabilitation methods are unknown. Hence the sensitivity ranking for the species is considered to be ***Extremely High***.

Areas of known and possible core habitat of Gurulmundi fringe myrtle are common in the north of the project development area and whilst no confirmed populations are known, its potential core habitat is continuous from the population in Gurulmundi eastwards to the Barakula population. The potential impact magnitude ranking is therefore considered ***High***. Without mitigation measures, project impacts are expected to occur over the life and scope of the project causing changes to local populations although never species extinction and the unmitigated impact significance is potentially ***Major (23).***

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Gurulmundi fringe myrtle will be prioritised.

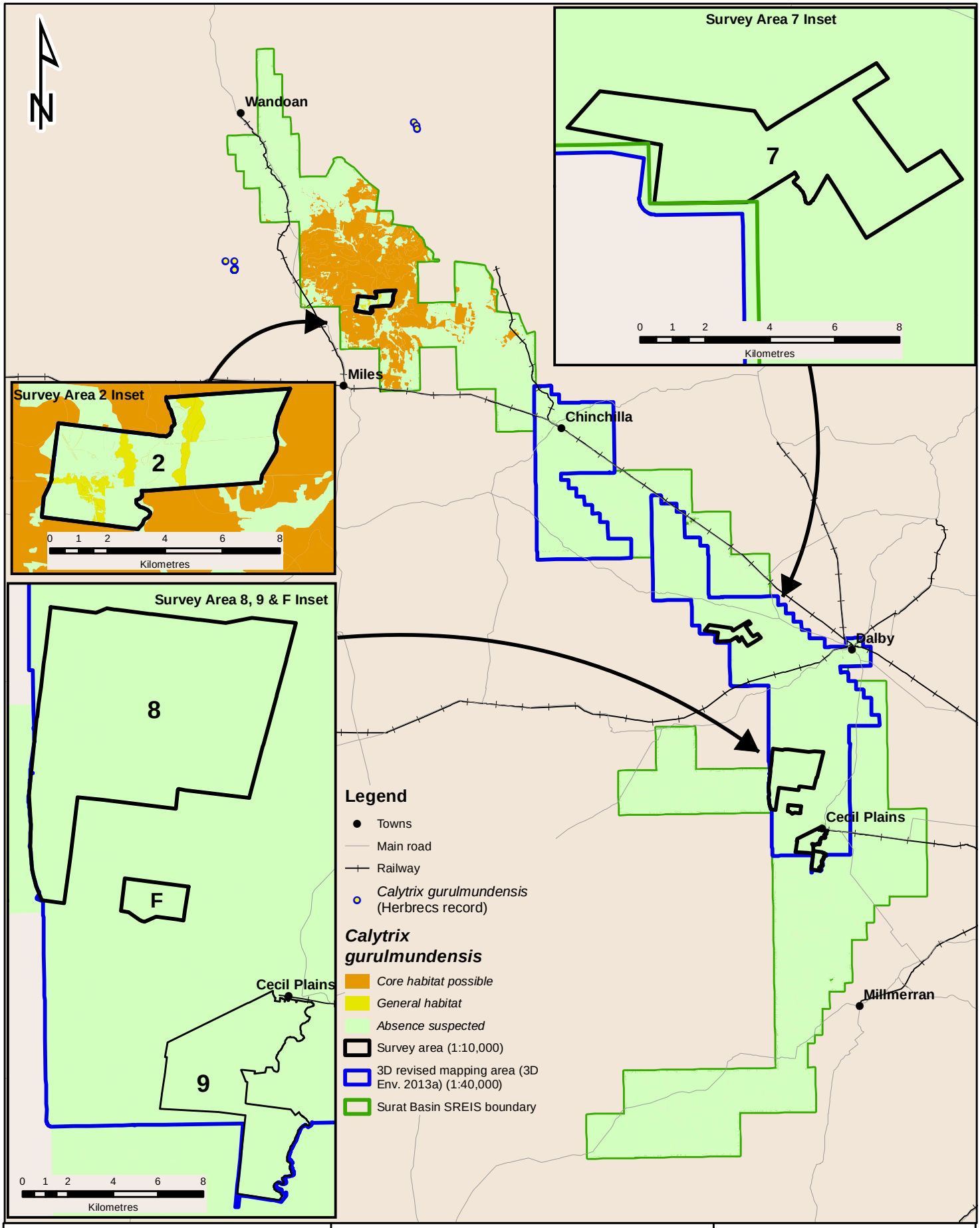
Similar to threatened acacia species, in addition, commitments C224 and C303 within Attachment 4 of the SREIS relating to site specific management for threatened species, will consider fire management in relation to this species where appropriate.

**Summary residual impact assessment:** No mitigation measures will alleviate clearing of core habitat and therefore avoidance is the only feasible mitigation measure in these situations. The effectiveness of translocation and/or propagation and rehabilitation programs is unknown and therefore reliance the likelihood of success cannot be confidently inferred. If infrastructure avoids known core habitat, impact is not expected. If other mitigation measures are implemented, such as rehabilitation, the project activities may result in a **Moderate** impact magnitude ranking, which produces a ***High (20)*** significance ranking.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | Moderate | High (20) |

* No clearing of vegetation within areas of core habitat known or core habitat possible.
# Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A11.** Gurulmundi fringe myrtle *(Calytrix gurulmundensis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. All RE polygons coinciding with confirmed high precision records should be treated as “core habitat known” regardless of classification (confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by EHP, 2012a). Mature regrowth (EHP 2012b) polygons are excluded.
3. The following REs within 50 km of known populations should be considered “core habitat possible”:
    - RE11.7.5, 11.7.2, 11.7.4, 11.7.6, 11.7.7 and 11.10.1 (confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by DEHP 2012a).
4. All other remnant vegetation and cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules are applied where the relevant regional ecosystems are found within the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A30.** Evaluation of impact significance for Gurulmundi fringe myrtle under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| ‘Important populations’ and ‘distribution of the species in the project development area. | Based on current knowledge, two populations are known from the study area being located within the Gurulmundi and Barakula State Forest areas. The species is currently unknown from the project development area although potential habitat for the species is widespread and abundant in the northern portion of the study area. Due to the highly endemic nature of the species, any additional populations discovered should be considered an ‘important population’. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2:** Whilst suitable habitat for the species exists in survey area 2, the species was not recorded during survey. It is not possible to totally discount occurrence of the species within survey area 2 and pre-clearance survey will be required once project footprints have been identified.<br><br>**Other Properties:** Survey areas 7, 8, 9, and F are not considered to host potential habitat for the species. |

| Criteria | Evaluation |
|---|---|
| | Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Whilst broad scale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of survey area 2 will not introduce landscape scale processes that have potential to affect the breeding cycle of an important population of Gurulmundi fringe mrtle. This would include any alteration to fire regimes that sustain populations contained within wildlife corridors.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact the species are not known to occur. |

| Criteria | Evaluation |
|---|---|
| | Myrtle rust is known from the Toowoomba Area (DAFF 2013) although is not known to affect species within drier habitats including those contained within the project development area.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | The species currently exists within intact populations in vicinity of the project development area. From current knowledge, these populations is stable and not in the process of recovery from prior disturbance.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |

**Conclusions:** For Gurulmundi fringe myrtle (*Caltyrix gurulmundensis)* no impact is expected from development activities.Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant

**Rule(s) for survey effort required in accordance with survey guidelines:** Gurulmundi fringe myrte is a relatively distinctive shrub that would be identifiable throughout the year without the requirement for seasonal consideration.

**Small-leaved denhamia (*Denhamia parvifolia*)**

**Family:** Celastraceae

**Status: NC Act**: Vulnerable; **EPBC Act**: Vulnerable; **BoT:** High

**Sensitivity:** Extremely High

**Recovery plan:** A recovery plan has not been prepared for small-leaved denhamia.

**Overview of small-leaved denhamia**

**Description** (based on Stanley & Ross 1986; Chinchilla Field Naturalists Club 1997; Pollock 1997b; Harden *et al*. 2006): A shrub to 3 m with mottled, white bark and orange roots. The alternatively arranged leaves are 0.5-2 cm long, with smooth margins or a few fine teeth. The leaves are broadest in the middle or the upper half and are prominently veined and rigid. The pale yellow flowers are grouped into clusters. The fruit are yellowish capsules that split into three or four sections to expose a black seed covered in red fleshy “aril”.

**Plate 14.** Small-leaved denhamia (*Denhamia parvifolia)* foliage and capsule. Copyright © Boobook

**Ecology:** Small-leaved denhamia probably lives for at least a decade. Flowering occurs in September to October and fruits are mature in the wet season, December to March (Stanley & Ross 1986; Pollock 1997b). The red fleshy aril covering of the seed is likely to encourage bird dispersal. There is no information regarding regeneration of small-leaved denhamia, and notes associated with collections do not record the presence of any seedlings.

**Habitat:** Small-leaved denhamia grows in semi-evergreen vine thickets, vine scrubs and brigalow (*Acacia harpophylla*) softwood communities on fertile, red brown sandy clay loam hillslopes and crests (DNR 2000). It has been collected in non-remnant clusters of vine thicket trees on roadsides and brigalow associations. Potential also exists for this community within basalt landscapes to the south of Millmerran, particularly in association with RE11.8.2a within which small pockets of RE11.8.3 might be scattered.

**Distribution:** Small-leaved denhamia is restricted to southern Queensland, north from Eidsvold to Chinchilla and east of Kingaroy and the Mundubbera district (Jessup 1994, Harden *et al*. 2006). Populations on the south-west edge of its known range grow to the north and south-west of Chinchilla (Chinchilla Field Naturalists Club 1997, DNR 2000, EHP 2013).

**Likelihood of occurrence and extent of habitat in the project development area:** The species is known to occur with two previous records existing within the project development area with collections made in 1978 (1600 m precision) and 1981 (1600 m precision) (EHP, 2013). The current status of these records is unknown and it is unsure if the populations still exist. Prior records occurred “on ridge country” and in “disturbed vine thicket” (AVH 2013d). In additional to its preferred habitat of remnant brigalow with a softwood species understorey or vine thicket elements (RE11.4.3, 11.8.3, 11.9.4a, 11.9.5), small-leaved denhamia may grow in small, non-remnant vine thickets throughout the project development area. The field survey did not locate additional populations despite extensive searches being undertaken within suitable habitat contained of the Chinchilla Sporting Shooters Range (which is located on the Chinchilla Sands Local Fossil Fauna Site) (RE11.4.3). The distribution of potential habitat for small-leaved denhamia is represented in **Figure A12** with a quantification of habitat extent indicated in **Table A31.**

**Table A31**. Extent of habitat for small leaved denhamia within the project development area and associated areas of assessment.

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 2241 | 0 |
| 3D Detailed Mapping Area** | 0 | 933 | 0 |
| 3D Detailed Mapping Area based on EHP (2012a and b)*** | 0 | 1065 | 0 |
| Survey area 2, 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** The species habitat has been heavily fragmented by clearing for agriculture. The remaining habitat, including scattered plants within small clusters of trees, is threatened by clearing and by degradation by invasive weeds such as *Lantana camara,* invasive grasses and by inappropriate grazing regimes (Pollock 1997b).

**Potential project-related impacts:** Impacts associated with the proposed project development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat and water quality from construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fires damaging trees, which can be fuelled by grasses and lantana that invade habitat following disturbance.

Of these disturbances, probably the most significant is the destruction or degradation of habitat (including erosion) or damage to individual trees. There is a particular risk to trees growing in small clusters, or as isolated trees, which are more difficult to find or recognise because the cluster is associated with non-remnant vegetation, and therefore not easily identified as habitat.

**Significance of project related impacts (Unmitigated):** Scattered individuals of small-leaved denhamia are susceptible to disturbance in remnant and non-remnant vegetation, both in paddocks and roadside strips in the Chinchilla area. The sensitivity of the species is considered to be ***Extremely High***, because it is a perennial rainforest tree, likely to be susceptible to habitat degradation from

weed invasion and damage by fires. In particular, invasion of exotic pasture grasses following mechanical disturbance is likely to degrade habitat and limit its ability to recolonise disturbed areas. It has very limited or erratic germination (no seedling observations have been recorded with collections) and therefore has very limited capacity for natural post-disturbance regeneration. Small-leaved denhamia is known to grow within the project development area, although it is uncommon. It is not known to grow within the 25 km buffer surrounding the project development area, so that all of the known local populations are contained within. However, most known populations occur within a triangle roughly between Chinchilla, Kingaroy and Eidsvold and potential habitat, based on remnant and mature regrowth mapping provided by EHP (2013a and 2013b) represents approximately 1% of the project development area. The local collections of this tree are from small unmapped patches of vine thicket that are too small to have been distinguished on the existing mapping databases. Therefore, the possible habitat of this species is difficult to quantify and hence the magnitude of potential impacts is considered ***Moderate***, with a significance ranking for this species of ***High (20)***.

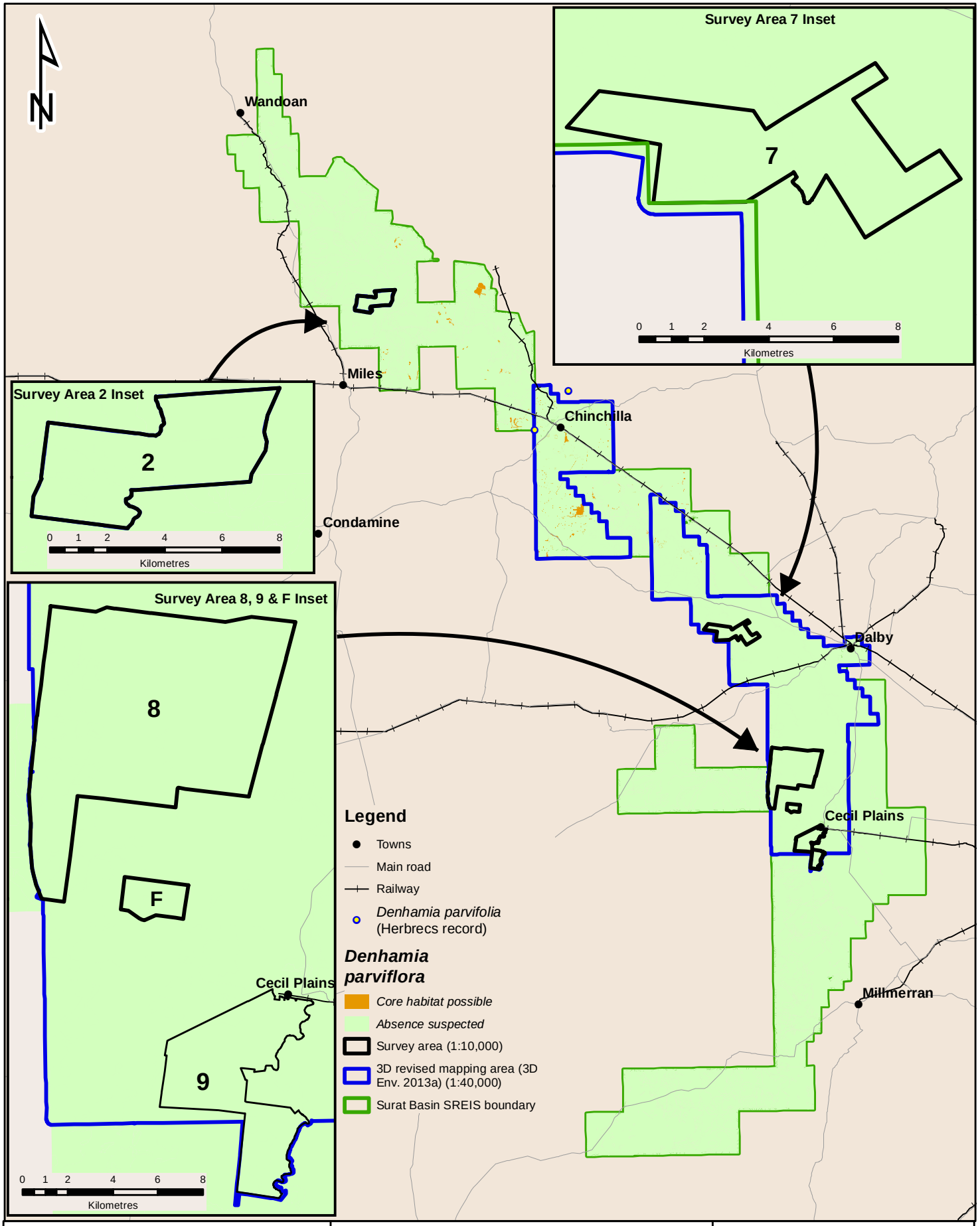
**Species specific mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of small-leaved denhamia will be prioritised.

**Summary residual impact assessment:** The unmitigated impact significance for this species is considered to be ***High (20)***. Brigalow associations on Land zones 3, 4 and 9 constitute possible core habitat for small-leaved denhamia. It is of note however that small-leaved denhamia has been collected in vine thickets too small to be included in remnant habitats. Avoiding 'core habitat known' will completely mitigate against impacts with surveys required within 'core habitat possible' areas to verify or exclude presence. Where the species is avoided, not impacts are expected

Where buffers around populations of small-leaved denhamia cannot be maintained, impact management measures outlined above, especially weed seed hygiene, retaining clusters of some undisturbed trees and rehabilitation, will reduce the impact magnitude to ***Moderate***. The resulting residual impact significance using alternative mitigation measures would be ***High (20)***. This significance ranking remains high due to the sensitivity of small-leaved denhamia to disturbance, the likely post-disturbance impacts from weeds and the lack of known of rehabilitation success for this species.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | Moderate | High (20) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A12.** Small leaved denhamia *(Denhamia parviflora)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for habitat mapping:**

1. Any confirmed, precisely location (± 500 m) should be buffered by a 1 km circumference and all remnant REs contained within treated as "core habitat known" ('high' confidence applies):
2. The following regional ecosystems in the Chinchilla area (within 50 km from town centre, -26.7381, 150.6252) should be classed as "core habitat possible" (includes, mature regrowth, EHP 2012b:
    - RE11.8.3, RE11.9.5, RE11.9.4 and RE11.4.3 (low confidence applies where applied to mapping produced by EHP (2012a and b) with 'high' confidence applied to the refined mapping layer, 3D Environmental, 2013).
    - Non-remnant brigalow/belah type regrowth and vine thicket regrowth on alluvium (land zone 3) and clay plains (land zone 4) (extent of habitat unquantified and many of these habitats will not be of mappable extent other than at 1:10 000 scale).
    - Non-remnant, small clusters of vine thickets, often along roadsides or within paddocks (extent of habitat unquantified extent of habitat unquantified and many of these habitats will not be of mappable extent other than at 1:10 000 scale).
3. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A32**. Evaluation of impact significance for small leaved denhamia under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area | Based on current knowledge, historical, low precision records in the Chinchilla area provide the only evidence for occurrence of the species in the project development area. The current status of the historical records is unknown. Given that any population of the species in the Chinchilla area would represent the south-west limits of species distribution, any population contained within the project development area would considered an 'important population'. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** These properties are not considered to host potential habitat for small leaved denhamia. Hence no long term decrease in the size of a small-leaved population is anticipated from development at these locations.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | **Survey areas 2, 7, 8, 9 and F:** Diseases specific to small-leaved denhamia or the Celestraceae family in general are not known.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For small-leaved denhamia (*Denhamia parvifolia)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (survey area 2, 7, 8, 9, F ) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

**Rule(s) for survey effort required in accordance with survey guidelines:** Small-leaved denhamia is a distinctive small tree that would be readily identified throughout the year without the requirement for seasonal consideration.

**Kogan waxflower (*Philotheca sporadica)***

(originally described as *Eriostemon sporadica*)

**Family**: Rutaceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Vulnerable; **BoT:** Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A species recovery plan has not been developed for Kogan waxflower. Permits to collect seed and propagate cuttings have been issued to Powerlink to conduct research and propogation trials (Kanowski 2005).

**Overview of Kogan waxflower**

**Description** (based on Bayly 1994): *Philotheca sporadica* is a multi-stemmed, spreading shrub to 1.5m high. Upper branchlets are green, with dark corky areas developing sporadically along the stem with age. The leaves are only 1 to 4 mm long, hairless, glandular below and fairly terete and broadest in the upper half – i.e. shaped like a club. The white flowers are solitary and occur on short stalks to 0.7 mm long at the end of branchlets.

**Plate 15 (left).** Kogan waxflower on the margins of Beelbee Road near Kogan (Photograph 3D Environmental) and **Plate 16.** Flower and foliage habit (Photograph © Boobook).

**Ecology:** Kogan waxflower is a perennial shrub, though its life span is not known. As it has been recorded from along roadsides, it has some ability to regenerate after disturbance, though whether this regeneration is from seedlings or vegetative coppice shoots is not documented. The response of the species to fire is unknown (TSSC 2008j). Translocation has been attempted (Kanowski 2005) and from observation, appears to have been successful (D. Fell and D. Stanton; personal observation 2010). Related species have been successfully propogated from cuttings (Halford 1995c). Flowers have been recorded in July to September, and fruit in September.

**Habitat:** The majority of records are in low open forest and woodland of *Acacia burrowii*, *Eucalyptus exserta*, *Eucalyptus crebra*, *Eucalyptus fibrosa* subsp. *nubila* and *Callitris glaucophylla* (Halford 1995 in TSSC 2008j), and also on residual hills which are remnants of laterised Cretaceous sandstones, where the soils are shallow, uniform sandy loams to clay loams of extremely low fertility and poor condition (Dawson, 1972 in TSSC 2008j). Herbrecs records (EHP 2013) placed over the Queensland Herbarium regional ecosystem mapping (EHP2013j) indicates records of Kogan waxflower coincide within the following habitats:

- RE11.7.4; *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust).
- RE11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.
- RE11.7.7; *Eucalyptus fibrosa* subsp. *nubila* +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

Kogan waxflower has been collected during the field survey in woodland *of Eucalyptus exserta, Eucalyptus crebra, Callitris glaucophylla, Corymbia trachyphloia* and *Acacia burrowii*, consistent with RE11.7.4. There are also a few collections recorded within:

- RE11.5.1; *Eucalyptus crebra, Callitris glaucophylla*, *Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.
- RE11.3.14; Eucalyptus spp., Angophora spp., Callitris spp. woodland on alluvial plains. Sandy soils
- RE11.3.18; *Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium.

It is expected that these collections may indicate inaccuracies in RE mapping databases rather than core habitat for the species.

**Distribution:** Kogan waxflower is a Queensland and bioregional endemic known from south-east Queensland, from just north of Tara, to approximately 12 km east of Kogan (TSSC 2008j). Of the 11 known populations, seven occur on road verges, seven extend onto freehold land and one population is within Braemar State Forest (Halford 1995c in TSSC 2008j). The species was also collected 40 km northeast of Goondiwindi during the EIS field survey within a tenement which has subsequently been relinquished by Arrow.

**Likelihood of occurrence and extent of habitat in the project development area:** The species is known to occur within the project development area. A number of discrete population clusters occur on the western margin of the project development area within the Braemar Creek Catchment and the species has been recorded during field surveys in *Eucalyptus exserta, Eucalyptus crebra, Callitris glaucophylla* woodland (RE11.7.6) on the Beelbee Rd near Kogan, plus a disjunct population recorded approximately five km south of Wyaga Creek off the Wyaga Creek road during the field

survey. Additional populations have the potential to occur in tracts of remnant vegetation and on disturbed roadsides on lateritic duricrusts (land zone 7). Similar habitat occurs elsewhere in the project development area which suggests additional populations may be present. Known species locations and extent of habitat is shown in **Figure A13**.

**Table A33.** Extent of habitat for Kogan waxflower within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 1251 | 34553 | 71979 |
| 3D Detailed Mapping Area** | 762 | 5143 | 6758 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 1251 | 7766 | 22761 |
| Survey area 2 **** | 0 | 0 | 1281 |
| Survey area 7 **** | 0 | 0 | 0 |
| Survey area 8 **** | 0 | 936 | 907 |
| Survey area 9 **** | 0 | 0 | 332 |
| Survey area F**** | 0 | 58 | 41 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** The loss of habitat and the absence of any secure populations within conservation reserves are considered serious risks to the populations of Kogan waxflower. Roadsides populations are at risk from general road maintenance activities and other disturbances (TSSC 2008j). Potential threats are grazing, invasive weeds, and inappropriate fire regimes.

**Potential project-related impacts:** Impacts associated with development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Altered and inappropriate fire regimes.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

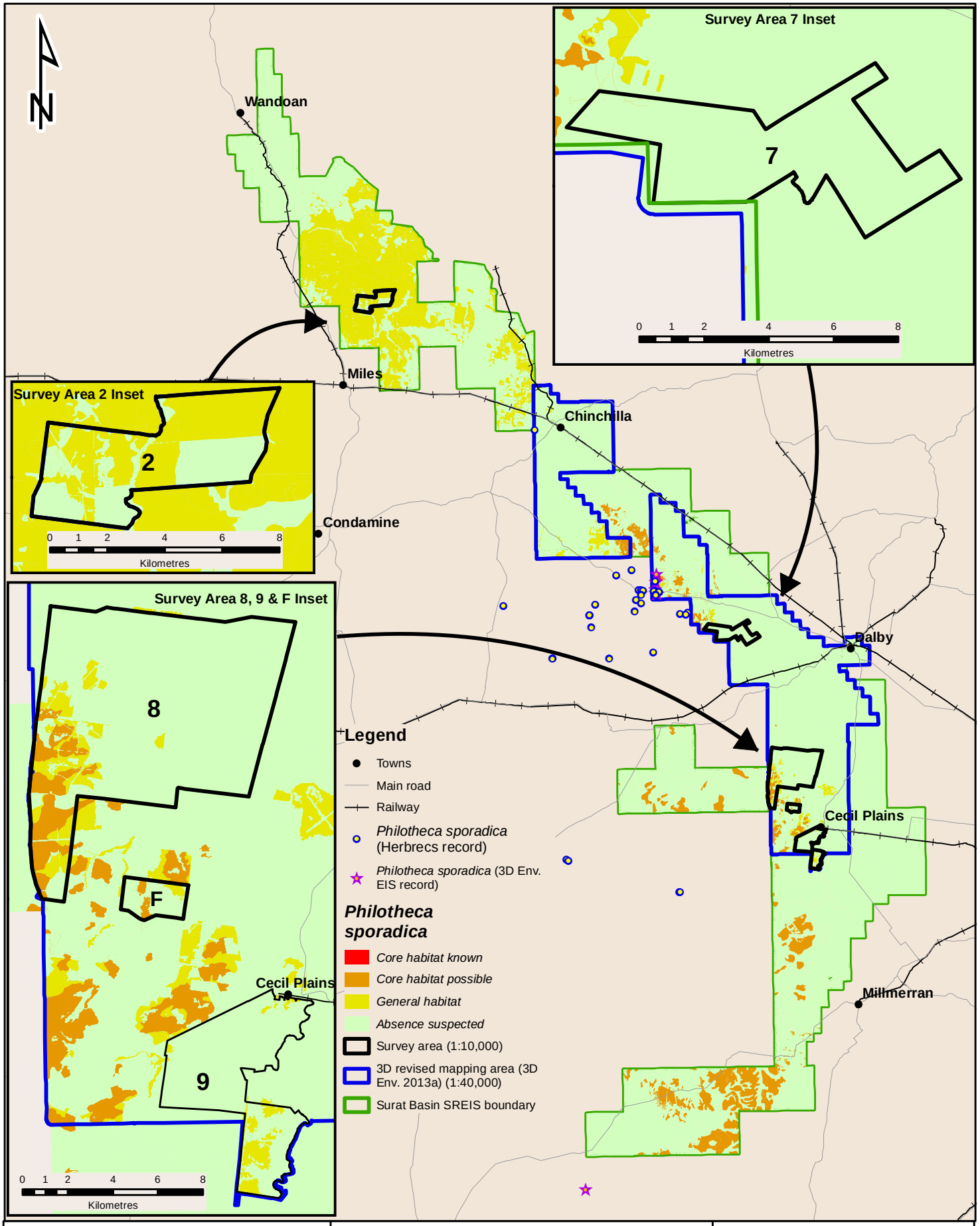
**Significance of project related impacts (unmitigated):** The sensitivity of Kogan waxflower to unmitigated impacts is considered to be ***Moderate***. This acknowledges the limited knowledge of the ecology of this perennial shrub, but which is known to have some ability to regenerate after disturbance, and has been successfully translocated. Kogan waxflower grows along roadsides so appears to have some ability to persist in disturbed areas. Approximately a quarter of the known populations occur within the project development area and suitable habitat ('core habitat known' and 'core habitat possible') accounts for approximately 7 % of available habitat based on RE mapping provided by EHP (2012a). There is considerable risk of broad scale impacts to this species during gas field development coupled with cumulative impacts of adjoining non-Arrow coal seam gas developments. Roadside populations along Beelbee Road to the north and south of the Kogan Road are particularly susceptible to disturbance. It has therefore been given an impact magnitude ranking of ***Major***. The species is considered to have an unmitigated impact significance ranking of ***High (22)***.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Kogan wax flower will be prioritised.

**Summary residual impact assessment:** In the absence of mitigation, impacts of ***High*** **(22)** significance will possibly occur. Avoiding areas identified known habitat and undertaking further survey work within areas of possible habitat is expected to completely mitigate against impact and result in no impact**.** Clear identification of any additional populations will allow adjustment and/or minimising of disturbance areas and establishment of suitable buffer zones. Where avoidance is not possible, the development of a threatened species management plan may be required to guide rehabilitation programs which include propagation from seed or cuttings, and translocation. Other mitigation measures will mostly mitigate impacts which may result in impacts of ***Moderate (13)*** significance*.*

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A13.** Kogan waxflower *(Philotheca sporadica)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |

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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" ('high' confidence is applied).
2. Regional ecosystems with confirmed records (<500 m precision) should be classed as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by DEHP, 2012a and 2012b).
3. The following regional ecosystems should be classed as "core habitat possible" (confidence as in 2 apply):
   - RE11.7.5, 11.7.4, 11.7.6, 11.7.7
4. The following regional ecosystems should be classed as "general habitat" (confidence as in 2 apply):
   - RE11.5.1, RE11.3.14, RE11.3.18
   - All REs for 'core habitat possible' where they occur north of Chinchilla (-27.75).
5. Roadsides in the Kogan area and regrowth (including mature regrowth as per EHP 2012b) derived from RE11.7.5, 11.7.4 and 11.7.7, particularly in the Braemar Creek Catchment, should also be considered "general habitat"
6. All other remnant vegetation and all cleared agricultural and grazing land in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A34.** Evaluation of impact significance for Kogan waxflower under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | The species shows a high level of endemicity and all populations are contained largely within intact habitat. Populations are all viable in the long-term and are important for preservation of genetic diversity. As such they are considered 'important populations'.<br><br>Survey areas 2, 7, 8 and F host potential habitat for Kogan waxflower (core habitat possible) although the species was not recorded during field survey. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, and F:** Possible habitat for Kogan waxflower is contained within these properties although the species was not recorded during field survey. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount species occurrence..<br><br>Based on current knowledge, an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. Pre-clearance survey will be required to totally discount the occurrence of the species within finalised impact footprints.<br><br>Survey area 9 does not contain suitable habitat for Kogan waxflower.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed. |

| Criteria | Evaluation |
|---|---|
| | In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | The species is not known to be affected by any disease which could be potentially introduced into the project development area.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Kogan waxflower (*Philotheca sporadica)* no impact is expected from development activities although this relies on the comprehensive pre-clearance surveys being undertaken in the stages prior to project construction, particularly on survey areas 8 and F where core habitat possible has been mapped.

Based on the current information, impacts are not considered significant when assessed under MNES criteria. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. Impact is considered known and predictable (no impact) and reversibility is not relevant. This assessment assumes appropriate pre-clearance survey is undertaken and the species is not found.

**Rule(s) for survey effort required in accordance with survey guidelines:** Kogan waxflower is a distinctive shrub that would be readily identified throughout the year without the requirement for seasonal consideration.

**Machin's macrozamia (*Macrozamia machinii*)**

**Family**: Zamiaceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Vulnerable; **BoT:** Critical

**Sensitivity:** Extremely High

**Recovery plan:** A species management profile for *Macrozamia machinii* has been prepared by Halford (1997). A multi-purpose recovery plan has also been developed for cycads (Queensland Herbarium 2007) which may have information relevant to the management of Machin's macrozamia.

**Overview of Machin's macrozamia**

**Description** (based on EHP 2012c; Flora of Australia Online, Jones and Forster 1994 referenced in DEWHA 2009; Halford 1997a): Machin's macrozamia is a cycad with an underground trunk that can branch to produce multiple growing points in a clump. There are one to eight leaves in a crown. These leaves are frond-like, blue to grey-green, 60 to 90 cm long and silky hairy when young. The leaflet arrangement along the central frond stalk (i.e. rachis) is moderately keeled (i.e. opposing leaflets inserted at 45–60° on rachis). The rachis is strongly spirally twisted. Each frond contains 80 to 140 leaflets, which are up to 32 cm long and 1 cm wide, much paler underneath than above. The basal leaflets are not reduced to spines, which are seen in some other cycads. The plants reproduce by male and female cones, which develop on separate plants. The female cones resemble pineapples with aggregated seed segments. The seeds are red and 2.5 to 3 cm long.

**Ecology**: Many perennial cycads live for several decades, if not centuries (Benson and McDougall 1993). The ability of the underground stem of Machin's macrozamia to re-shoot multiple crowns probably indicates a strong regenerative ability after soil surface disturbance. Indeed, most if not all Australian cycads survive fires through vegetation regeneration and some can survive some minor level of mechanical disturbance (Forster 1997). However, it is unknown what level of disturbance would kill Machin's macrozamia plants. The leaves and fruits of Machin's macrozamia are poisonous to domestic stock and there are suspicions that some graziers have tried to eradicate it in the past (Halford 1997). Collection by cycad enthusiasts for horticulture may also have caused some population declines (Halford 1997). The mechanism of pollination for macrozamia species in general is poorly understood although generally involves a relationship with a particular insect, a thrip or a beetle. Mature cones of Machin's macrozamia have been recorded from September to December. Ripe seeds are present between February and April although as for all macrozamia species, the fresh seed is not ready to germinate for another 12 months, due to the delayed fertilisation process unique to cycads (Norstog and Nicholls 1997). Delayed fertilisation renders them susceptible to disturbance. Cones may not be annual when conditions are unfavourable. (Halford 1997).

**Habitat:** The primary habitat of Machin's macrozamia is smooth barked apple (*Angophora leiocarpa*, , white cypress pine (*Callitris glaucophylla*), and budgeroo (*Lysicarpus angustifolius*) woodlands on hills

with deep sands or lateritic rocky surfaces (Halford 1997). Previous collections typically fall within three main REs:

- RE 11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri*, *Eucalyptus* chloroclada, *Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces on deep sands.
- RE 11.7.4; Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust.
- RE 11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rock.
- RE 11.7.7; *Eucalyptus fibrosa subsp. nubila* +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

**Distribution:** Machin's macrozamia is restricted to an area to the north and south of Inglewood in south-east Queensland. It is thought to span eight known populations in that area (Halford 1997). Some key populations occur in state forest in areas of remnant vegetation, with several populations on private or leasehold land, and one population along a stock route (TSSC 2008h).

**Likelihood of occurrence and extent of habitat in the project development area:** Known to occur in the project development area. Approximately half of the 41 collections of this cycad have been collected within the Wondul Range (including the National Park) section of the project development area to the north of Inglewood. It was not recorded in field surveys. The extent of habitat in the project development area is indicated in **Table A35** with distribution of habitat shown in **Figure A14.**

**Table A35**. Extent of habitat for Machin's macrozamia within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 1534.22 | 24432.16 | 0 |
| 3D Detailed Mapping Area** | 0 | 0 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 0 | 0 |
| Survey areas 2, 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** Loss and damage through forestry operations, inappropriate fire regimes (which kills surface seed and young seedlings); failure of the insect pollination mutualism; vulnerability to illegal collecting; trampling of seedlings by stock; and deliberate killing; are considered as the major threats (TSSC

2008h). Other major threats are genetic inbreeding with possible impact on long term population viability (Forster 2004; Forster 2007 in TSSC 2008h), and trampling of seedlings by stock.

**Potential project-related impacts:** Impacts associated with develoment activities could include:

- Direct loss of individuals during habitat clearing from mechanical removal.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmentation of contiguous vegetation which modifies the natural movement of fire through the landscape.

**Significance of project related impacts (unmitigated):** The sensitivity of Machin's macrozamia is considered to be ***Extremely High.*** This ranking is based on the fact that, while its ecology is poorly known, it has some capacity to regenerate from vegetative coppicing, and possibly seedlings. However, it is very likely to be a slow maturing, long lived species, so that rehabilitation after disturbances may not produce a successful result for decades, if ever. Around half of the known populations of Machin's macrozamia occur within the project development area. On this basis, the magnitude of unmitigated impacts to populations within the project development area is considered ***Major***. Therefore the significance of unmitigated impacts *is* ***Major (25).***

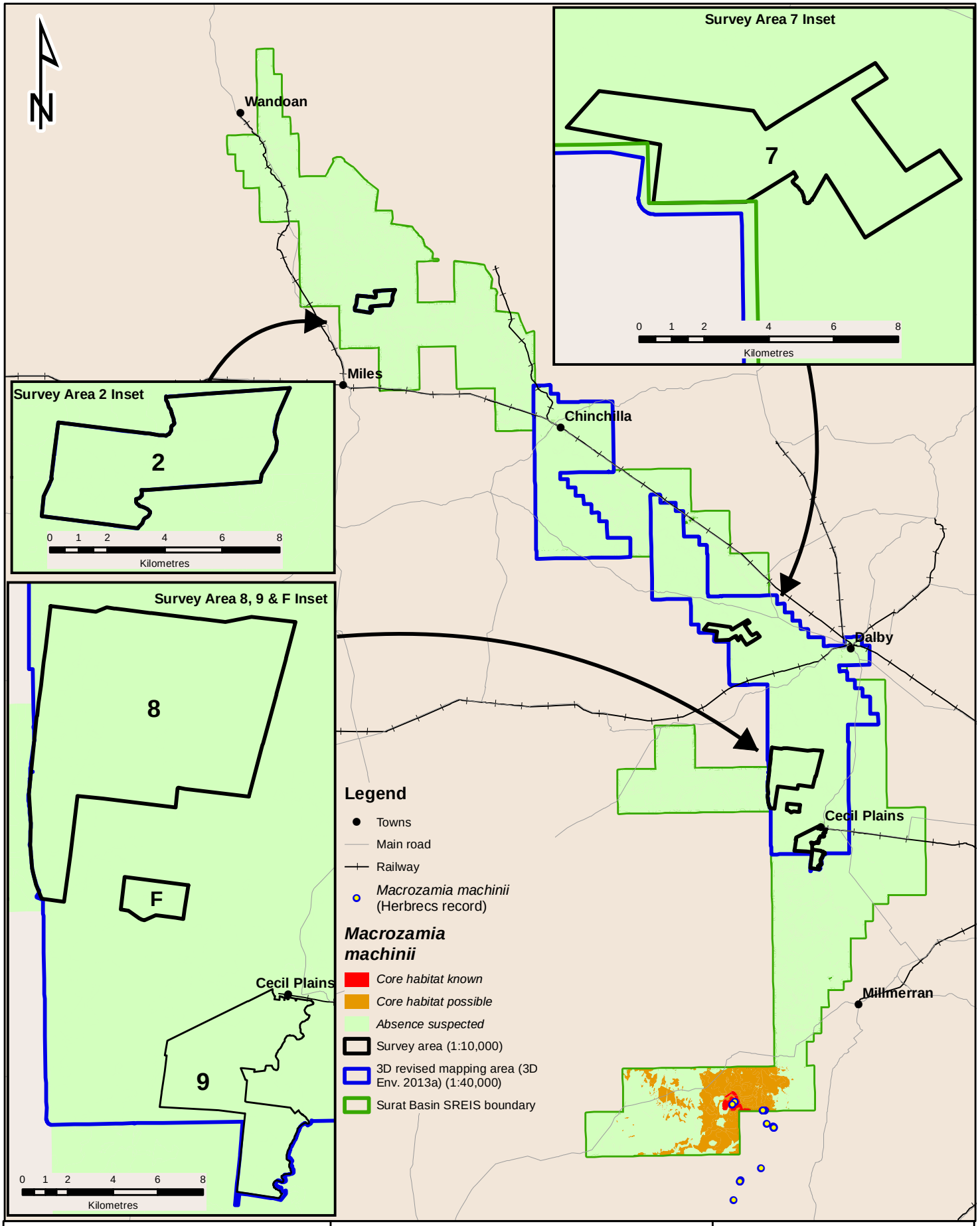
**Species specific mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Machin's macrozamia will be prioritised. The following mitigation measure is recommended, additional to current commitments:

- Record the location of any newly identified populations of Machin's macrozamia (*Macrozamia machinii*) and confidentially notify relevant authorities. [C563]

**Summary residual impact assessment:** In the absence of mitigation, a significance ranking impacts of ***Major*** **(25)** significance will potentially occur. Avoidance of core habitat in remnant vegetation in the south west of the project development area is the most effective mitigation measure and if habitat and individuals are avoided, no impact will be incurred**.** Some cycads are amenable to translocation and this measure could be investigated, although there is no means of being sure without ecological trials. Therefore, the impact magnitude with mitigation measures (other than avoidance) remains ***Major (25).***

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | High | Major (25) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A14.** Machin's macrozamia *(Macrozamia machinii)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant REs, regardless of classification treated as "core habitat known" ('high'confidence is applied).
2. RE polygons with confirmed records (≤500 m precision) should be treated as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. Mature regrowth (EHP 2012b) is not included in the habitat calculations.
4. The following regional ecosystems in the Wondul Range area, encompassing the associated north-south trending wildlife corridor should be classed as "core habitat possible":
    - RE11.10.1, 11.5.4, 11.5.1, 11.7.5, 11.7.4 (confidence levels in 2 apply).
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A36**. Evaluation of impact significance for Machin's macrozamia under MNES guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | The habitat for Machin's macrozamia is centred on intact vegetation within the southern portion of the project development area, containing half of all known records.<br><br>Due to the high degree of endemicity and viability of populations which are associated with intact vegetation, all populations should be considered important populations.<br><br>No property considered for development contains habitat for Machin's macrozamia. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9, and F:** It is not considered that these properties host potential habitat for Machin's macrozamia.<br><br>An 'Important Population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9, and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. These properties will not impact on the north-south trending wildlife corridor within which the species occurs.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact macrozamia species are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, 9, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Machin's macrozamia (*Macrozamia machinii)* no impact is expected from development activities. The level of impact caused by development on subject properties (survey areas 2, 7, 8, 9 and F) will result in no impact to Machin's macrozamia. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. Provided pre-clearance activities are undertaken in areas where potential habitat is mapped, and any populations are avoided, impact is considered known and predictable (no impact).

**Rule(s) for survey effort required in accordance with survey guidelines:** Machin's macrozamia is a perennial that should be readily identified throughout all seasons regardless of whether fertile material is visible. Hence no specific survey timing is required to effectively detect the species.

**Tara wattle *(Acacia lauta)***

**Family:** Mimosaceae

**Status: NC Act:** Vulnerable **EPBC Act:** Vulnerable; **BoT:** Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A national species recovery plan has not been developed for Tara wattle (*Acacia lauta*).

**Overview of Tara wattle**

**Description:** A sprawling shrub to 2 m tall and very closely allied to *Acacia johnsonii* . The phyllodes 20–40 mm long, 1.5–2.5 mm wide, patent to reclined, midrib slightly raised and rather distinct (when dry). The eccentrically rostellate mucro occurs at right angles to laminae. Peduncles are sparsely puberulous. *Acacia lauta* is a member of the '*Acacia johnsonii* group' and its relationship to its very close relative, *Acacia. Johnsonii*, warrants further study (Maslin, 2005 cited in TSSC 2008o).

**Plate 17.** Tara wattle (*Acacia lauta).* Photograph Copyright © Boobook

**Ecology:** The typical life span of Tara wattle is unknown. As a hard-seeded legume, the seed banks of *Acacia lauta* are likely to be long lived. Like many acacia species, there is potential for vegetative regeneration from root suckers, and fire-promoted germination is possible. Tara wattle flowers during August–September and sets fruit in December (Pedley 1979, Maslin, 2005). The impacts of stock grazing are unknown, but damage from grazing by feral goats has been observed.

**Habitat:** Associated with sandy soils hosting ironbark woodland. Known populations have been mapped within REs 11.7.7, 11.7.4 and 11.7.5. These REs provide a representative mix of shrubland and woodland of which ironbark (*Eucalyptus crebra, Eucalyptus sideroxylon or Eucalyptus fibrosa)*

forms a dominant to sub-dominant component. Habitat descriptions from Herbrecs (EHP 2013) indicate that the species may also be associated with REs 11.5.4 and 11.5.1 and some collections have been associated with spinifex patches which occur in sandy soils over lateritised sandstone. A single record in the study area occurs in mature regrowth vegetation (RE11.5.1).

**Distribution:** Confined to a small region of the Darling Downs in south-east Queensland, between Inglewood and Tara. Three populations are known being 15 km north of Tara at Spinifex Corner (five collections); 16 km east of Tara (three specimens); and one specimen from Marron Glen, 15 km south of Inglewood (TSSC 2008o). The populations occur within both road reserve and freehold land. Tara wattle is not known to occur within any protected area. A single record is also known from Barakula State Forest to the north of Chinchilla although the precision of this record is unknown (AVH 2013g).

**Likelihood of occurrence in project development area:** The species is not known to occur within the project development area with the nearest record 17 km west of the boundary and 63 km west of Dalby. Eight collections of Tara Wattle have been made within the study area (EHP 2013). Whilst not known to occur within the project development area, the proximity of known collections, the availability and suitability of habitat for the species suggests that its occurrence cannot be discounted. **Table A37** provides an indication of the extent of Tara wattle habitats within the project development area with broad distribution indicated in **Figure A15.**

**Table A37**. Extent of habitat for Tara wattle within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 49889 | 5180 |
| 3D Detailed Mapping Area** | 0 | 7155 | 4779 |
| 3D Detailed Mapping Area based on EHP (2012a and 2012b)*** | 0 | 13401 | 3129 |
| Survey area 7****. | 0 | 118 | 0 |
| Survey area 8****. | 0 | 1544 | 201 |
| Survey area 2, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** The species is poorly known and ecology poorly documented. Being associated with road side verges, road widening is considered a major threat. Too frequent fire is considered to potentially

destroy soil seed banks (TSSC 2008o) although this does not take into account fire intensity and the patch burn size. For populations occurring on roadside verges, the invasion of exotic grasses, particularly buffel and African love grass has potential to significantly impact the species due to their ability to modify fire behavior and increase fire intensity and frequency.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, changed fore regimes, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (unmitigated):** The species is not known to occur in the project development area and as such, known populations will not be impacted. The major risk will be to populations that have not yet been discovered. Further survey of potentially suitable habitats is required prior to disturbance to ensure potential impacts to the species are accounted for. Whilst the ecology of the species is poorly studied, like many acacia species, the seed bank is likely to be long lived and the shrub will likely be capable of regenerating vegetatively. Hence the sensitivity of the species is considered to be ***Moderate***. The species is not known to occur in the project development area although an abundance of suitable habitat suggests that the magnitude of potential habitats may be ***Moderate*****.** The magnitude of impact may need to be re-assessed if new populations are discovered within the project development area although based on current knowledge, the significance of unmitigated impacts is considered to be ***Moderate*** **(13)**.

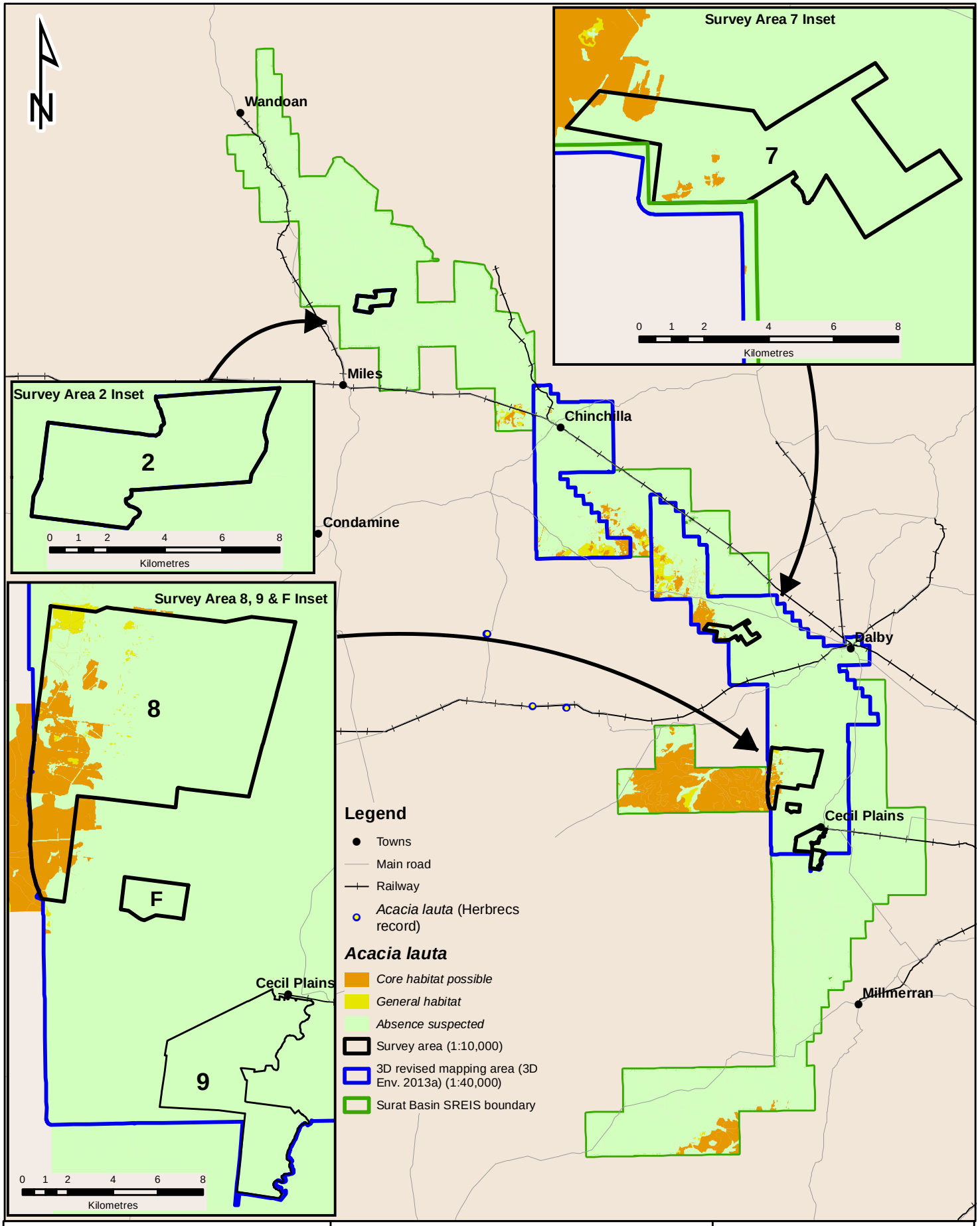
**Species specific management/ mitigation measures:** Management of this species is covered by Arrow commitments defined in Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Tara wattle will be prioritised.

**Summary residual impact assessment:** Avoiding 'core habitat possible' areas is the preferred mitigation measure and will completely mitigate against impact. In the absence of mitigation, impacts of ***Moderate (13)*** significance are likely**.**

Where potential habitat cannot be avoided, further survey work prior to clearing in an attempt to determine the presence or absence of the species will be necessary. The invasion of exotic grasses can be managed by strict weed hygiene measures being imposed on all machinery. Based on application of a range of generic mitigation measures, the resulting residual impact significance would be ***Low (8).***

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Low | Low (8) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A15.** Tara wattle *(Acacia lauta)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
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**Rule(s) for habitat mapping:**

1. Confirmed species record (<500 m precision) should be buffered by a 1km circumference and all remnant habitats regardless of RE classification treated as 'core habitat known' (high confidence levels apply). This includes mature regrowth datasets (EHP 2012b).
2. Regional Ecosystem polygons with the confirmed record (<500 m precision) should be treated as 'core habitat known'('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping (3D Environmental 2013) and 'low' when applied to mapping produced by EHP 2012a).
3. The following regional ecosystems within 50 km of known records should be classed as "core habitat possible" (confidence levels as in 2 apply):
   - RE11.7.4, RE11.7.5, RE11.7.6, RE11.7.7, RE11.5.1, RE11.5.4
4. Mature regrowth of potential habitat (REs as per core habitat possible) within 50 km of records is considered "general habitat" (low confidence levels apply)
5. All other remnant and non-remnant vegetation in the project development area should be treated as 'absence suspected'.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A38**. Evaluation of impact significance for Tara wattle under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge three populations of Tara wattle occur to the west of the project development area with an additional population present in Barakula State Forest to the east.<br><br>Survey area 8 and survey area 7 contains "core habitat possible" for the species. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount occurrence of the species in suitable habitats.<br><br>Other development locations (survey area 9, survey area 2 and Survey area F) are not considered to contain suitable habitat.<br><br>Whilst no populations are known in the project development area, the highly endemic nature of the species, would render any additional population found an 'important population'. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 7, 8,:** Field survey failed to locate this species within suitable habitat. It is not possible to totally discount occurrence Tara wattle within the property and pre-clearance survey will be required once project footprints have been identified. No other property is considered likely to host Tara wattle populations. Other survey areas 2, 9 and F are not considered to contain suitable habitat for the species.<br><br>Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 9, 7, 8, F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey area 2, 9, 7, 8, F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 9, 7, 8, F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 2, 9, 7, 8, F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 9, 7, 8, F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Whist Tara wattle populations are associated with state wildlife corridors, these corridors will not be impacted by the proposed development.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 9, 7, 8, F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of exotic species within tenements are proposed.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact acacia species are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey area 2, 9, 7, 8, F:** Will not interfere with the recovery of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Tara wattle (*Acacia lauta)* no impact is expected from development activities. Impacts are not considered significant when assessed under MNES criteria provided pre-clearance survey is undertaken in survey areas 7 and 8 where potential habitat is mapped and mitigations are applied to any populations located. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. Impact is considered known and predictable (no impact) assuming appropriate pre-clearance surveys are applied and the species is not found.

**Rule(s) for survey effort required in accordance with survey guidelines:** Tara wattle is a perennial shrub species that should be apparent throughout all seasons. It may however be difficult to distinguish Tara wattle from *Acacia johnsonii* in the absence of fertile material. For the purpose of certainty, survey during its fertile period from August to December is recommended.

**Queensland white gum (*Eucalyptus argophloia*)**

**Family:** Myrtaceae

**Status: NC Act**: Vulnerable **EPBC Act**: Vulnerable; **BoT:** Critical

**Sensitivity:** Moderate

**Recovery plan:** A national species recovery plan has not been developed for Queensland white gum (*Eucalyptus argophloia*). A species management manual has been prepared by Halford (1997b).

**Overview of Queensland white gum**

**Desription** (based on Boland 2004, Brooker and Kleinig 2004, EHP 2012d): Queensland white gum is a medium sized to tall tree growing to 40 m and the tall, erect habit makes this tree very distinctive (Boland et al. 2006). The bark is smooth, grey and reddish over yellow weathering which may be white and powdery (Brooker and Kleinig, 2004). The trunk is free of branches for one-half or more of the total tree height. The smooth bark is shed in strips and has a mottled appearance with patches of yellow, pinkish grey, reddish grey, bluish grey and white. The juvenile leaves are linear to narrowly lance-shaped, up to 9 cm long by 1.4 cm wide, greyish-green in colour and arranged at first in opposite pairs then alternating along the branch. The dull, green, adult leaves are lance-shaped and measure up to 13 cm long by 1.3 cm wide. A prominent feature of the leaves is the intra-marginal vein being remote from the leaf edge (EHP 2012d). The flowers are simple, axillary and sometimes terminal, in groups of up to 7 and buds are ovoid to almost globular (Boland et al. 2006). The seed capsules are hemispherical to cup-shaped and are 2.5-5 mm long by 4-7 mm diameter with 4-6 valves opening at rim level or slightly exerted. (Brooker & Kleining 2004).

**Plate 18.** Queensland white gum (*Eucalyptus argophloia)* buds and foliage. Photograph Copyright © Boobook

**Ecology:** The typical life span of Queensland western white gum is unknown. Much of its current population exists in disturbed regrowth vegetation and the species regenerates from seed. The species is highly tolerant of frost and drought and its use in forestry plantations suggests that its seed is readily harvested and available for regeneration. It is a fast growing species.

**Habitat:** The existing natural population exists largely in highly disturbed regrowth vegetation with associated tree species including brigalow (*Acacia harpophylla),* grey box (*Eucalyptus molluccana/ Eucalyptus microcarpa)* white cypress pine (*Callitris glauca)* and poplar box *(Eucalyptus populnea).* The tree is associated with red loams, grey brown clays and clay loams of moderate to high fertility (Boland et al. 2006). According to TSSC (2008p), no known populations occur in vegetation classified as remnant under the VM Act. Possible REs providing habitat include RE11.4.3, 11.3.1, 11.4.7, 11.4.12, 11.5.1 and 11.5.20.

**Distribution:** The species has a highly restricted distribution contained within an area of 40 km long and 12 – 15 km wide in an area to the north of Chinchilla, Queensland (Boland et al, 2004).

**Likelihood of occurrence in project development area:** The nearest record of Queensland white gum is located 7 km from the edge of the project development area, 16 km northeast of the Chinchilla town centre. A total of thirteen records are known from the study area. It is considered likely that due to the distinctive nature of this tree, the existing locations have been well documented. There however remains the possibility that this species will occur within the project development area in the Chinchilla area. The species is used extensively in plantation throughout the region and these should not be confused with local natural populations. **Table A39** provides an indication of the extent of Queensland white gum habitats within the project development area with broad distribution indicated in **Figure A16.**

**Threats:** The main threats to the local populations of Queensland western white gum are:

- Habitat destruction for agriculture.
- Timber harvesting.
- Lack of seedling regeneration due to weeds and planted pasture species (TSSC 2008p).

**Table A39.** Extent of habitat for Queensland white gum within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 4138 | 0 |
| 3D Detailed Mapping Area** | 0 | 640 | 0 |
| 3D Detailed Mapping Area based on EHP mapping*** | 0 | 1936 | 0 |
| Survey area 2, 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones;

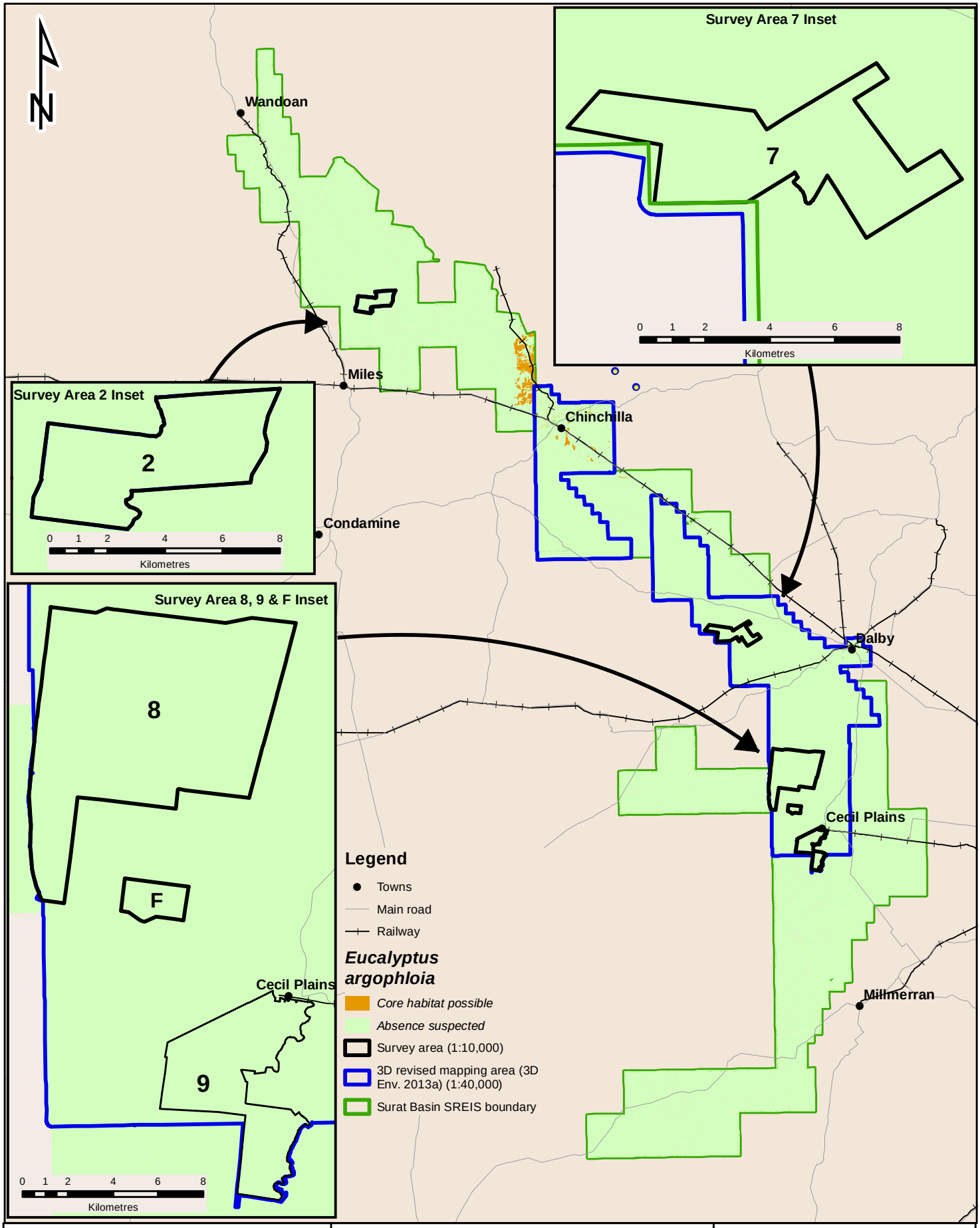
**Significance of project related impacts (unmitigated):** The species can regenerate via seed in disturbed habitats and can be propagated readily from seed. Hence the sensitivity of Queensland white gum to project related impacts is considered ***Moderate.*** All known natural populations occur outside the project development area and any occurrences contained within are likely to be scattered individuals. Hence the potential magnitude of impacts is considered to be ***Low (8).***

**Species specific management/ mitigation measures:** Management of this species is covered in Arrow commitments provided within Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Queensland white gum will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Low (8)*** significance to Queensland white gum populations within the project development area. Whilst the species is not known to occur in the project development area, there is potential for scattered individuals to occur within disturbed habitats in the vicinity of Chinchilla. Mature trees should be readily avoided and mitigation measures are considered largely effective. Assuming habitat and individual trees can be avoided, there will be no residual impact incurred. With mitigation measures other than avoidance, residual impact will be ***Low*** (4).

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Extremely Low | Low (4) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A16.** Queensland white gum *(Eucalyptus argophloia)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" (high confidence applies) for all RE and mature regrowth (EHP 2012a and 2012b) contained within the buffer
2. RE and mature regrowth polygons with the confirmed record (<500m precision) should be treated as 'core habitat known' ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. All remnant and mature regrowth habitats (from EHP 2012a and 2012b) within 20 km of confirmed records should be considered 'core habitat possible' (confidence levels as in 2 apply).

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A40.** Evaluation of impact significance for Queensland white gum under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area | Based on current knowledge, with the exception of populations occurring in plantation, Queensland white gum does not occur in the project development area.<br><br>Given that any record of a non-cultivated specimen that is located in the project development area would be considered a range extension, any natural population occurring would qualify as an important population.<br><br>Populations occurring within plantations should not be considered important to the survival of the species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9 and F:** These areas are not considered to host potential habitat for Queensland white gum. Hence no long term decrease in the size of a Queensland white gum population is anticipated from development at these locations.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 3: fragment an existing important population | **Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | **Survey area 2, 7, 8, 9 and F:** Diseases specific to Queensland white gum are not known although the species may be susceptible to thrip and borer attack. It is considered unlikely that an increase in such attack would be facilitated by development activities.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey area 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For Queensland white gum (*Eucalyptus argophloia)* no impact is expected from development activities. Further assessment will however be required in areas where core habitat possible for the species is mapped when working more broadly in the project development area. Provided pre-clearance survey are appropriately applied, impact is considered known and predictable (no impact) and reversibile if the species is identified. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** Queensland white gum is a distinctive tree species that will be apparent throughout all seasons. Specific survey timing is not warranted for this species.

***Eucalyptus virens***

**Family:** Myrtaceae

**Status: NC Act**: Vulnerable **EPBC Act**: Vulnerable

**Sensitivity:** High

**Recovery plan:** A national species recovery plan has not been developed for *Eucalyptus virens*. A species management manual has been prepared by Halford (1998).

**Overview of *Eucalyptus virens***

**Description** (Based on Brooker and Kleinig 2004): *Eucalyptus virens* is a small to medium sized tree that is ironbark throughout with bark that is sometimes soft and flaky and soft and corky on branchlets. The juvenile leaves are petiolate, opposite for three or four pairs, then alternating. Adult leaves are concolorous, bright glossy green and densely reticulated. The buds are pedicellate and rhomboidal with a conical operculum with fruit that are obconical, 0.5 x 0.5 cm. The white flowers emerge in November and persist to February (Brooker & Kleining 2004).

**Plate 19.** *Eucalyptus virens* buds and foliage. Photograph Copyright © Boobook

**Ecology:** Limited information is available on the ecology of *Eucalyptus virens* and its typical life span is unknown. Its typical flowering period occurs from November through to February (Brooker & Kleining 2004).

**Habitat:** The species is known to inhabit plateaus and sandstone escarpments and sandy soils which form low rises. Based on Herbrecs data (EHP 2013), populations are mapped as occurring in association with REs11.7.7, 11.7.4. 11.7.5, 11.7.6 and11.5.1, all associated with residual soils with the initial three occurring on lateritic sandstones.

**Distribution:** The species is restricted to four disjunct populations near Inglewood, Tara, northeast of Eidsvold and near Mt Moffat. The species is endemic to Queensland (Brooker and Kleinig, 2004). Two herbarium records of the species occur in the study area although these are located 18 km southwest of the project development area boundary and 60 km west of Dalby.

**Likelihood of occurrence and extent of habitat in the project development area:** The nearest confirmed record is located 18 km south-west of the project development area and 16 km northeast of Tara with two prior collections in the study area. The species in not known to occur in the project development area although due to proximity and suitability of habitat, it is considered a possible occurrence, particularly on lateritic and sandstone rises in the Kumbarilla area. **Table A41** provides an indication of the extent of *Eucalyptus virens* habitats within the project development area with broad distribution indicated in **Figure A17.**

**Table A41**. Extent of habitat for *Eucalyptus virens* within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 0 | 0 |
| 3D Detailed Mapping Area** | 0 | 3536 | 4544 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 0 | 0 |
| Survey areas 2, 9, 8 and F****. | 0 | 0 | 0 |
| Survey area 7**** | 0 | 100.24 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** The main threats to the local populations of *Eucalyptus virens* are:

- Timber harvesting.
- Disturbance of habitat during timber clearing.
- Wholesale clearing of habitat (TSSC 2008q).

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

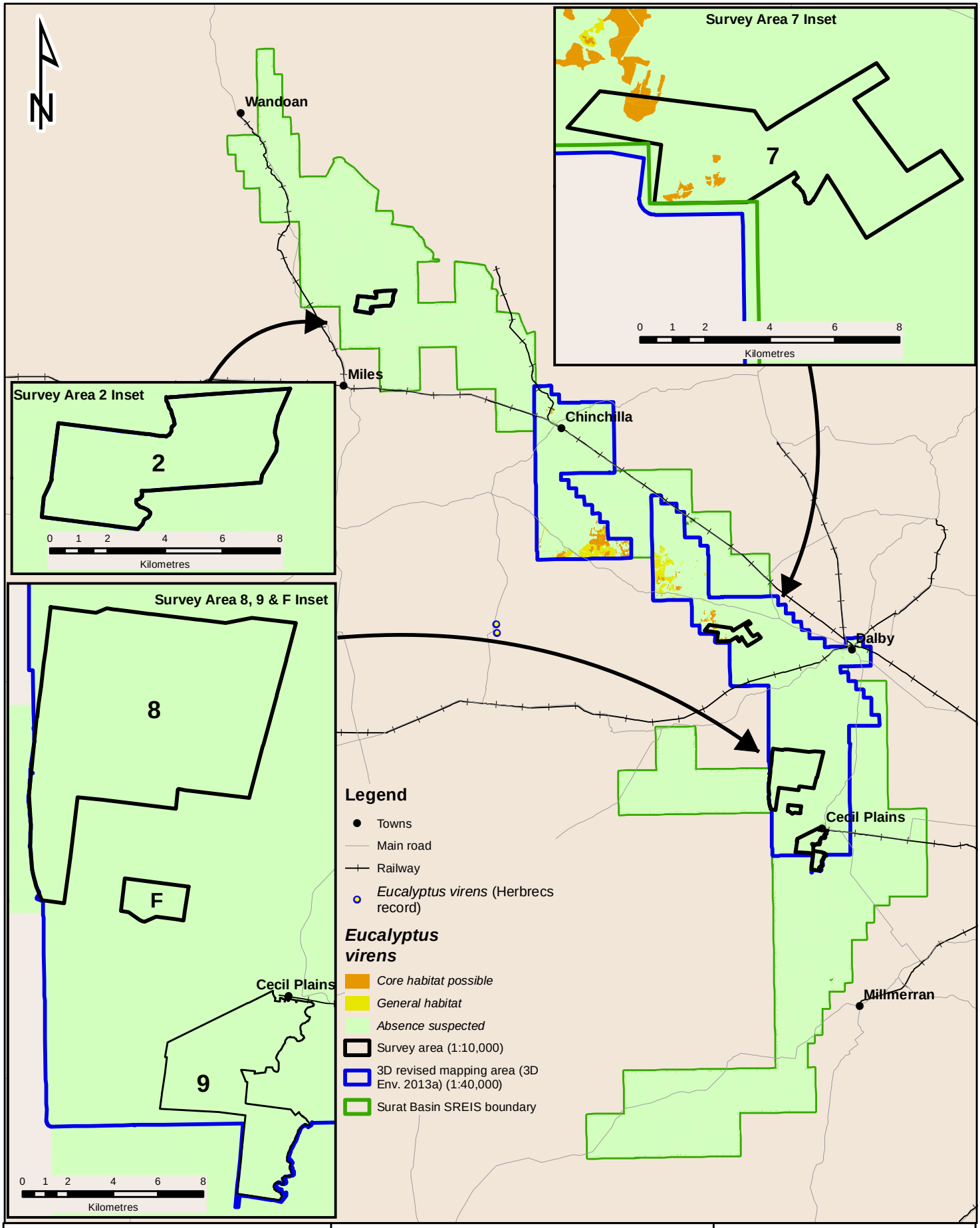
**Significance of project related impacts (unmitigated):** The species is not known to occur in the project development area and hence any impacts incurred will be within previously unrecognised populations. Reproduction ecology is unknown although the species is expected to regenerate through seeding and like other related eucalypt species, is likely to re-generate via coppicing. Seedlings may take many years to mature. The species sensitivity is considered ***High*** and the potential magnitude of project related impacts, based on the availability of potential habitat in the project development area, is considered ***Moderate***. The significance of unmitigated impacts is potentially ***Moderate (17)***.

**Species specific management/ mitigation measures:** Management of this species is covered in Arrow commitments provided within Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of *Eucalyptus virens* will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Moderate (17)*** significance to *Eucalyptus virens* populations within the project development area. Whilst the species is not known to occur, there is potential for additional populations to be identified, particularly in escarpment and sandstone areas in the vicinity of Tara. All identified populations should be avoided during disturbance activities. The suitability of the species for rehabilitation is unknown and hence this is not considered a viable mitigation measure until further tested. Assuming avoidance of populations, no residual impact will be incurred. Other methods of mitigation, including use of seedlings in rehabilitation will result in impacts of ***Moderate (12)*** significance.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A17.** *(Eucalyptus virens)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 3/05/2013 | A4 |

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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" (high confidence applies).
2. The RE polygons within which the species occurs should be mapped as 'core habitat known' ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping (3D Environmental 2013) and 'low' when applied to mapping produced by EHP, 2012a).
3. All habitats comprising REs 11.7.5, 11.7.4, 11.7.6, 11.7.7 and 11.5.1 within 50 km of known populations should be considered 'core habitat possible' (confidence levels as in 2 apply). mature regrowth datasets (EHP 2012b) and regrowth habitats (3D Environmental 2013) derived from 'core habitat possible' REs are attributed 'general habitat'.
4. All other vegetation should be considered 'absence suspected'.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A42.** Evaluation of impact significance for *Eucalyptus virens* under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, four populations of *Eucalyptus virens* are known although these all occur outside the project development area.<br><br>The proposed facility site at survey area 7 contains "core habitat possible" for the species. Pre-construction surveys will be required to totally discount occurrence of the species in suitable habitats.<br><br>Other development locations (survey areas 8, 9, 2 and F) are not considered to host potential habitat for the species based on known distribution.<br><br>Whilst no populations are known in the project development area, the highly endemic nature of the species, would render any additional population found an 'important population'. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 7:** Field survey failed to locate this species within suitable habitat. It is not possible to totally discount occurrence of the *Eucalyptus virens* within the property and pre-clearance survey will be required once project footprints have been identified. No other property is considered likely to host *Eucalyptus virens* populations.<br><br>Based on current knowledge an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 4.<br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Whist *Eucalyptus virens* populations are associated with state wildlife corridors, these corridors will not be impacted by the proposed development.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 5.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | Diseases which impact eucalyptus species are not |

| Criteria | Evaluation |
|---|---|
| | known to occur.<br><br>In accordance with **Criteria 8,** a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey area 2, 7, 8, 9 and F:** Will not interfere with the recovery of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For *Eucalyptus virens* no impact is expected from development activities and impacts are not considered significant when assessed under MNES criteria. Provides pre-clearance surveys are adopted in areas mapped as possible habitat and appropriate mitigations are applied, impact is considered known and predictable (no impact) and reversibility is not relevant. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** The tree may be easily overlooked as other ironbark species and although foliage is characteristic, there is a necessity to collect fertile material for positive identification. Optimal survey timing is from November through to March.

***Prostanthera* sp. (Dunmore D.M.Gordon 8A)**

**Family**: Lamiaceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Vulnerable; **BoT**: Not Listed

**Sensitivity:** Extremely High

**Recovery plan:** A national species recovery plan has not been developed for *Prostranthera* sp. (Dunmore D.M. Gordon 8A).

**Overview of *Prostanthera sp.* (Dunmore D. M. Gordon 8A)**

**Description** (based on Stanley and Ross 1983, TSSC 2008k, DNR 2000): Low, upright, aromatic shrub, to 1 m tall but often only 50 cm tall. Leaves are with whorled, stalk-less (i.e., sessile), linear leaves 0.8 to 1.2 cm long, and up to 2 mm wide. The leaf margins are curved underneath back towards the midrib. Flowers are clustered into terminal racemes or panicles, two-lipped, mauve to purple-blue and about 8 mm long.

**Ecology:** The life span of *Prostanthera* sp. (Dunmore D.M.Gordon 8A) is not known, other than being a perennial. Flowering plants have been documented in June, August and October (Wang 1996). No other ecological information is known, other than habitat preferences.

**Habitat:** *Prostanthera* sp. (Dunmore D.M.Gordon 8A) grows in sandy soils and on stony ridges, including amongst rocks (Wang 1996). Regional ecosystems likely to form habitats include:

- RE11.5.1; Eucalyptus and Callitris woodland in shallow sandy soil or Eucalyptus woodland on hard sandstone ridge tops.
- RE11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri, Eucalyptus chloroclada, Angophora leiocarpa* on Cainozoic sand plains.
- RE11.7.4; *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust.
- RE11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.

The species has not been recorded in regrowth or otherwise “non-remnant” vegetation.

**Distribution:** A Queensland and bioregional endemic known only from four locations in a small area west of Millmerran, southern Queensland with a total extent of occurrence of less than 100 km² (TSSC 2008l). One population occurs on private land and three within state forest, including one on the border with Wondul Range National Park (EHP 2013, TSSC 2008k). Populations are possibly stable (EPA 2002). All collections occur south of Cecil Plains. The distribution of the species coincides with relatively contiguous tracts of remnant vegetation and the occurrence in the project development area coincides with a broad north-south trending wildlife corridor (see **Figure A18**).

**Likelihood of occurrence and extent of habitat in the project development area:** *Prostanthera* sp. (Dunmore D. M. Gordon 8A) is known to occur within one of the six previous Herbrecs records occurring within the project development area boundary between Wondul Range National Park and Bulli State Forest (EHP 2013). The species was not recorded during field surveys.

**Table 43.** Extent of habitat for *Prostanthera sp.* (Dunmore D. M. Gordon 8a) within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 1312 | 40318 | 0 |
| 3D Detailed Mapping Area** | 0 | 765 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 1623 | 0 |
| Survey area 2, 7, 8, 9, F | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** Habitat disturbance, including timber harvesting or mechanical activities and inappropriate fire regimes are possible threatening processes for the species (DNR 2000, TSSC 2008k).

**Potential project-related Impacts:** Impacts associated with the proposed development activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Altered and inappropriate fire regimes.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (Unmitigated):** The species is considered to have an ***Extremely High*** sensitivity to disturbance. This is based on the absence of any ecological information, especially regarding seed germination and post-disturbance regeneration. The genus prostanthera has several threatened species listed under the EPBC Act, so that it is possible that the ability of the genus to recover after disturbance is limited. However, there is suitable habitat within the project development area that could support as yet unknown populations. The consequences of

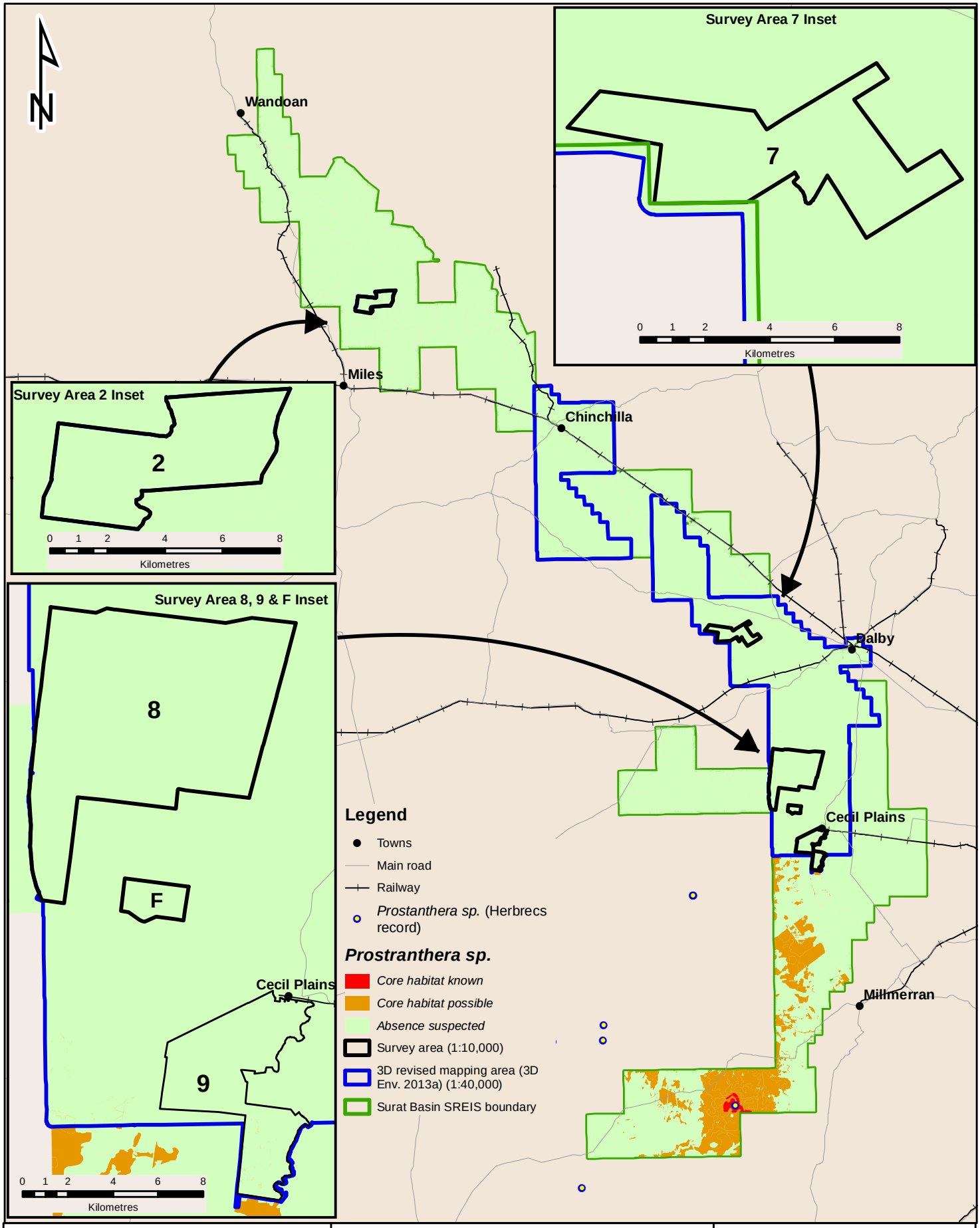
unmitigated impacts on a local population may be ***High*** with an unmitigated impact significance of ***Major* (25).**

**Specific management/ mitigation measures:** Mitigations for management of this species are covered by commitments made within Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Prostanthera sp. (Dunmore D, M. Gordon),

**Summary residual impact assessment:** In the absence of mitigation, impacts of ***Major* (25)** significance will possibly be inflicted upon populations in the vicinity of disturbance. Avoidance of core and possible habitat in remnant vegetation, including management buffers around known populations, will totally mitigate impact and residual impact will not be incurred**.** Due to the species sensitivity and the untested nature of many mitigation measure, any disturbance will result in residual impact that is potentially ***High (20).***

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | Moderate | High (20) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A18.** *Prostranthera sp.* (Dunmore D.M. Gordon) distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

1. The species in not recorded north of Cecil Plains (-27.53).
2. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence applies) for all REs contained within the buffer. .
3. Regional ecosystem polygons coninciding with confirmed records (<500m precision) should be classed as “core habitat known” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping (3D Environmental 2013) and ‘low’ when applied to mapping produced by (EHP, 2012a). mature regrowth datasets (EHP 2012b) are not considered.
4. The following regional ecosystems in the in the project development area to the south of Cecil Plains should be classed as “Core Habitat Possible” (confidence levels as in 3 apply).
    - RE11.7.4, RE11.7.5, RE11.5.1, RE11.5.4 (‘low’ confidence applies where applied to EHP datasets (EHP 2012a)).
5. All other remnant and regrowth vegetation, cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

**Evaluation under MNES referral guidelines**

**Table A44.** Evaluation of impact significance for *Prostanthera* sp. (Dunmore D. M. Gordon) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| ‘Important populations’ and ‘distribution of the species in the project development area. | Due to the high degree of endemicity of the species, known from a limited number of locations to the west of Millmerra, all populations should be considered important populations.<br><br>No property considered for development contains habitat for *Prostanthera* sp. (Dunmore D. M. Gordon). |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9, and F:** It is not considered that these properties host potential habitat for *Prostanthera* sp. (Dunmore D. M. Gordon).<br><br>An ‘important population’ is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur.<br><br>In accordance with **Criteria 1**, a significant impact is not expected. |

| Criteria | Evaluation |
|---|---|
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9, and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. These properties will not impact on the north-south trending wildlife corridor within which the species occurs.<br><br>In accordance with **Criteria 6**, a significant impact is not expected. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected. |
| Criteria 8: introduce a disease | There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area.<br><br>In accordance with **Criteria 8**, a significant impact is not expected. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, 9, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected. |

**Conclusions:** For *Prostanthera sp.* Dunmore (DM Gordon No. 8), no impact is expected from development activities. No impact will be incurred on the species by the proposed development on any survey area and habitat for the species will not be affected. The activities proposed by Arrow will not contribute to the cumulative impact to this species across a range of proponents. Impact is considered known and predictable (no impact) and reversibility is not relevant. Pre-clearance survey will be required when working in areas of potential habitat to ensure significant impact is not incurred when working more broadly in the project development area.

**Rule(s) for survey effort required in accordance with survey guidelines:** Limited ecological information is available to guide survey requirements for this species. The likely availability of fertile material in the period from June through October suggests that this period presents the optimal timing for survey. It is likely however that this species can be identified in the absence of fertile material.

## Grasses

### Lobed blue grass (*Bothriochloa biloba*)

**Family: Poaceae**

**Status: EPBC Act**: Vulnerable; **NC Act**: Least Concern; **BoT:** Not Listed

**Sensitivity:** Moderate

**Recovery plan:** A recovery plan has not been prepared for lobed blue grass.

**Overview of lobed blue grass**

**Description** (based on Sharp and Simon 2002; Harden 1993): An erect or decumbent, tufted perennial grass to 1 m high. The ligule (i.e. membrane at the base of the leaf against the stem) is fringed with hairs. The leaves are 3 to 5 mm wide with margins that are slightly rough. The flowering stalk is often branched at the nodes. The inflorescence (i.e. the flower and seed head) consists of 3 to 6 arms, each 4 to 10 cm long, which emerge from almost the same point, resembling fingers on a hand. Each arm of the flower/seed head has long white hairs (6.5 to 8 mm long), giving a silky look. The lemmas (i.e. the lower of two bracts enclosing each flower) that are awned (i.e. with bristles) are two-lobed.

**Plate 20.** Specimen of lobed blue grass (*Bothriochloa biloba).* Copyright © Boobook.

**Ecology:** Lobed blue grass is a perennial grass related to some of Australia's most valuable pasture species, yet it may be fairly unpalatable to stock. Bean (1999) saw no evidence that cattle grazed lobed blue grass and was told by NSW graziers that when other grasses are available, stock do not graze it.

Lobed blue grass has been collected in flower or with seed heads between November to June (EHP 2013; Sharp and Simon 2002). Compared with some other bothriochloa species, lobed blue grass

produces low levels of viable seed. This is mainly due to a high proportion of seed formation following a process called apomixes, where the seed are produced asexually without pollen from a second plant (Yu *et al*. 2003). Many of the lobed blue grass seeds formed through the apomixes process do not mature into viable seed.

**Habitat:** Lobed blue grass has a preference for heavier-textured brown or black clay soils (Bean 1999); although Fensham (1998) felt that it appeared "relatively unspecific" in its habitat preference. On the Darling Downs region it is often found in cleared alluvial sandy clay sites. It has been collected in cleared eucalypt forests with derived non-remnant grasslands in alluvial areas, often on the edge of RE11.3.4; disturbed roadside habitats of the Condamine flood plain; Queensland blue grass (*Dichanthium sericeum*) grassland on heavy alluvium (RE11.3.21), as well as within road and rail reserves where heavy alluvium occurs (EHP 2013; EHP 2012b).

Lobed blue grass was found during the in EIS surveys within the project development area in open grassy woodland dominated by Queensland blue gum (*Eucalyptus tereticornis*) on the flood plain of the Condamine River. The woodland structure of the habitat where the species was collected has been heavily disturbed by extensive timber extraction and heavy grazing pressure to the extent that the site is considered non-remnant.

**Distribution:** Known from the Darling Downs district in south east Queensland, south along the western slopes of the Great Dividing Range into NSW to North Star, Warialda, Bingara and Merriwa (Quinn *et al.* 1995; NSW Scientific Committee 2004). Recorded from Miles (2 km south of Condamine River), in the locality of Cecil Plains, and; 10 km north, 14 km NE and 6 km east of Goondiwindi at Yelarbon, Yellowbank (EHP 2013). A vouchered survey record was collected from 5 km north-northeast of Cecil Plains. The species is documented to be common within the bioregion and has been delisted in Queensland to common status (EPA 2002). The Darling Downs represents the northern geographic limit of the species.

**Likelihood of occurrence and extent of habitat in the project development area:** Lobed blue grass is known to occur within the project development area with three previous records contained with Herbrecs (EHP 2013) located to the south of Miles and the Cecil Plains area. A collection during baseline surveys 5 km north-northeast of Cecil Plains (project vegetation survey site AS346) strongly suggests that the species will occur relatively extensively on alluvial habitats associated with the Condamine River floodplain. Lobed blue grass has also been collected to the east of Goondiwindi, approximately 50 km to the south of the project development area. This falls within a polygon mapped by the Herbarium as RE 11.5.14 although the record precision is considered low ($\pm$ 16000 m) and REs associated with Land Zone 5 should at best be considered 'general habitat'. Lobed bluegrass has potential to occur within all areas proposed for development although suitable habitat is most prevalent in survey area 9, survey area 7 and survey area 8. A summary of potential habitat within the project development area is provided in **Table A45** with spatial representation of records and habitats provided in **Figure A19.**

**Table A45.** Extent of habitat for lobed bluegrass within the project development area and associated areas of assessment

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 1477 | 23965 | 0 |
| 3D Detailed Mapping Area** | 364 | 6352 | 12822 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 51 | 8788 | 0 |
| Survey area 2 | 0 | 56 | 0 |
| Survey area 7 | 0 | 77 | 7 |
| Survey area 8 | 0 | 104 | 1277 |
| Survey area 9 | 0 | 137 | 402 |
| Survey area F | 0 | 0 | 42 |

* Based on attribution of regional ecosystem mapping of EHP (2013) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.

**Threats:** Threats to lobed blue grass are identified by Fensham (1998, 1999), NSW Scientific Committee (2004) and Quinn *et al*. (1995) in Threatened Species Scientific Committee (2008d) include:

- Competition from exotic species such as coolatai grass (*Hyparrhenia hirta*), nut grass (*Cyperus rotundus*) and lippia (*Phyla nodiflora*); African love grass (*Eragrostis curvula*), *Paspalum dilatatum,* Guinea grass (*Megathrysus maximus*)*,* feathertop (*Pennisetum villosum*)*,* and Johnson grass (*Sorghum halepense*).
- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.
- Heavy ongoing grazing pressure.

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Habitat edge effects such as promoting conditions for invasion of weeds and exotic grasses which induce altered habitat structure along gathering lines, tracks and clearing zones.
- Direct loss of individuals during habitat clearing, and
- Direct loss of habitat through construction of facilities and development and maintenance of access tracks.

**Significance of project related impacts (Unmitigated):** The known populations of lobed blue grass occur in the vicinity of roadsides, and on river frontages. It is a species often collected within non-remnant cleared or otherwise disturbed areas. As a perennial grass, it is likely to be able to vegetatively survive some disturbances, with some seed germination. Therefore, given its demonstrated ability to survive in disturbed habitats, and its likely ability for vegetative survival and some seed germination, it is given a sensitivity ranking of ***Moderate***.

Half of the eight collections of lobed blue grass known from the study have been collected from within the project development area. This indicates a high proportion of the local populations are known from within the areas that are potentially disturbed. Approximately 20% of the project development area contains “core habitat possible” based by mapping of EHP (2012a) and in addition, the species is well represented in non-remnant habitats, indicating that it may be fairly widespread with the distribution of local populations difficult to predict. There is a high potential for invasion of aggressive grassy weeds along disturbance corridors, and these weeds are considered primary threats to this species. Therefore the potential impact magnitude is considered to be ***High.***

**Species specific management/ mitigation measures:** The following measures are considered specific to the management of impacts to lobed blue grass:

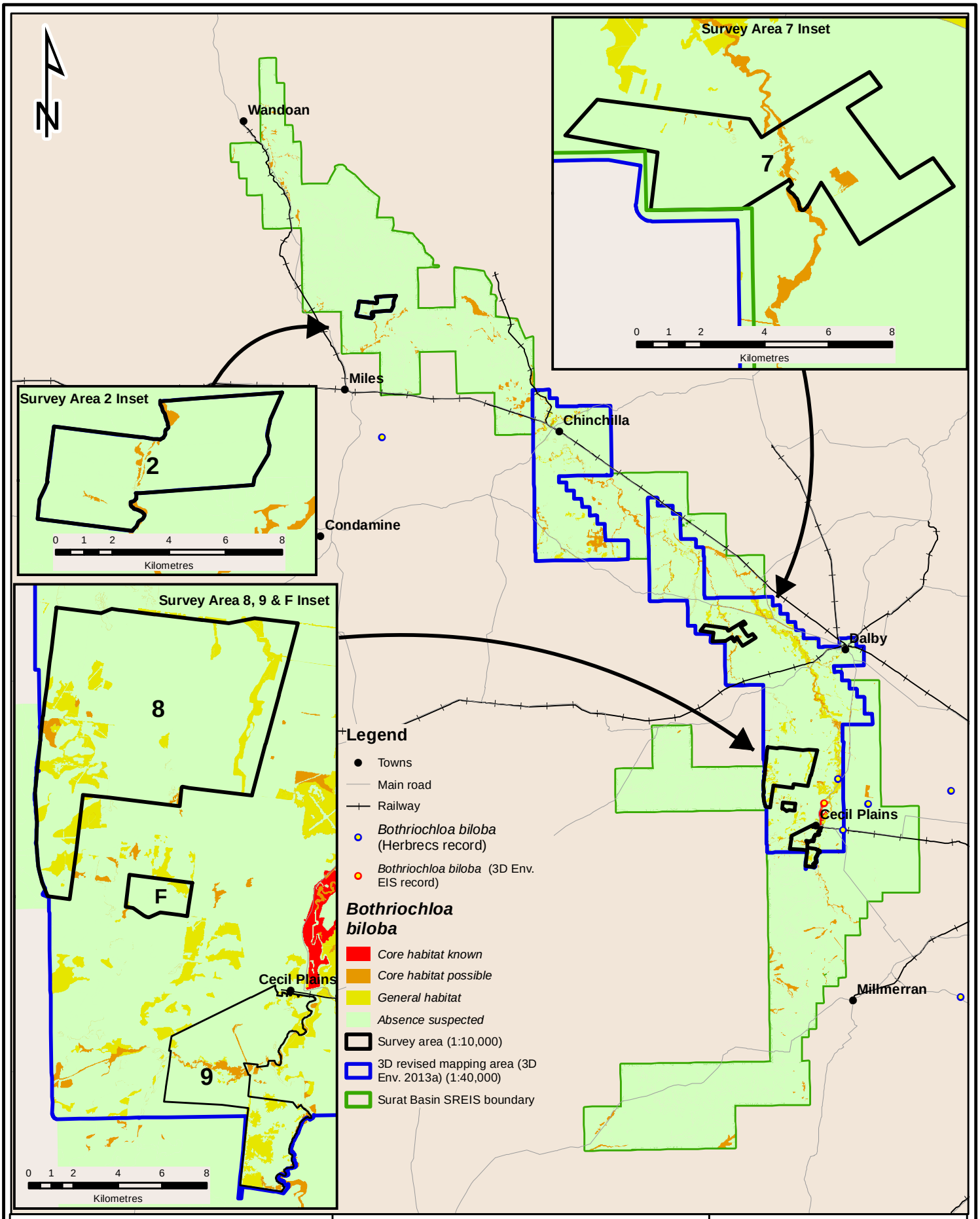
- Extend pre-clearance surveys into non-remnant areas, particularly derived grassland habitats associated with the Condamine River floodplain to allow sensitive placement of infrastructure in relation to lobed bluegrass populations.
- Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort.

Infrastructure design and site selection that seeks to avoid core habitat known of Lobed blue grass will be prioritised.

**Summary residual impact assessment:** Project related activities may result in impacts of ***Moderate* (18)** significance to potential lobed bluegrass populations within the project development area**.** The avoidance of grassland and poplar box woodlands on alluvium will significantly reduce potential impacts although development activities must be cognisant that this species also occurs within non-remnant habitats. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against impacts to a large degree, to the extent that minor loss in a local population of significant species is expected. If infrastructure avoids core habitat and individual species, no impact will be incurred. If other mitigation measures are implemented, particularly those requiring translocation and rehabilitation, project activities may result in impacts of ***Moderate (13)*** significance.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A19.** Lobed blue grass *(Bothriochloa biloba)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for Habitat Mapping**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence applies).
2. Regional Ecosystem polygons with confirmed records (<500 m precision) should be treated as “core habitat known” (‘high’ confidence applies to refined vegetation mapping layers).
3. Derived native grasslands should also be mapped as ‘core habitat known’ where they coincide with high precision records (3D Environmental (2013) datasets).
4. The following regional ecosystems occurring should be classed as “core habitat possible”:
   - RE11.3.2, RE11.3.3, RE11.3.4, RE11.3.21 (‘high’confidence applies to refined vegetation mapping with ‘low’ confidence applied to mapping produced by EHP (2012a)).
5. Non-remnant derived grassland on land zone 3 should be classed as “general habitat” (‘high’ confidence applies).
6. RE11.5.1 and RE11.5.4 should be considered general habitat except where survey indicates habitat suitability is low (‘high’confidence applies to refined vegetation mapping with ‘low’ confidence applied to mapping produced by EHP (2012a)).
7. All other remnant and non-remnant vegetation in the project development area should be treated as “absence suspected”.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A46.** Evaluation of impact significance for lobed blue grass under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| ‘Important populations’ and ‘distribution of the species in the project development area. | Based on current knowledge, lobed blue grass is relatively broadly dispersed throughout the project development area with scattered occurrences focused mostly on previously disturbed alluvial habitats. The project development area, being within the Darling Downs represents the northern limit of the species range and hence any population should be considered an ‘Important Population’. It is likely that a number of discrete local populations of the species occur in the project development area although these are all largely contained in highly disturbed locations and not likely to be viable in the long term. They are however potentially important for preserving genetic diversity of the species.<br><br>Potential habitat (‘core habitat possible’ or ‘general habitat’) for the species is indicated in all survey areas although the most extensive habitat is indicated in survey area 8, and 9. Field survey did not confirm the presence of this species within these properties. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. Particular habitats within survey area 9, survey area 8 and survey area 7 are considered suitable habitat for lobed bluegrass and it may be present. Comprehensive pre-clearance surveys are required within potential habitats prior to disturbance.<br><br>The species is considered amendable to translocation and relatively insensitive to habitat disturbance. It is therefore unlikely that project development in these location will lead to a long term decrease in the size of an important population when a full range of mitigation measures are introduced.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Pre-clearance searches are required within potential habitats to ascertain the presence of the species. Based on current knowledge, impacts to areas of suitable habitat will not lead to a decline of the species<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |

| Criteria | Evaluation |
|---|---|
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** The project proposes all activities be guided by a detailed weed management plan to prevent facilitated invasion of exotic species which have potential to out-compete lobed bluegrass.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur. |
| Criteria 8: introduce a disease | Diseases which impact lobed blue grass are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in **Criteria 1**.<br>In accordance with **Criteria 9**, a significant impact is not expected to occur. |

**Conclusions:** For lobed blue grass (*Bothriochloa biloba)* no impact is expected from development activities provided preclearance surveys are undertaken and methods employed are suitable for detection of grasses. Whilst suitable habitat for the species exists on survey area 9, 8 and 7, the species has not been previously recorded and impacts are not considered significant when assessed under MNES criteria, provided mitigation strategies are employed. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions and impacts are considered known, predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable.

**Rule(s) for survey effort required in accordance with survey guidelines:** Lobed blue grass is a perennial grass species that requires fertile material for positive identification. Suitable periods for field identification are from November to June when the species has been collected in flower or with seed heads. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

**King blue grass (*Dichanthium queenslandicum*)**

**Family:** Poaceae

**Status: EPBC Act**: Endangered (status upgraded from Vulnerable in January 2013 (TSSC 2013a and 2013b); **NC Act**: Vulnerable; **BoT:** Not Listed

**Sensitivity:** High

**Recovery plan:** A recovery plan has not been prepared for king blue grass. A draft recovery plan for the 'bluegrass (Dichanthium spp.) dominant grassland of the Brigalow Belt Bioregions (north and south)' endangered ecological community is relevant to the species (Butler 2007)

**Overview of king blue grass**

**Description** (based Stanley and Ross 1989 and Sharp and Simon 2002): A tufted, perennial grass to 80 cm tall. Culms (i.e. flowering stalks) with 4 to 5 nodes, the middle nodes with a circle of hairs. The ligule (i.e. membrane at the base of the leaf against the stem) is a fringed membrane, 1 to 1.5 mm long. Leaves are 9 to 18 cm long, 3 to 5 mm wide. Racemes (i.e. flowering branches) are 5 to 10 cm long, usually occur singularly, but sometimes have two branches. Individual flowers and seeds have awns up to 2 cm long.

**Plate 21.** King blue grass habit, occurring within native grasslands (Photograph: 3D Environmental) and **Plate 22.** Seed head (raceme) of king blue grass (Photograph 3D Environmental).

**Ecology:** King blue grass flowers mainly in the wet season, November to January (Sharp and Simon 2002) although the species has been recorded in flower during May (pers. observation 3D Environmental). This perennial grass is a palatable stock grazing species and can decline with heavy grazing pressure (Fensham 1999). Some sections along stock routes in the Darling Downs contain healthy populations of king blue grass (Fensham 1999). Vogler *et al*. (2006) found that king blue grass significantly increased in density after experimental burning and also after mowing treatments, regardless of the season of treatment.

**Habitat:** King blue grass grows in remnant and non-remnant derived grasslands on alluvium, cracking clays, and basalt. All collections within the Darling Downs have been from non-remnant areas. In fact, 70% of the entire 67 collections of this species stored in Australian Herbaria, overlay areas mapped by the Queensland Herbarium as non-remnant.

Where king blue grass has been collected within remnant ecosystems (all from > 150 km north of the project development area), 80% have been within RE11.8.11: *Dichanthium sericeum* grassland on Cainozoic igneous rocks; and RE 11.8.5: *Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks. Whilst these ecosystems are not known from the project development area, RE11.3.21 offers similar native habitat features.

Outside the project development area, king blue grass has also been collected within an area mapped as a mixture of RE11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains), RE11.3.3 (*Eucalyptus coolabah* woodland on alluvial plains), and RE11.3.11 (Semi-evergreen vine thicket on alluvial plains).

**Distribution:** King blue grass has been collected from Dalby to north of Hughenden. The greatest density of known populations is on black clay soils around Emerald. Fensham (1998 and 1999) considered king blue grass may have become restricted to the Central Highlands with the Darling Downs population now extinct, because at the time of their reports the species had not been collected in the Darling Downs since 1951. However king blue grass has recently been collected growing along the Warrego Highway roadside and adjacent stock route, near Jondaryan, south east of Dalby, in 2001, 2004 and 2011 (EHP 2013). It has also been reported to have been recently seen near Roma (W.J. Scattini, unpublished data, in Silcock *et al*. 2007). However, there is no Herbarium voucher specimen for the recent Roma sighting, so it must be considered only a possible population.

**Likelihood of occurrence and extent of habitat in the project development area:** King blue grass possibly occurs although has not been collected within the project development area and was not observed during field survey. The only three collections in the Darling Downs since 1951 are located approximately 20 km east of the project development area growing alongside the Warrego Highway within at stock route, south east of Dalby. All other collections (representing 91% of all the total collections of king blue grass) are located in central Queensland, over 150 km north of the project development area. There is a gap of approximately 250 km between the Darling Downs and Central Queensland collections. **Table A47** provides an indication of the extent of king blue grass habitats within the project development area with broad distribution of habitat indicated in **Figure A20.**

**Table A47**. Extent of habitat for king blue grass within the project development area and associated areas of assessment

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 16552 | 0 |
| 3D Detailed Mapping Area** | 0 | 1344 | 7649 |
| 3D Detailed Mapping Area based on EHP mapping*** | 0 | 6976 | 0 |
| Survey area 2 | 0 | 0 | 0 |
| Survey area 7 | 0 | 0 | 21 |
| Survey area 8 | 0 | 0 | 329 |
| Survey area 9 | 0 | 90 | 70 |
| Survey area F | 0 | 0 | 4 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** The species grassland habitat has been heavily fragmented by clearing for agriculture and replacing native grasses within exotic pasture species. Remaining habitat in the darling Downs, which is currently only known from roadside and adjacent stock routes, is threatened by degradation from exotic pasture grasses, invasive weeds, inappropriate grazing regimes and mechanical disturbance.

**Potential project-related impacts:** Impacts associated with the proposed development activities could include:

- Direct loss of individuals during habitat clearing from mechanical removal.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (Unmitigated):** The sensitivity of king blue grass is considered to be ***High.*** This ranking is based on king blue grass being a perennial species, likely to be capable of some vegetative regrowth via coppicing, and probably some seed germination. It is

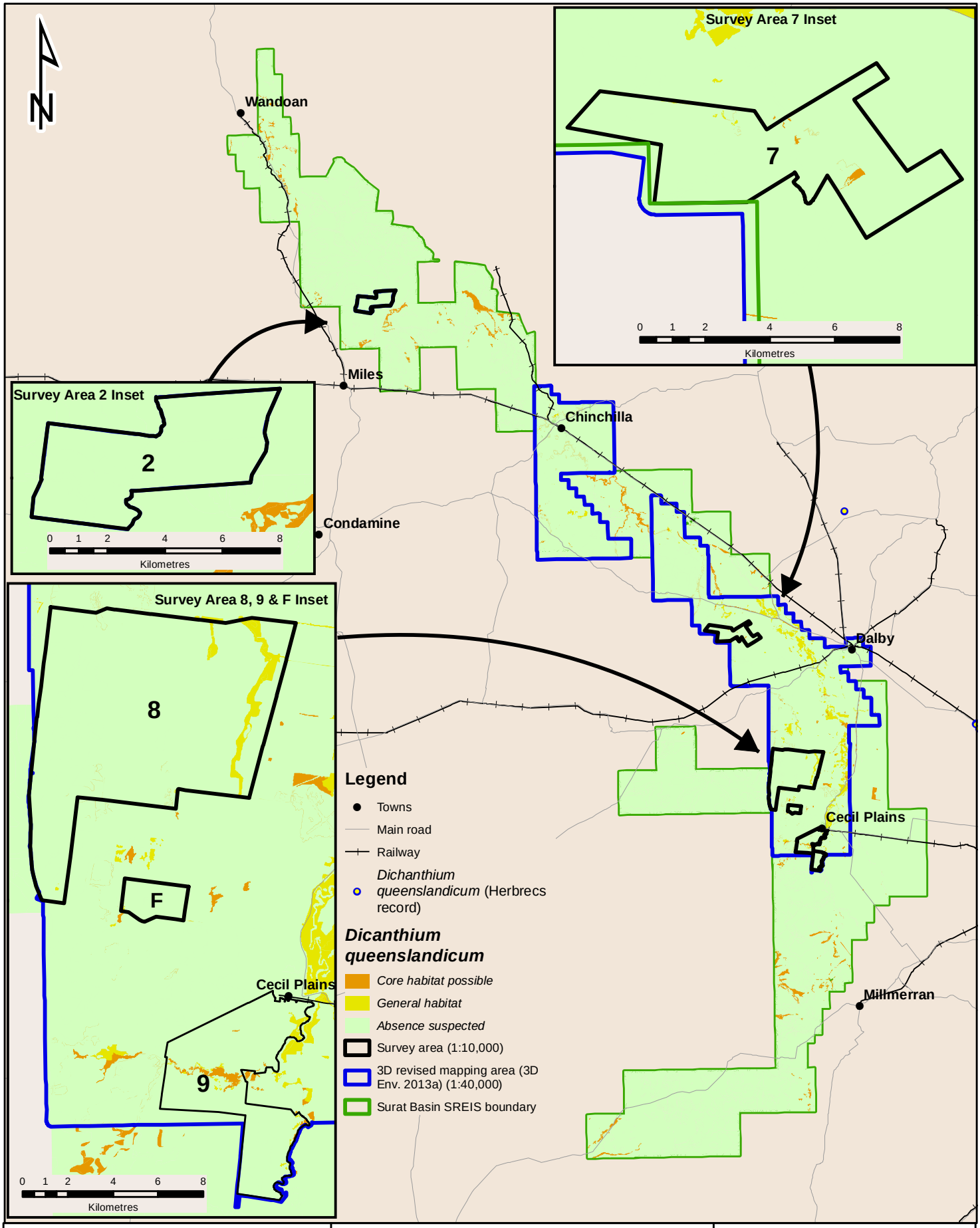
particularly sensitive to replacement by exotic pasture grasses and weeds that occur in the area. It is also sensitive to heavy grazing pressure. However, it is known to be tolerant of disturbed habitats, specifically roadsides. The species is not known from the project development area however potential habitat occurs within remnant grasslands on alluvium (RE11.3.21) and derived grasslands. Further survey is required to determine the extent of populations in tracts of remnant and non-remnant vegetation on alluvial soils of land zone 3. Based on this information, the magnitude of unmitigated impacts to populations within the project area is considered ***Low***.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented in Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort. Infrastructure design and site selection that seeks to avoid core habitat known of king blue grass will be prioritised.

**Summary residual impact assessment:** The possibility of this species occurring is low, however areas mapped as potential habitat warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding possible habitat in stock routes and road reserves supporting grasslands and grassy woodlands on alluvium is preferable and will completely mitigate against impacts with no impact incurred. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree although the suitability of the species for translocation or re-seeding requires further investigation. The significance of impacts after alternative mitigation measures remains ***Moderate (12).*** Grassland and grassy woodland habitats support a number of other EVNT flora species and are particularly vulnerable to mechanical disturbance. Implementation of mitigation measures such as rehabilitation of disturbance areas using seeding of native grasses of local provenance, and management of exotic grass and herb invasion, should reduce the potential impacts on this species.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Mod (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A20.** King blue grass *(Dicanthium queenslandicum)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for habitat mapping:**

Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" ('high' confidence is applied) where it intersects remnant habitats.

The following regional ecosystems in the project development area should be classed as "core habitat possible":

- RE11.3.21, 11.3.2 and 11.3.3 ('high' confidence applied to property scale vegetation mapping; 'moderate' confidence applied to revised RE mapping at 1:40 000 scale and low confidence applied to RE mapping produced at 1:100 000 (EHP 2012a)).

The following habitats should be classified as "general habitat"

- Non-remnant derived grasslands on land zone 3 ('high' to 'moderate' confidence applies).
- Regrowth vegetation derived from REs classified as "core habitat possible" including those from mature regrowth (EHP 2012b)

All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A48.** Evaluation of impact significance for king blue grass under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, king blue grass does not occur in the project development area and is restricted to non-remnant habitats within 20 km from the margins of the project development area boundary. The Darling Downs represents the southern limit of the species range and any population that occurs or is found within the project development area would be considered an important population. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species and important sources of seed dispersal. Therefore, all populations should be considered important and requiring preservation.<br><br>Core habitat for the species occurs in survey area 7 with general habitat for the species is indicated in survey area 7, 8, 9 and F. Field survey did not confirm the presence of this species. Other properties are not considered to contain suitable habitat for the species. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 7, 8, 9 and F:** SREIS field survey within these properties did not locate the species. It is considered unlikely that an important population of king blue grass exists within these properties and hence no decrease in the size of an important population is likely.<br><br>There is no suitable habitat within survey area 2.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 3: fragment an existing important population | **Survey area 2, 7, 8, 9 and F:** Development will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 7, 8, 9 and F::** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. Suitable habitat for the species exists within survey area 8 and survey area 9 although it has fairly general habitat requirements and can withstand moderate levels of disturbance.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Suitable habitat is contained within properties survey area 8 and survey area 9 and pre-clearance survey will be required to discount the occurrence king blue grass on these properties.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |

| Criteria | Evaluation |
|---|---|
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur. |
| Criteria 8: introduce a disease | Diseases which impact blue grass habitats are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur |

**Conclusions:** For king blue grass (*Dicanthium queenslandicum)* no impact is expected from development activities provided preclearance surveys are undertaken. Methods employed must be suitable for detection of grasses and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** King blue grass is a perennial grass species that requires fertile material for positive identification. The most suitable periods for field identification are from November to May when the species has been collected in flower or with seed heads. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

**Finger panic grass (*Digitaria porrecta*)**

**Family:** Poaceae

**Status: EPBC Act:** Endangered; **NC Act:** Near Threatened; **BoT**: Not Listed

**Sensitivity:** High

**Recovery plan:** A draft recovery plan has been prepared by Halford (1995b).

**Overview of finger panic grass**

**Description** (based on Sharp and Simon 2002; Halford 1995a): A perennial grass to 80 cm tall, which can spread along rhizomes. The ligule (i.e. membrane at the base of the leaf against the stem) is a hairless membrane, 2 to 3 mm long. Leaves are flat, 6 to 15 cm long, 2.8 to 4 mm wide, with rough hairs along the margins. The inflorescence (i.e. seed head) is a wide, compound, panicle, similar in outline to a panicum grass seed head. The angle of the primary inflorescence branches is roughly horizontal (compared to the more vertical branching in some closely related digitarias). Each raceme arm is up to 27 cm long.

**Ecology:** Finger panic grass is a spreading perennial that can reproduce vegetatively (Halford 1995b). Older clumps are reported to die in the centre, with the outer edges of the clump becoming separate plants. Seeds drop to the ground when mature, but appear to have a six month to one year dormancy prior to germinating (Halford 1995b). This is similar to some other sub -tropical grasses, such as black spear grass, and delays germination until the wet season rains. The species produces fertile material from March to April (TSSC 2008f).

**Habitat:** Finger panic grass grows in grasslands, woodlands and open forests with a grassy understory, on black soil plains of the Darling Downs, and lighter textured soils to the west (Goodland 2000, Halford, 1995a; Fensham 1998). Fensham (1998) found it is most abundant in grassland, but is "relatively unspecific" in its habitat preference. It is not restricted to high quality native grasslands, but also grows along roadsides and can be found in highly disturbed sites (Goodland 2000). Finger panic grass been recorded inside the project development area, within roadside remnant grasslands on dark cracking clay plains (RE11.3.21); poplar box (*E. populnea*) open forest and woodland with grassy understorey, on dark cracking clay plain (RE11.3.2); and along disturbed railway reserves on dark cracking clay soils (EHP 2013). The primary habitats for this species in the project development area are RE11.3.2, RE 11.3.21 and non-remnant derived grasslands.

**Distribution:** Finger panic grass is known from four disjunct areas extending over 1000 km across NSW and Queensland. The Queensland distribution includes broad populations in the Nebo district; the Central Highlands between Springsure and Rolleston; and from Jandowae south to Warwick. In NSW, it is known from near Inverell, south to the Liverpool Plains near Coonabarabran and Werris Creek (TSSC 2008f).

**Likelihood of occurrence and extent of habitat in the project development area:** The species is known to occur in the project development area. Finger panic grass was not recorded during field survey, however there are eight Queensland Herbarium records from the eastern parts near Dalby, and a total of 28 records from within a 25 km buffer surrounding the project development area. Of these 28 collections, 89% are recorded from within non-remnant vegetation, based on Queensland Herbarium RE mapping (EHP 2012a). The non-remnant habitat of finger panic grass is often on roadsides and rail way reserves on heavy clay soils. It should be noted that only a single collection of this species has been made within the study area post 1995 with a 2010 collection made in the project development area buffer 27 km to the north of Dalby. It is not known as to whether populations of the species have declined dramatically post 1995.

The two remnant habitats that finger panic grass has been collected within the study area are; RE 11.3.2, poplar box (*Eucalyptus populnea*) woodland on alluvial plains; RE 11.3.21, Queensland blue grass (*Dichanthium sericeum*) and/or mitchell grass (*Astrebla* spp.) grassland on alluvial plains with cracking clay soils. The extent of habitat is provided in **Table A49** with spatial representation of habitats and prior records provided in **Figure A21**.

**Table A49.** Extent of habitat for finger panic grass within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 13100 | 16324 | 0 |
| 3D Detailed Mapping Area** | 591 | 1331 | 7104 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 259 | 7968 | 0 |
| Survey area 2 | 0 | 0 | 0 |
| Survey area 9 | 0 | 90 | 70 |
| Survey area 8 | 0 | 0 | 369 |
| Survey area 7 | 0 | 16 | 3 |
| Survey area F | 0 | 0 | 4 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** The grassland habitat for this species has been heavily fragmented by clearing for agriculture, and sowing of exotic pasture grasses that can replace finger panic grass. It is mainly restricted to stock routes and road reserves and threatened by degradation from mechanical disturbance, invasive weeds and inappropriate grazing regimes. Goodland (2000) notes that finger panic grass can withstand disturbance, although populations decline where introduced species (e.g., Rhodes grass) become dominant.

**Project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Competition from exotic species, such as coolatai grass (*Hyparrhenia hirta*), Guinea grass (*Megathrysus maximus*), feathertop (*Pennisetum villosum*), and Johnson grass (*Sorghum halepense*).
- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (Unmitigated):** Many of the known populations of finger panic grass in the region grow along roadsides and railway lines. Therefore it is able to survive in disturbed habitats. It is a perennial grass known to be capable of vegetative spread (Halford 1995b) and it probably also has some seed germination after disturbance. However, it is very likely to be particularly sensitive to being smothered by exotic grasses. Given its demonstrated ability to survive in disturbed habitats, but its sensitivity to exotic species, it is given a sensitivity ranking of ***High***.

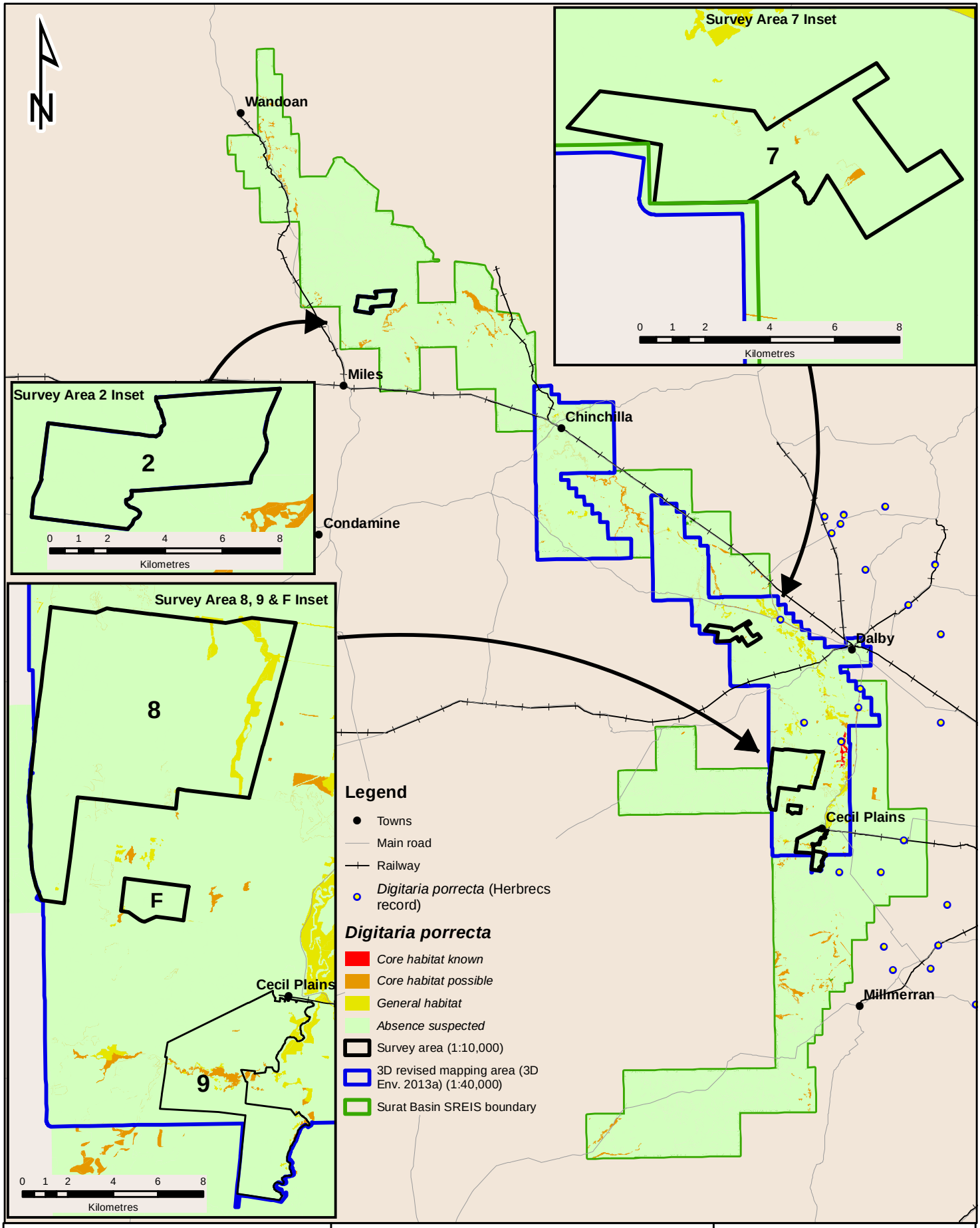
Eight of 28 known populations (29%) of finger panic grass within the study area have been collected within the project development area. That is, a high proportion of the local populations are known from within areas that may potentially be disturbed. Whilst the remnant ecosystems that finger panic grass has been collected within account for approximately 3 % of the project development area (based on mapping produced by DEHP 2012a), this grass is primarily known from roadsides and disturbed areas. Therefore potential habitat may be relatively extensive and difficult to predict, particularly within the Dalby district. Due to the relatively large number of prior records and potentially extensive nature of suitable habitat within the project development area, the potential impact magnitude is considered to be ***High.***

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of finger panic grass will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***High(21)*** significance to finger panic grass populations within the project development area**.** The avoidance of finger panic grass populations will significantly reduce potential impacts. Areas mapped as core and general habitat may warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding likely areas of core habitat (especially grassland and poplar box woodlands on alluvium, and areas known to have previous records of finger panic grass) will totally mitigate against impact.. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree, to the extent that minor loss in a local population may occur. The resulting impact significance would be ***Moderate*** **(12).**

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A21.** Finger panic grass *(Digitaria porrecta)* distribution in project development area.

**Client** Arrow

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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" ('high' confidence is applied) where it intersects remnant habitats.
2. RE polygons with confirmed records (<500 m precision) should be treated as "core habitat known" ('high' when applied to property specific mapping (3D Environmental 2013), 'moderate' when applied to 1: 40 000 scale mapping (3D Environmental 2013) and 'low' when applied to mapping produced by DEHP, 2012a and 2012b).
3. Derived grassland and mature regrowth (EHP 2012b) should also be treated as 'core habitat known' when applied as rules 1 and 2.
4. The following regional ecosystems should be classed as "core habitat possible":
   - RE11.3.2, RE11.3.21 and RE11.3.24 (confidence levels as applied in 2).
5. Non remnant derived grassland and regrowth woodland habitats derived from RE11.3.2 should otherwise be treated as "general habitat" (confidence levels as applied in 2).

All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A50.** Evaluation of impact significance for finger panic grass under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, finger panic grass is scattered throughout non-remnant and remnant habitats with most records in the project development area occurring between Dalby and Cecil Plains. Other major occurrences are found to the north of Dalby, outside the project development area. The sub-populations that occur in the Dalby area are part of a much broader population occurring within the Darling Downs region that extends from Warwick in the south, Toowoomba in the east and Dalby in the north.<br><br>Local populations in the Dalby area are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important and requiring preservation. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important sub-population of finger panic grass exists within these properties and hence no decrease in the size of an important population is likely.<br><br>Suitable habitat for finger panic grass is however present within survey area 7, survey area 8, survey area 9 and pre-clearance survey is required to discount the species from within the finalised project footprint. Provided preclearance surveys are undertaken and appropriate mitigations applied when necessary, no significant impact to populations is expected.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Suitable habitat for the species occurs within survey area 7, survey area 8 and survey area 9. Pre-clearance survey will be required within these habitats when project footprints are finalised. Based on current knowledge, project related development will not modify, destroy, remove or isolate or decrease habitat leading to the decline of the |

| Criteria | Evaluation |
|---|---|
| | species.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur. |
| Criteria 8: introduce a disease | Diseases which impact finger panic grass habitats are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur. |

**Conclusions:** For finger panic grass (*Digitaria porrecta)* no impact is expected from development activities provided preclearance surveys are undertaken, survey methods employed are suitable for the detection of grasses in areas where possible habitat is mapped (survey areas 7, 8, 9) and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** Finger panic grass is a perennial grass species that requires fertile material for positive identification. The most suitable periods for field identification is from March to April when the species is known to produce fertile material. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

**Belson's panic (*Homopholis belsonii*)**

**Family**: Poaceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Endangered **BoT:** Not Listed

**Sensitivity:** High

**Recovery plan:** A draft recovery plan has been prepared by Menkins (1998).

**Overview of Belson's panic**

**Description** (based on Sharp and Simon 2002; Harden 1993): A perennial grass which grows to 50 cm in height, with rhizomes that allow it creep horizontally to form mats across the ground. The base of the leaf partially clasps around the stem, and has a membranous ligule, 8 to 1.5 mm long. Leaves are flat, 3 to 15 cm long, 2 to 4.5 mm wide. The inflorescence (i.e. seed head) is a compound, open panicle, similar in shape to a panicum grass seed head. The seed head branches are stiff and up to 15 cm long.

**Plate 23.** Belson's panic (*Homopholis belsonii)*. Copyright © Boobook

**Ecology**: Belson's panic tends to grow in shade under trees, but can grow in cleared regrowth. As a rhizomatous perennial grass, it probably is capable of living for many years, and to have some tolerance to fire and at least low levels of grazing. It is reported to spread out very rapidly (Menkins 1998). Flowers have been recorded between February and May (Sharp and Simon 2002).

**Habitat:** Belson's panic prefers moderate to highly fertile soils, especially those derived from basalt and fertile alluvial flats. It is generally associated with poplar box and brigalow woodlands on light red/brown earths (Fensham and Fairfax 1997, Goodland 2000). It has been collected from the following remnant ecosystems (EHP 2013):

- RE11.3.1; *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.
- RE11.3.17; *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.
- RE11.3.2/11.5.1: *Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.
- RE11.3.25/11.3.19/11.3.2: *Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines / *Callitris glaucophylla*, Corymbia spp. and/or *Eucalyptus melanophloia* woodland on Cainozoic alluvial plains / *Eucalyptus populnea* woodland on alluvial plains.
- RE11.9.5: *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.
- RE 11.9.5/11.9.10: *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks / *Acacia harpophylla, Eucalyptus populnea* open forest on fine-grained sedimentary rocks.

Belson's panic is also capable of growing within disturbed habitats. Of the 22 collections within the study area, 15 (68%) are located in non-remnant areas such as roadside easements. It has been seen growing among fallen timber at the base of trees or shrubs, among branches and the bottom of netting fences (Trémont & Whalley 1993 in TSSC 2008g).

**Distribution:** In Queensland, major populations occur on the Darling Downs near Oakey, Jondaryan, Bowenville, Dalby, Acland, Sabine, Quinalow, Goombungee, Gurulmundi and Millmerran, and further west between Miles and Roma (Goodland 2000, EHP 2013). Also known from the north-western slopes and plains of NSW (TSSC 2008g).

**Likelihood of occurrence and extent of habitat in the project development area:** Known from within the project development area from one historical record from Dogwood Creek north of Miles. It was not recorded during field surveys. A further 20 collections have been made of Belson's panic within the study area. A record on the Inglewood road reserve south of Millmerran in brigalow regrowth suggests the high likelihood that it will be present within similar remnant and non-remnant roadside brigalow-belah habitats in the project development area. The extent of habitat within various portions of the project development area is provided in **Table A51** with spatial representation provided in **Figure A22**.

**Table A51.** Extent of habitat for Belson's panic within the project development area and associated areas of assessment.

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 9783 | 112633 |
| 3D Detailed Mapping Area** | 0 | 1723 | 12370 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 2554 | 22489 |
| Survey area 2 | 0 | 0 | 966 |
| Survey area 9 | 0 | 1 | 38 |
| Survey area 8 | 0 | 2 | 817 |
| Survey area 7 | 0 | 20 | 470 |
| Survey area F | 0 | 1 | 42 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General threats to the species:** Loss of habitat from vegetation clearing, pasture improvement, and overgrazing is a major threatening process (TSSC 2008g). Belson's panic declines in abundance with grazing pressure and appears to grow best under tree or shrub cover. Roadside populations are threatened by invasion of pasture grasses such as green panic (*Megathyrsus maximus* var. *trichoglume*), and road works (Goodland 2000), however it is known to re-colonise disturbed areas if tree cover is available (Menkins 1998 in TSSC 2008g).

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Competition from exotic species such as coolatai grass (*Hyparrhenia hirta*), Guinea grass (*Megathrysus maximus*),feathertop (*Pennisetum villosum*), and Johnson grass (*Sorghum halepense*).

- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (unmitigated):** Many of the known populations of Belson's panic in the region grow along roadsides, so it is able to survive in disturbed habitats. It is a perennial grass known to be capable of vegetative spread in mats. It may also have some seed germination capacity after disturbance. However, it is very likely to be particularly sensitive to being smothered by exotic grasses. Given its demonstrated ability to survive in disturbed habitats, but its sensitivity to exotic species, it is given a sensitivity ranking of ***High***. One of the 22 known local populations, 9% of these have been collected from within the project development area. The remnant REs that Belson's panic has been collected within account for approximately 12 % of the project development area. The potential area of occupancy is however much larger than this because it is also known from roadsides and disturbed areas. Therefore many of potential habitats are not accounted for in project vegetation mapping (both EHP 2012a and more specific mapping undertaken for this exercise). Due to an inability to accurately account for potential habitat without broad scale and intensive survey, the potential magnitude of impact is considered to be ***High***.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort. Infrastructure design and site selection that seeks to avoid core habitat known of Belson's panic will be prioritised.

**Summary residual impact assessment:**

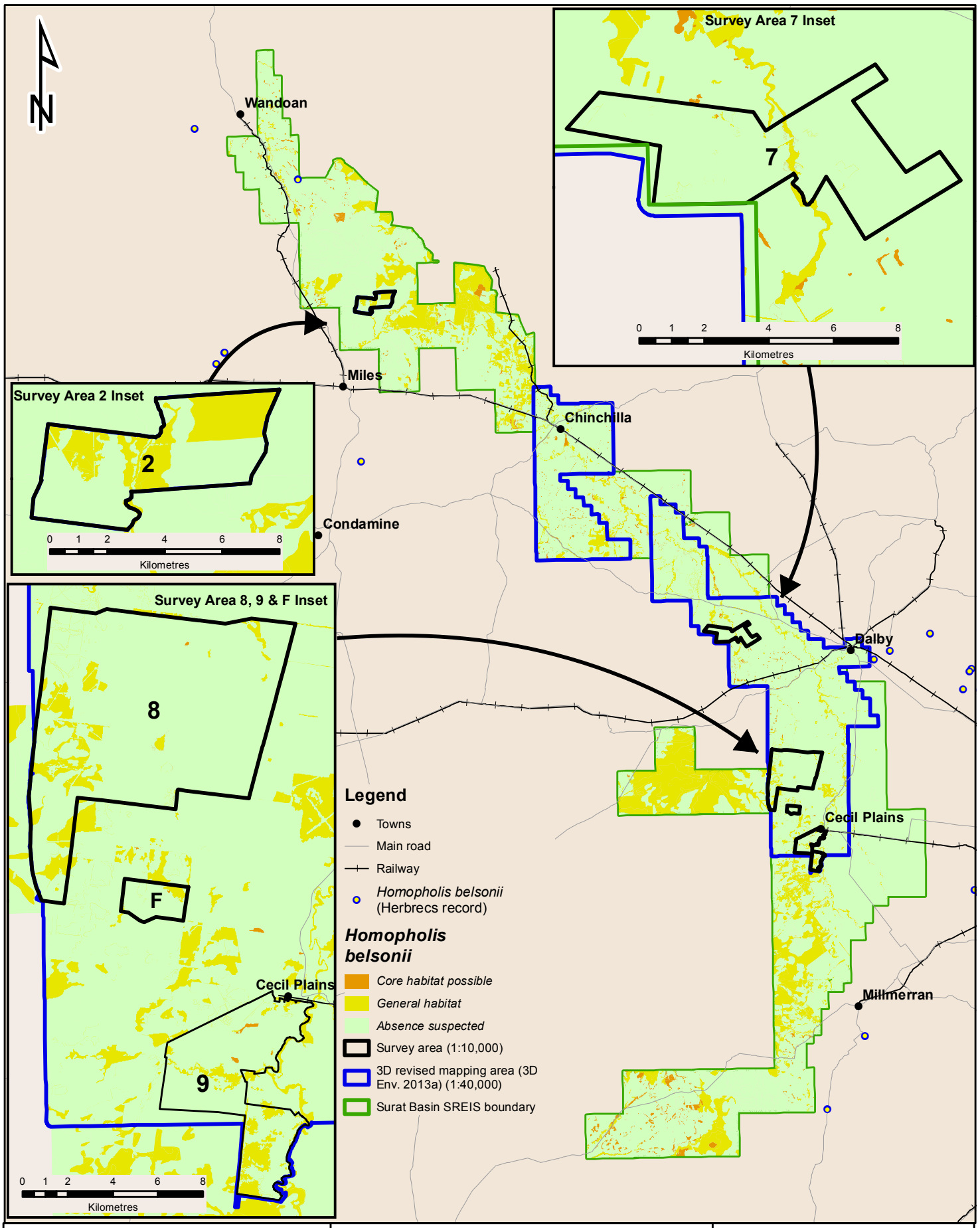
Unmitigated project related activities may result in impacts of ***High*** **(21)** significance to potential Belson's panic populations within the project development area**.** The avoidance of Belson's panic populations will significantly reduce the potential for impact.

Areas mapped as core habitat (both known and possible), may warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding likely areas of core habitat (especially poplar box and brigalow woodland on alluvium, and areas known to have prior collections of Belson's panic) is the prefered option and will totally mitigate against impact. Adjacent habitat may remain vulnerable to edge effects (invasion of exotic pasture grasses) if canopies are disturbed.

Where avoidance of Belson's panic habitat is not possible, the identified impact management measures should be mostly effective and may mitigate against an impact to a large degree, to the extent that minor loss in a local population may occur. This is based on the knowledge that Belson's panic currently grows in disturbed locations and therefore is likely to be successfully rehabilitated. The resulting impact significance would be ***Moderate (12)*****.**

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A22.** Belson's panic *(Homopholis belsonii)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" ('high'confidence is applied) where it intersects remnant habitats.
2. RE polygons and derived regrowth vegetation (including mature regrowth as per EHP 2012b) with confirmed records (<500 m precision) should be treated as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by DEHP 2012a).
3. The following regional ecosystems and derived regrowth should be classed as "core habitat possible":
   - RE11.3.1, RE11.3.17, RE11.9.5, RE11.4.3, RE11.4.10 and RE11.9.10 (confidence levels as per 2).

   The following habitats should be considered "general habitat" (confidence levels as per 2).
   - RE11.3.2, RE11.3.25, RE11.5.1 and non-remnant derived grasslands on land zone 3.
   - Regrowth derived from REs listed as potential habitat. General habitat should be removed where ground inspection demonstrates habitat to be unsuitable.
4. All other remnant and non-remnant vegetation in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A52.** Evaluation of impact significance for Belson's panic grass under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, Belson's panic is scattered throughout non-remnant and remnant habitats in the study area with only a single record occurring in the project development area. The majority of populations occur to the east of the project development area, forming a component of a much broader regional population that is centred on the area between Dalby and Toowoomba.<br><br>Populations in the Dalby area are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important and |

| Criteria | Evaluation |
|---|---|
| | requiring preservation. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 9:** Survey area 9 contains minor remnants of brigalow and RE11.3.17 which are potential habitat for the species. Despite intensive survey in these habitats, Belson's panic was not recorded. No long term decrease in the size of an important population is expected to occur during development at this site. Pre-clearance survey is required prior to disturbance to identify any populations that have not been accounted for.<br><br>**Survey area 8, 7, 2 and F:** Intensive field survey within these properties did not locate the species and habitat contained within is considered sub-optimal. It is considered unlikely that an important sub-population of finger panic grass exists within these properties and hence no decrease in the size of an important population is likely.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 9, 8, 7, 2 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 3: fragment an existing important population | **Survey area 9, 8, 7, 2 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 9, 8, 7, 2 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 9, 8, 7, 2 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |

| Criteria | Evaluation |
|---|---|
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 9, 8, 7, 2 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Pre-clearance surveys within survey area 9 are required to discount occurrence from survey area 9 if potential habitats are to be disturbed.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 7: result in the establishment of an invasive species | **Survey area 9, 8, 7, 2 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 8: introduce a disease | Diseases which impact Belson's panic habitats are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. |

**Conclusions:** For Belson's panic (*Homopholis belsonii)* no impact is expected from development activities provided preclearance surveys are undertaken in potential habitat (survey areas 7, 8, 9 and F), survey method is suitable for the detection of grasses, and where a potential habitat is identified, appropriate mitigation is applied. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** Belson's panic grass is a perennial grass species whose positive identification is aided by collection of fertile material. The most suitable periods for field identification is from February to May when fertile material material has been previously recorded Intensive meander searches will be required to ensure that the species is adequately searched for. Quadrat searches are likely to be less effective as ground cover in suitable habitat is typically sparse.

## Herbs (including ground orchids)

### *Microcarpaea agonis*

**Family:** Scrophulariaceae

**Status: EPBC Act:** Endangered; **NC Act:** Endangered; **BoT:** Not Listed

**Sensitivity:** Extremely High

**Recovery plan:** A species recovery plan has not been prepared for this species.

**Overview of Microcarpaea agonis**

**Description** (based on Bean 1997; TSSC 2008i): *Microcarpaea agonis* is a small herb, which grows to 5 cm tall, spreading to 10 cm wide. Stems are hairless but angular. Leaves are simple, opposite each other along the branchlets, linear and up to 9 mm long and 0.5 mm wide. The flowers occur singularly in the axils of leaves. They are tubular, white, with the tube approximately 3 mm long, and 2-lipped at the apex. *Microcarpaea agonis* is distinguished from the closely related *M. minima* by having longer linear leaves and an unribbed green calyx.

**Ecology:** Very little is known about the ecology of this very restricted and recently described species, other than that it is an annual herb of wetlands.

**Habitat:** Occurs on the margins of a seasonally inundated swamp dominated by sedges (*Eleocharis* spp *and Cyperus* spp) on sandy soil (EHP 2013, Bean 1997). The wetland habitat is consistent with RE11.3.27.

**Distribution:** A Queensland and bioregional endemic known only from a small population in the Boondandilla State Forest, approximately 55 km west of Millmerran, southeast Queensland (Bean 1997). This locality is approximately eight km northwest of its closest point on the boundary of the project development area.

**Likelihood of occurrence in project development area:** The species possibly occurs in the project development area although has not been previously recorded. The species has not been found in areas that have been comprehensively surveyed, including Lake Broadwater and the Chinchilla district (see Bean 1997). The only known locality of this species is from a small seasonal wetland dominated by sedges, which is probably a small example of RE11.3.27. However the wetland is too small to have been delineated in current RE mapping (EHP 2012a). The known collection site is located on the boundary of two mapped woodlands being; RE11.3.18 (*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium) and RE11.5.1 (*Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces). As a precautionary measure, any small ephemeral wetlands in the Yarril and Wyaga Creek catchments within the project development area within 50 km of the known population should be considered potential habitat. Wetlands of this nature are not represented in

DEHP mapping and hence the distribution of potential habitat (core habitat possible) is difficult to predict. The extent of habitat within various portions of the project development area is provided in **Table A53** with spatial representation provided in **Figure A23**.

**Table A53.** Extent of habitat for *Microcarpaea agonis* within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 0 | 2225.7 |
| 3D Detailed Mapping Area** | 0 | 0 | 0 |
| 3D Detailed Mapping Area based on EHP (2012a)*** | 0 | 0 | 0 |
| Survey area 2, 7, 8, 9 and F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** Threats to the single population of 10 individuals are draining of the wetland, smothering by aggressive exotic wetland plants, grazing, road works and trampling by cattle (Bean 1997).

**Project-related impacts:** Impacts associated with development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks, including damage that affects wetland hydrology.
- Altered and inappropriate fire regimes in this seasonally dry wetland.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Damage to the wetland habitat caused by accidental release of saline water from well heads.

**Significance of project related impacts (unmitigated):** Based on known threats, the sensitivity of the habitat, and extremely limited knowledge in regard to the species ecology, the species is considered to have an ***Extremely High*** sensitivity. That the only know population occurs just outside the project development area, any impact to an identified extant population would be of ***Major*** magnitude. Unmitigated impact significance and any impacts would be of ***Major* (25)** significance.

**Species specific management / mitigation measures:** The following commitments are recommended, in addition to commitments outlined in Attachment 4, Commitments Update of the SREIS, specific to the management of *Microcarpaea agonis* populations that may be identified within the project development area during field surveys:

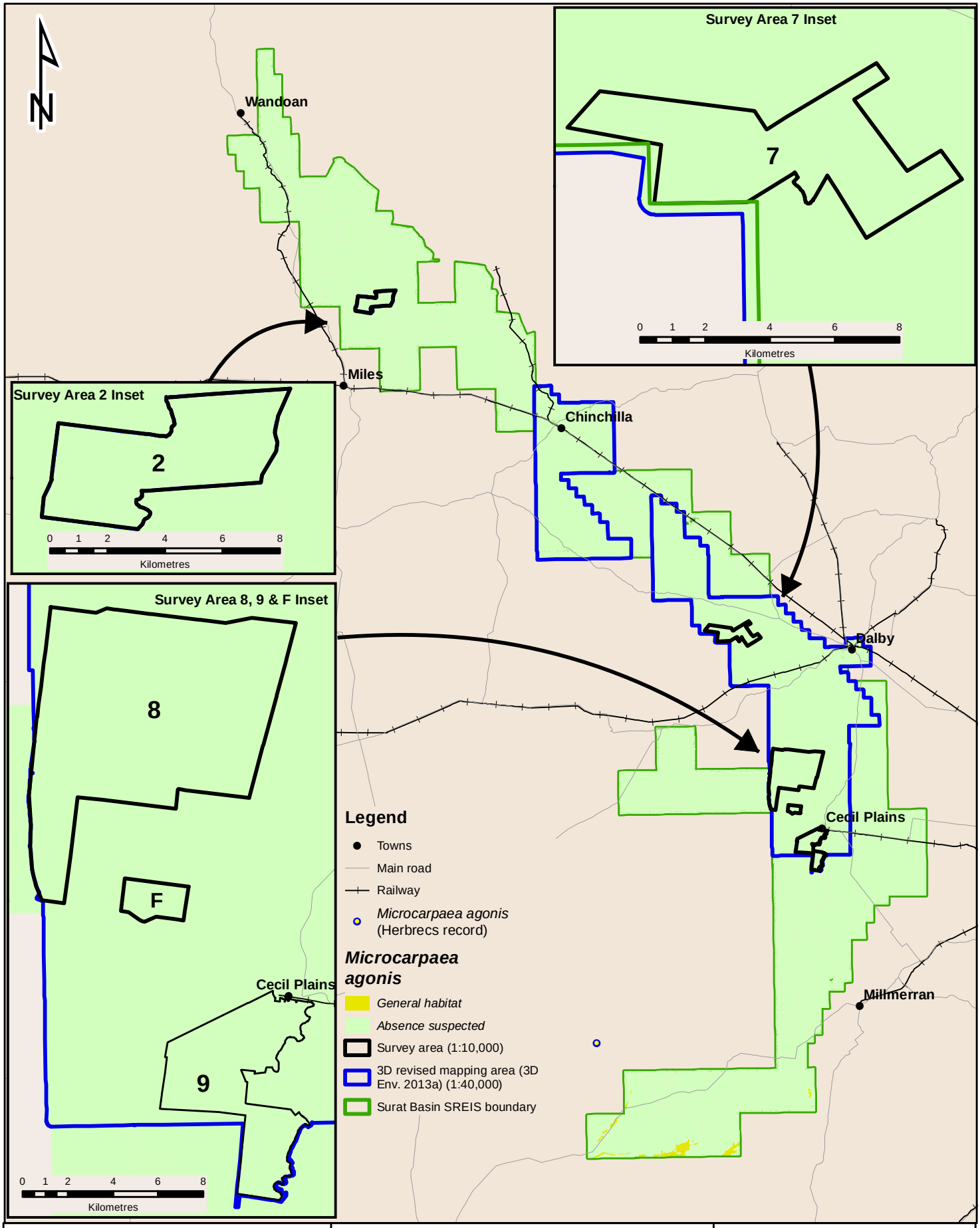
- Develop a site-specific management plan to reduce changes to wetland habitat hydrology, including water quality, in areas of ground-truthed populations of *Microcarpaea agonis* adjacent to work sites. [C558]
- Demarcate in order to restrict access to any ground truthed populations of *Microcarpaea agonis* identified adjacent to work sites. [C559]

Infrastructure design and site selection that seeks to avoid core habitat known of *Microcarpaea agonis* will be prioritised.

**Summary residual impact assessment:** In the absence of mitigation, impacts of ***Major Significance* (25)** will potentially occur. Avoidance of possible habitat and populations is the most effective mitigation measure and will completely avoid any residual impact**.** Where avoidance is not possible, further survey of possible habitat in areas designated for disturbance will clearly identify populations and allow opportunity for minimisation of disturbance. Due to limited information on species ecology including resilience, any disturbance would be considered to have a residual impact that is ***Major (23)***.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | High | Major (23) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

**Figure A23.** *(Microcarpaea agonis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

- Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as "core habitat known" ('high' confidence is applied) where they intersect remnant vegetation regardless of the RE. .
- The following regional ecosystems in the Yarril and Wyaga Creek catchments ( within 50 km of known populations) should be classed as "core habitat possible":
    - 11.3.27 ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by DEHP, 2012a). It should be noted many of these habitat are beyond resolution of existing mapping databases and are not represented in DEHP databases in the region. Hence 'core habitat possible' for the species is not shown.

3. The following regional ecosystems in the Yarril and Wyaga Creek catchments should be classed as "general habitat" (confidence levels as in 2 apply):
    - 11.3.25 (with associated ephemeral swamps)
    - 11.3.4 (with associated ephemeral swamps)
    - 11.3.18 (with associated ephemeral swamps)
4. All other remnant vegetation and non-remnant cleared land in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A54.** Evaluation of impact significance for *Microcarpaea agonis* under MNES guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Due to the high degree of endemicity of the species, known from only one location, all populations should be considered 'important populations'.<br><br>No property considered for development contains habitat for *Microcarpaea agonis*. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9 and F:** It is not considered that these properties host potential habitat for *Microcarpaea agonis*.<br><br>An 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. |

| Criteria | Evaluation |
|---|---|
| | In accordance with **Criteria 1**, a significant impact is not expected to occur. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur. |
| Criteria 3: fragment an existing important population | **Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur |
| Criteria 5: disrupt the breeding cycle of an important population | **P Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur |
| Criteria 8: introduce a disease | There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur |
| Criteria 9: interfere with the recovery of the species | **Survey area 2, 7, 8, 9 and F:** Will not interfere with |

| Criteria | Evaluation |
|---|---|
| | the recovery of a species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur |

**Conclusions:** For *Microcarpaea agonis* no impact is expected from development activities provided preclearance surveys are undertaken and avoidance is applied as a mitigation to any populations identified. Impact is considered known and predictable (no impact) in survey areas and more broadly in the project development area when specific mitigation is applied (see above). It is unknown if impacts incurred to the species are reversible as translocation and rehabilitation have not been tested. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** *Microcarpaea agonis* is a perennial herb that has habitat requirements specific to ephemeral wetlands. Surveys may not adequately account for the species during periods of high water levels or seasonal drought when the habitat dries. Hence, survey should undertaken during these periods should not provide justification for suspected absence of the species.

**Hawkweed (*Picris evae*)**

**Family**: Asteraceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Vulnerable; **BoT:** High

**Sensitivity:** Moderate

**Recovery plan:** A national species recovery plan has not been developed for Hawkweed. NSW government has developed a Priority Action Statement for the species (DECC, 2005c).

**Overview of hawkweed**

**Description** (based on Stanley and Ross 1983): Hawkweed is an annual herb, which grows up to 1.7 m tall. The stems can be reddish and are longitudinally ribbed with stiff hairs. The leaves lack a stalk (i.e., are sessile). Lower basal leaves are up to 30 cm long and 3 cm wide, often with a toothed or lobed margin. Leaves on the stem and apex of the plant are much smaller than basal leaves. Flowers are daisy-type, yellow and 8–10 mm wide. Seeds are "achnes" 5 to 8 mm long, with feathery apexes up to 8 mm long.

**Ecology:** As an annual daisy, hawkweed is likely to germinate to some extent in disturbed areas. Seeds are wind dispersed, which allows colonization across the landscape. The abundance of Hawkweed is thought to be reduced by moderate and heavy grazing (Fensham 1998). It is unclear whether this is due to being consumed by cattle, or damaged by trampling. The response of the species to fire and requirements for burning are unknown.

**Habitat:** All of the three collections contained within the study area occur in non-remnant vegetation, particularly roadsides. In regards to remnant vegetation, hawkweed may also occur in eucalypt woodland (e.g., *Eucalyptus melliodora*) with a grassy understorey composed of *Dichanthium* spp. (TSSC 2008k), in grassland of *Dichanthium sericeum* adjacent to cultivated paddocks on black clay soil (EHP 2013), and in grasslands to woodlands on ridges (Goodland 2000). Regional ecosystems likely to provide habitat for hawkweed in the project development area include:

- RE11.3.2: *Eucalyptus populnea* woodland on alluvial plain.
- RE11.3.21: *Dichanthium sericeum* and/or Astrebla spp. grassland on alluvial plains on cracking clay soils.

Non-remnant derived grassland also provides potential habitat for the species.

**Distribution:** Hawkweed occurs from the Darling Downs and Moreton pastoral districts in south-east Queensland (Bostock & Holland 2010), to north of the Inverell area on the NSW northern tablelands (DECC 2005c). In the Darling Downs, it has a restricted distribution but may be locally abundant along roadsides (Goodland 2000). The nearest vouchered record is on a roadside south of Dalby, approximately 10 km east of the project development area.

**Likelihood of occurrence and extent of habitat in the project development area:** The species is considered likely to occur. Herbrecs (EHP 2013) records it on the eastern margin of the project development area on the Millmerran-Pittsworth Road within remnant bluegrass habitats (RE11.3.21). Similar habitat occurs in the project development area which suggests that the species is likely to occur, particularly in the Dalby area. It may also occur along disturbed roadsides and on the margins of cultivated areas and grazed paddocks. Occurrences on non-alluvial habitats are difficult to predict. The extent of habitat within the project development area is indicated in **Table A55** with spatial representation provided in **Figure A24**.

**Table A55.** Extent of habitat for hawkweed within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 13750 | 0 |
| 3D Detailed Mapping Area** | 0 | 1344 | 6415 |
| 3D Detailed Mapping Area based on EHP *** | 0 | 5356 | 0 |
| Survey area 2 | 0 | 0 | 0 |
| Survey area 9 | 0 | 90 | 36 |
| Survey area 8 | 0 | 0 | 266 |
| Survey area 7 | 0 | 0 | 0 |
| Survey area F | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** Hawkweed is often found growing mixed with roadside species. It therefore tolerates some light disturbance, but may be impacted by road works. As mentioned above, hawkweed is thought to be reduced by moderate and heavy grazing (Fensham 1998). In New South Wales, it is considered to be threatened by weed invasion, inappropriate fire regimes, habitat fragmentation and clearing of vegetation for cropping and grazing (DECC 2005c).

**Potential project-related impacts:** Impacts associated with proposed development could include:

- Direct loss of individuals during clearing of habitat.

- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

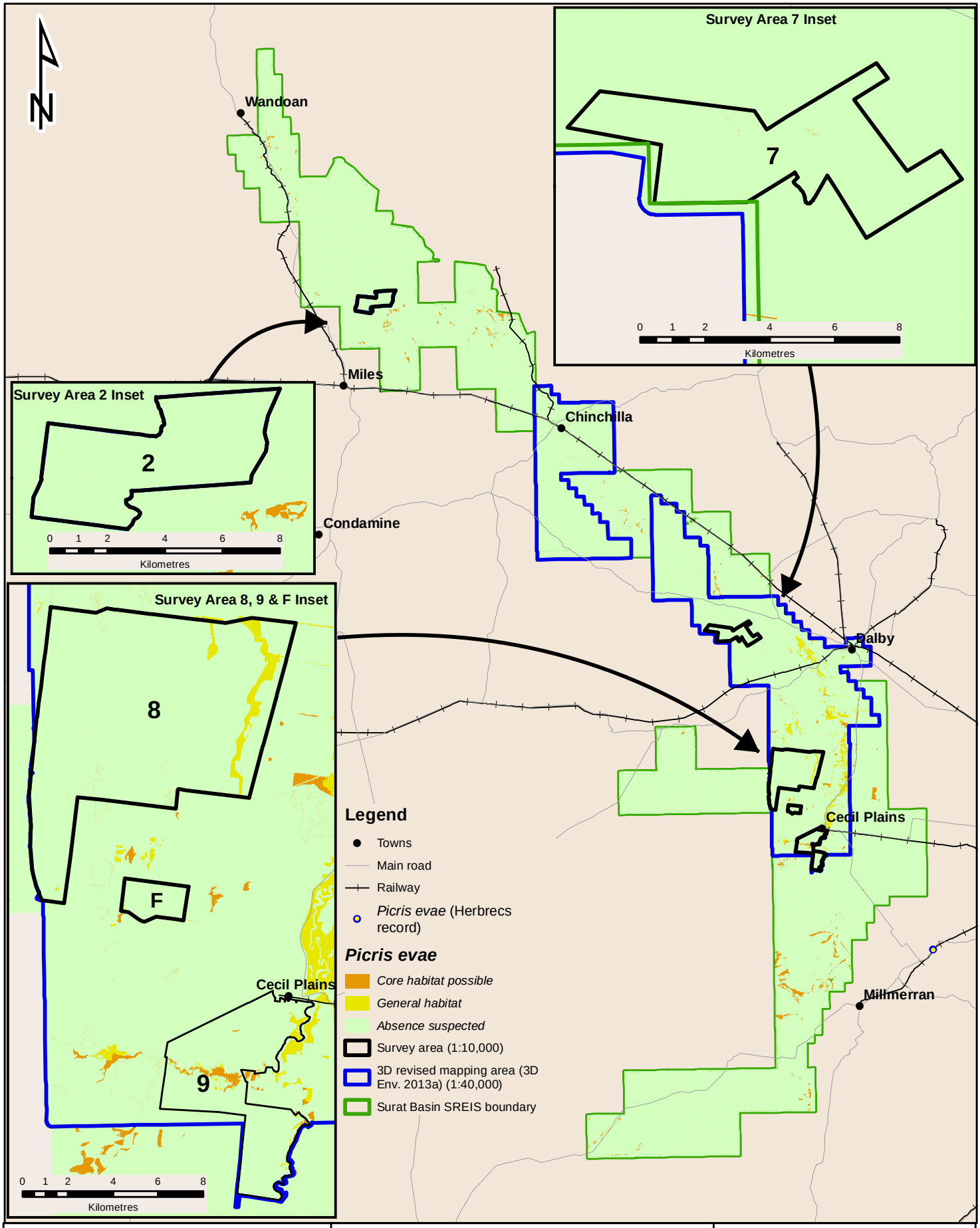
**Significance of project related impacts (unmitigated):** Hawkweed is considered to have a ***Moderate*** sensitivity. This is because it is an annual species, capable of regular germination and capable of surviving adjacent to disturbed road sides. It has wind dispersed seed which assist the colonisation of adjacent areas. Hawkweed has not been recorded in the project development area but is known from about 10 km away to the southeast. As its habitat is often within stock routes and road reserves, it is at risk of mechanical disturbance associated with linear infrastructure such as pipelines and to follow on effects, such as invasion of introduced grasses and herbs. Therefore the potential magnitude of impact for disturbances within the project development area is considered to be ***Moderate***. The potential significance of unmitigated impacts is considered ***Moderate*** **(13).**

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort.

**Summary residual impact assessment:** In the absence of mitigation, impacts of ***Moderate*** **(13)** significance will potentially occur. If infrastructure disturbance avoids hawkweed habitat, no residual impact will be incurred**.** Where avoidance is not possible, application of generic mitigation measures will result in impacts of low magnitude and the resultant residual impact will be ***Low*** **(8).**

| . **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Low | Low (8) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A24.** Hawkweed *(Picris evae)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

1. As a precautionary measure the following regional ecosystems within the project development area should be classed as "core habitat possible":
   - RE11.3.2, RE11.3.21 ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a). The mature regrowth dataset (EHP 2012b) is to be included within calculations.
2. The following should be classed as 'general habitat':
3. Non-remnant derived grasslands on land zone 3 ('High' level of confidence applied).
   - Regrowth vegetation derived from relevant regional ecosystems (confidence as in 2 apply).
4. All other remnant vegetation in the project development area and cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A56.** Evaluation of impact significance for hawkweed under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, hawkweed does not occur in the project development area. with the nearest record 10 km east of the boundary and 40 km south east of Dalby. Any record occurring within the project development area would represent the northern limits of the species range and hence be considered an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species and be a useful source of seed for both natural dispersal and propagation. Therefore, all populations should be considered important and requiring preservation.<br><br>Potential habitat (core habitat possible) for the species is indicated in survey area 9 with 'general habitat' indicated in survey area 8 although field survey did not confirm the presence of this species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of hawkweed exists within these properties and hence no decrease in the size of an important population is likely. Pre-clearance survey is required within possible habitats for full clearance when final development footprints are developed. |

| Criteria | Evaluation |
|---|---|
| | **Survey areas 2, 7 and F:** Habitats within these properties is not considered suitable for hawkweed.<br><br>Based on this information, no long-term decrease in the size of an important population is likely to result from development activities. In accordance with **Criteria 1**, a significant impact is not expected to occur |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Development will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur |
| Criteria 8: introduce a disease | Diseases which impact hawkweed or the family Asteraceae are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur |

| Criteria | Evaluation |
|---|---|
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur |

**Conclusions:** For hawkweed (*Picris evae)* no impact is expected from development activities provided preclearance surveys utilising suitable methods of assessment and appropriate mitigation is applied to any populations identified. Potential habitat is most widespread on survey areas 8 and 9. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species. Potential impacts to the species are not considered significant when assessed under MNES significant impact guidelines.

**Rule(s) for survey effort required in accordance with survey guidelines:** Hawkweed is a perennial species where identification would be assisted by the availability of fertile material for positive identification. The most suitable periods for field identification are likely to be from September through to May, although specific periods of fertility have not been documented. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately accounted for. Background information on quadrat sampling techniques are provided in Neldner et al (2012).

**Cobar greenhood orchid (*Pterostylis cobarensis*)**

**Family:** Orchidaceae

**Status: EPBC:** Vulnerable; **NC Act:** Not Listed; **BoT:** Not Listed

**Sensitivity:** High

**Recovery plan:** A national species recovery plan has not been developed for Cobar greenhood orchid. EHP (2012b) identifies 11 priority actions to assist species recovery.

**Overview of Cobar greenhood orchid**

**Description** (Based on Harden 1993; Jones 1993; TSSC 2008l): A ground orchid with approximately 7 to 12 basal rosette leaves. The leaves are narrow, broadest in the middle, up to 2.5 cm long and 8 mm wide. Flowers are fairly transparent with brown and green markings and approximately 12 mm long. The stalk flower is 40 cm tall, with several stem-sheathing leaves along its length.

**Ecology:** Flowering of Cobar greenhood orchid has been recorded in September to November, with seeds maturing after that. They are pollinated by the males of small gnats which are attracted to the scent of the flower (DEH 2012b). Cobar greenhood orchids die back annually to below ground tubers following seed maturity (TSSC 2008l). New rosettes of leaves are produced following soaking autumn and winter rains. Vegetative spread is not common in this group of orchids, but it is possible that a daughter tuber may be vegetatively produced sometimes (TSSC 2008l).

**Habitat:** Records from the Barakula and Chinchilla districts occur in woodland of cypress pine (EHP 2013). In NSW, it is known from eucalypt woodland, open mallee, or cypress shrubland on low stony ridges and slopes, among rocks on low hills, and on slopes above streams (DEH 2012b, Jones 1993). Cobar greenhood orchids usually grow in very localised populations with potential habitat contained within:

- RE11.3.2; *Eucalyptus populnea* woodland on alluvial plains, sometimes with *Callitris glaucophylla*
- RE11.5.1; *Eucalyptus crebra, Callitris glaucophylla*, A*ngophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces
- RE11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri, Eucalyptus chloroclada, Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces, with deep sands
- RE11.5.5; E*ucalyptus melanophloia, Callitris glaucophylla* woodland on Cainozoic sand plains/remnant surfaces, on deep red sands
- RE11.5.21; *Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces

The species has not been recorded in regrowth or non-remnant vegetation although may be able to withstand some soil disturbance.

**Distribution:** Queensland populations of Cobar greenhood orchid are known from four records in the Darling Downs district and a single collection from the Maranoa (Bostock and Holland 2010). These represent the northern limit of the species distribution. It also occurs in the far western of plains of NSW within the Nyngan–Cobar–Bourke district (TSSC 2008l).

**Likelihood of occurrence and extent of habitat in the project development area:** The species has been recorded from a single low precision (± 11 000 m) record near Chincilla (AVH 2013e) although it is not known if the collection was made within the project development area. A further two records are located on the margins of the project development area to the north of Chinchilla within cypress pine woodland approximately 7 km north of Chinchilla on Auburn Rd. The records occur within Barakula State Forest. This small terrestrial orchid is a difficult species to detect, and likely to occur in cypress pine habitats on sandy loams north of Chinchilla. It was not recorded during field surveys although has potential to be widely distributed with few collections made due to the cryptic nature of the species. The extent of suitable habitat within the project development area is provided in **Table A57** with spatial distribution illustrated in **Figure A25**.

**Table A57**. Extent of habitat for Cobar greenhood orchid. within the project development area and associated areas of assessment

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 0 | 133558 | 0 |
| 3D Detailed Mapping Area** | 0 | 7431 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 18502 | 0 |
| Survey area 2**** | 0 | 943 | 0 |
| Survey area 7**** | 0 | 47 | 0 |
| Survey area 8**** | 0 | 754 | 0 |
| Survey area 9**** | 0 | 421 | 0 |
| Survey area F**** | 0 | 40.5 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** Identified threats include habitat damage by feral goats (*Capra hircus*); broad-scale vegetation clearing; grazing pressure changed hydrology increasing salinity; fragmentation; and loss of remnants (TSSC 2008l). The main potential threats to the species include habitat degradation (granite ridge and rocky slope habitat are particularly vulnerable to erosion caused by feral goats); and weed invasion (TSSC 2008l).

**Project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat, such as for cypress pine logs;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks;
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Consequence of project related impacts (unmitigated):** With consideration given to the species known threats, the species sensitivity to disturbance is considered High. This is based on its ability to die back and regrow from tubers, which may provide some resilience to minor soil surface disturbance. The limited amount of ecological knowledge for this species is also recognised. Large areas of potential habitat exists throughout the project development area (15% of the entire area based on EHP 2012a) in cypress pine dominated woodlands (RE11.5.1 and RE11.5.4) and ecosystems where patches of cypress occur as sub dominant trees (e.g., RE11.3.18 and RE11.3.2). The species is likely to be more common within the project development area than herbarium records indicate because it is a difficult plant to find during much of the year. Field surveys within the flowering season of September to November in areas of possible habitat identified for clearing are required to determine the presence and extent of populations. The magnitude of unmitigated potential impacts is considered ***High***, due to the extent of possible habitat and potential for one of the three known local populations occurs to occur within the project development area. The significance of unmitigated impacts is assessed as ***High (21).***

**Specific management/ mitigation measures:** Mitigations for management of this species are covered by committments made within Attachment 4, Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Cobar greenhood orchid will be prioritised.

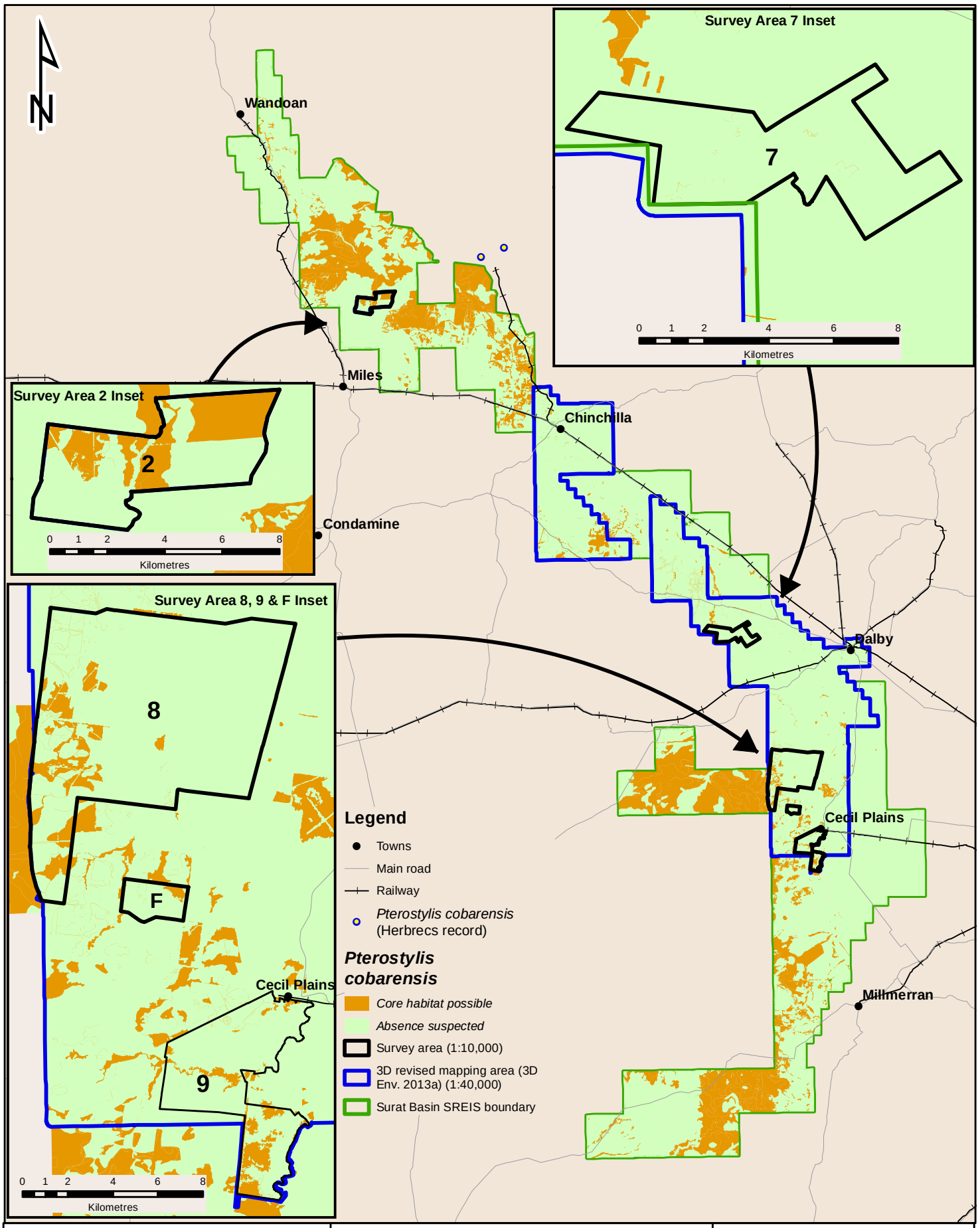
**Summary residual impact assessment:** In the absence of mitigation, impacts of ***High*** magnitude will potentially occur and the preliminary impact significance will be ***High (21)***. Areas mapped as 'core habitat possible', warrant further survey work within areas proposed for clearing in an attempt to determine the presence or absence of the species. Assuming adequate surveys are carried out in optimal seasonal conditions (i.e., flowering period) avoidance will mitigate against impacts. However, it will be difficult to gain complete confidence that this species can be completely avoided given the

difficulty in detection. If surveys of impact footprints are undertaken within the optimal seasonal window, impacts to the species is not expected.

Where avoidance is not possible, translocation is considered the best risk management measure and will be mostly effective, although minor loss in a local population may still occur. Implementation of other mitigation measures such as limiting the width of disturbance corridors, establishing and maintaining buffers and rehabilitation of disturbance areas may result in a residual impact significance of ***Moderate (17)*** significance.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Moderate | Moderate (17) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A25.** Cobar greenhood orchid *(Pterostylis cobarensis)* distribution in project development area.

**Client** Arrow

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Kilometres

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**Rule(s) for habitat mapping:**

1. Any confirmed species record (<500 m precision) should be buffered by a 1 km circumference and treated any remnant habitats contained within the buffer treated as "core habitat known" ('high' confidence applies).
2. Regional ecosystems coinciding with confirmed records (<500 m precision) should be classed as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. The following regional ecosystems in the broader region should be classed as "core habitat possible" (confidence levels as in 2 apply). This includes those REs contained within the mature regrowth dataset (EHP 2012b):
   - RE11.3.2, RE11.3.18, RE11.5.1, RE11.5.4, RE11.5.21, RE11.5.4, RE11.10.9
4. All other remnant vegetation, regrowth vegetation derived from possible habitats and cleared agricultural and grazing land in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES Referral Guidelines**

**Table A58**. Evaluation of impact significance for Cobar greenhood orchid (*Pterostylis cobarensis*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Populations of this species recorded to the north of Chinchilla represent the northern distributional limit for this species. All populations should be considered 'important populations' based on criteria provided by DEWHA (2008).<br><br>Survey area 2, 7, 8, 9 and F contain 'core habitat possible' for Cobar greenhood orchid. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 2, 7, 8, 9 and F:** Intensive survey in these survey areas failed to locate this species. Survey was completed outside the optimal survey period of September - November. Based on current knowledge, the project will not lead to a long term decrease in the size of an important population. This assessment needs to be supplemented with additional survey within the optimal survey window, during pre-clearance measures when final impact footprints are identified.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys |

| Criteria | Evaluation |
|---|---|
| | are undertaken in suitable habitat and a suitable seasonal window prior to disturbance |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat and a suitable seasonal window prior to disturbance |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat and a suitable seasonal window prior to disturbance |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Pre-clearance survey work is required in the optimal seasonal window to verify this assessment.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F: :** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |

| Criteria | Evaluation |
|---|---|
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur. |
| Criteria 8: introduce a disease | There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur. |
| Criteria 9: interfere with the recovery of the species | **Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur. |

**Conclusions:** For Cobar greenhood orchid (*Pterostylis cobarensis)* no impact is expected from development activities provided preclearance surveys are undertaken utilising appropriate survey methods and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** The species is likely to be detectable only during flowering periods from September to November which presents the most suitable window for pre-clearance surveys.

**Austral cornflower (*Rhaponticum australe*)**
Previously known as *Stemmacantha australis*)

**Family:** Asteraceae

**Status: EPBC Act:** Vulnerable; **NC Act:** Vulnerable; **BoT:** High

**Sensitivity:** Moderate

**Recovery plan:** A national species recovery plan has not been developed for Austral cornflower.

**Overview of Austral cornflower**

**Description** (based on Harden 1993; TSSC 2008m): Austral Cornflower is an erect, perennial herb growing to 60 cm tall. The stems and branches are woolly hairy. The leaves are deeply lobed, up to 18 cm long and 6 cm wide on the lower leaves. Leaf size declines with height on stem.

Flower heads, pink to purplish, are 3 to 6 cm diameter, and are produced at the top of the stem and branches. The individual seeds (i.e., “achenes”) are striate, 7 or 8 mm long with a feathery top approximately 2 cm long.

**Plate 24.** Austral cornflower habitat (Copyright © Boobook).

**Ecology:** Other than being a perennial, the lifespan of Austral cornflower is unknown, though as a daisy it is probably a fairly short-lived perennial (e.g., living < 5 years). The seeds are wind dispersed, which should assist colonisation. It has the ability to survive along disturbed roadsides and blocks of land (Goodland 2000; Gardner 2008). Austral cornflower can occur in large populations. Notes from collections indicate one particularly large population (i.e., > 1000 plants) was recorded in a partially cleared paddock with a few scattered ironbarks, south-west of Biggenden (AVH 2013f). Some other abundance records are of 100 to 300 plants, but others are from much smaller populations.

**Habitat:** Austral cornflower grows in eucalypt open forest with grassy understory, paddocks and along roadsides, on basalt soils and alluvial flats. Goodland (2000) reports that Austral cornflower appears to have no habitat preference or soil preference, being located in mountain coolibah (*Eucalyptus orgadophila*) grassy open woodlands, on stony red soil ridges and to the deep cracking black clay soils of the floodplains. Populations of the species are virtually restricted to roadsides in the Darling Downs (Goodland 2000). They have also been seen on a neglected town block in Toowoomba (Gardner 2008).

**Distribution:** Endemic to eastern Australia but now presumed extinct in New South Wales and Victoria. In Queensland it is known from a large number of sites ranging from Cania Gorge (west of Gladstone), Mount Moffat in the north, to Gatton in the south (Goodland 2000). The most extensive occurrence is around Toowoomba with another cluster of populations south of Biloela.

**Likelihood of occurrence and extent of habitat in the project development area:** The species possibly occurs. There are no records from within the project development area and Austral cornflower was not recorded during the field survey. However, it has been collected between 15 and 25 km east of the of the project development area in several locations to the north-east of Dalby and near Pittsworth. Suitable habitat occurs on road reserves supporting grasslands and poplar box woodlands on alluvium as well as relatively extensive areas of derived grassland. The extent of habitat for Austral cornflower in the project development area is presented in **Table A59** and the spatial distribution of these species is provided **Figure A26.**

**Table A59.** Extent of habitat for Austral cornflower. within the project development area and associated areas of assessment

| | Core Habitat Known (Ha) | Core Habitat Possible (Ha) | General Habitat (Ha) |
|---|---|---|---|
| Project development area* | 0 | 13750 | 0 |
| 3D Detailed Mapping Area** | 0 | 1344 | 6415 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 5355 | 0 |
| Survey area 8 | 0 | 0 | 266 |
| Survey area 9 | 0 | 90 | 36 |
| Survey area 2, 7, F | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** Mainly found on roadsides or in undisturbed reserves where the species may regenerate after moderate mechanical disturbance. However, road work operations have been known to completely destroy entire sites (EPA 2002, Goodland 2000). Austral cornflower may be outcompeted when roadsides become infested by exotics (e.g., Johnson's grass and green panic; EPA 2002). The condition of populations may be related to grazing pressure, because it is thought to have a high sensitivity to grazing (Fensham 1997).

**Potential project-related impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

**Significance of project related impacts (Unmitigated):** The sensitivity of Austral cornflower is considered ***Moderate***. This is based on its known ability to produce dense populations and its ability to survive in disturbed paddocks and along roadsides, both of which suggest a capacity for abundant seed germination. Its seed is also wind dispersed, and likely to colonise adjacent areas. However,

following mechanical disturbance (e.g., of roadside) invasion of exotic pasture grasses and weeds has the potential to degrade habitat and limit the re-colonisation of disturbed areas.

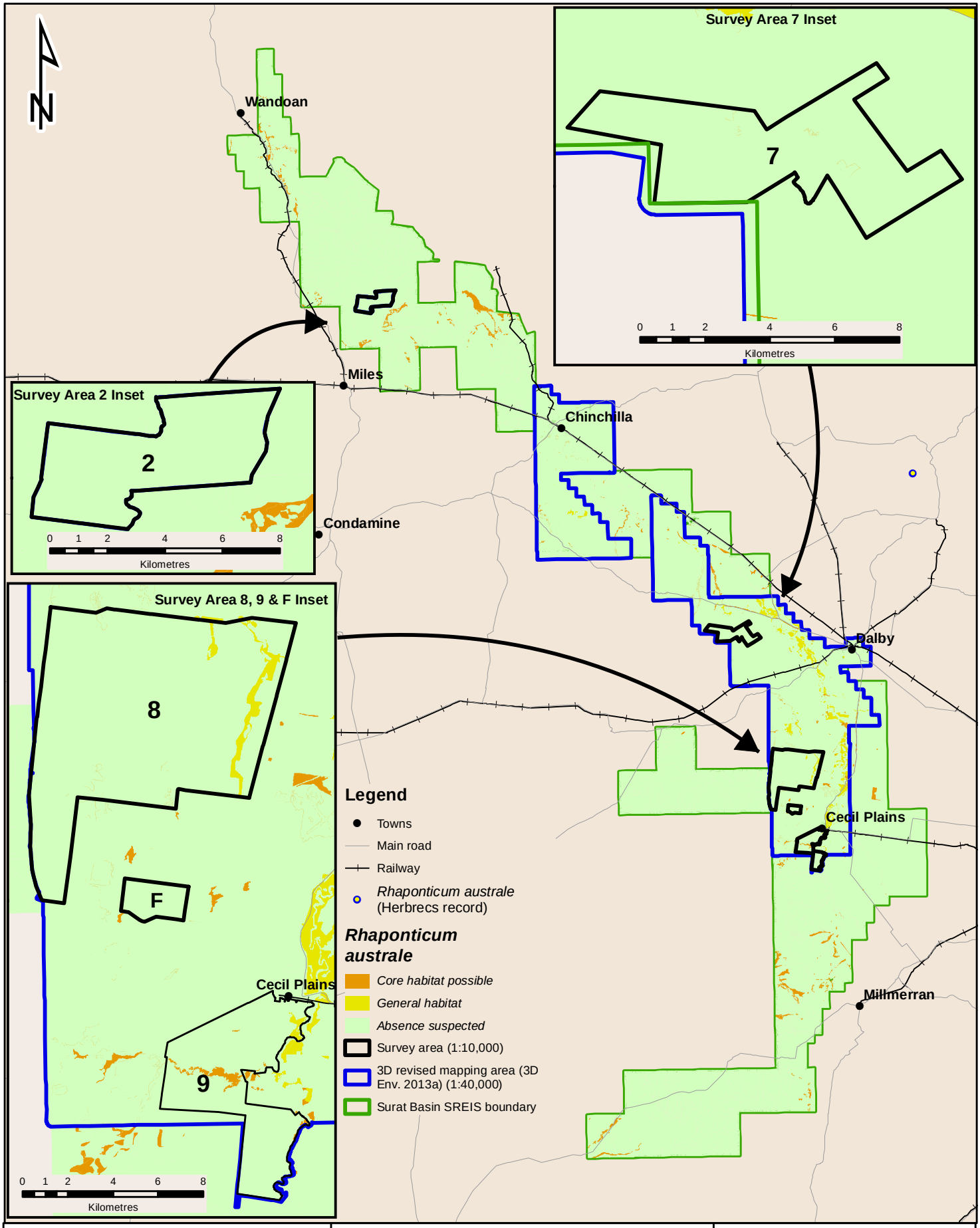
Any remnant and derived grassland and poplar box woodlands on alluvium are potential habitat and susceptible to disturbance. The species, which is not currently known from the project development area, is widely distributed in nearby pockets of habitats which are under pressure from clearing, agricultural development, weed invasion and overgrazing. Stock routes and road reserves supporting grasslands, poplar box woodlands, and derived grasslands are most susceptible to disturbance associated with linear infrastructure such as pipelines. The potential magnitude of impact is considered ***Moderate.*** Unmitigated activities in the vicinity of local populations and possible habitats are therefore likely to have an impact significance of ***Moderate*** **(13).**

**Species specific management/ mitigation measures:** Management of this species is covered in commitments made within Attachment 4 Commitments Update of the SREIS. Infrastructure design and site selection that seeks to avoid core habitat known of Austral cornflower will be prioritised.

**Summary residual impact assessment:** In the absence of avoidance of the local populations, impacts of ***Moderate (13)*** significance will potentially occur. Areas mapped as 'core habitat possible', warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding areas of potential core habitat will mitigate against impacts and residual impacts will be not be incurred*.* Grassland and grassy woodland habitats support a number of other EVNT flora species and are particularly vulnerable to mechanical disturbance. Implementation of mitigation measures such as establishing and maintaining buffers, limiting the width of disturbance corridors, rehabilitation of disturbance areas using seeding of native grass seed of local provenance, and management of exotic grass and herb invasion will be largely effective to a degree that impact significance is ***Low*** **(8)**.

| **Residual Significance Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Low | Low (8) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A26.** Austral cornflower *(Rhaponticum australe)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

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**Rule(s) for habitat mapping:**

1. As a precautionary measure the following regional ecosystems and mature regrowth (as per EHP 2012b) should be classed as "core habitat possible" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by DEHP, 2012a and 2012b):
   - 11.3.2
   - 11.3.21 and 11.3.24
   - Non-remnant derived grasslands on land zones 3.
2. All other remnant vegetation in the project development area and cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A60.** Evaluation of impact significance for Austral cornflower under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, Austral cornflower does not occur in the project development area and is restricted to non-remnant habitats within 20 km from the project development area boundary. It does however have the potential to occur throughout the entire project development area, most notably in eastern portions. The project development area would represent the western limits of the species distribution. Hence, under the guidelines of DEWHA 2008, any population that occurs within the study area would be considered an 'important population'.<br><br>Habitat for the species is indicated in properties survey areas 8 and 9. Field survey within these properties did not locate the species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of Austral cornflower exists within these properties and hence no decrease in the size of an important population is likely.<br><br>Survey areas 2, 7 and F do not present suitable habitat for the species.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur |

| Criteria | Evaluation |
|---|---|
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur |
| Criteria 8: introduce a disease | Diseases which impact Austral cornflower or other members of the Asteraceae family are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur |

**Conclusions:** For Austral cornflower (*Rhaponticum australe)* no impact is expected from development activities Potential impacts to the species are not considered significant when assessed under MNES significant impact guidelines. This assumes provided preclearance surveys are undertaken utilising suitable methods when working within areas of possible habitat (survey area 9) and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species..

**Rule(s) for survey effort required in accordance with survey guidelines:** The species, being a short lived perennial, should be detectable throughout most of the year. Limited information is available on its flowering and seeding period although like most species of the Asteraceae family, is likely to be most robust in the period from September to May.

**Austral toadflax (*Thesium australe*)**

**Family:** Santalaceae

**Status: EPBC Act:** Vulnerable **NC Act:** Vulnerable

**Sensitivity:** High

**Recovery plan:** A national species recovery plan has not been developed for Austral toadflax although DEH (2012c) provides 15 priority actions to aid the recovery of the species. Griffith (1992) has prepared a recovery plan for the species.

**Overview of Austral Toadflax**

**Description** (based on Stanley and Ross 1983; Harden 1993, DEH 2012c, DSE 2003): Austral toadflax is a small biennial or perennial herb or subshrub. It grows to 40 cm tall, with wiry, slender stems. Leaves are alternate, linear yellowish-green. The leaf stalks (i.e. petioles) extend down the stem a little, forming a ridge. The yellow-green flowers, < 2 mm long, occur individually in the leaf axils. The globular fruit is a nut approximately 2.5 mm diameter, with the tiny petals persisting at the apex.

**Ecology:** A root parasite of kangaroo grass (*Themeda triandra*) and other grasses, Austral toadflax lives for at least two years. Flowers have been recorded from spring to autumn with fruit developing in summer. Austral toadflax has been observed to germinate prolifically after fire and also after drought. The species is relatively short lived, persisting up to two years after germination (Department of Sustainability and Environment (DSE) 2003).

**Habitat:** Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE11.3.2) northwest of Dalby, within the project development area. Other Herbarium collection records of Austral toadflax are from along roadsides, mountain coolibah (*Eucalyptus orgadophila*) grassy open woodlands with kangaroo grass (*Themeda triandra*) and Queensland blue grass (*Dichanthium sericeum*). Relevant regional ecosystems within the project development are:

- RE11.3.2; *Eucalyptus populnea* woodland on alluvial plains.
- RE11.3.21; *Dichanthium sericeum* and/or Astrebla spp. grassland on alluvial plains. Cracking clay soils.
- RE11.3.24; *Themeda avenacea* grassland on alluvial plains. Basalt derived soils.

**Distribution:** Historical collections (including the late 1800's) were made from Tasmania, but it is now considered extinct in that state (DSE 2003). Austral Toadflax occurs in eastern Victoria, NSW and southern Queensland. The majority of southern Queensland collections are from the Darling Downs and Moreton districts (Bostock and Holland 2010). The Dalby area represents the species western limits on the Darling Downs.

**Likelihood of occurrence in project development area:** The species is known to occur in the project development area, being recorded in non-remnant grassland approximately 4 km west of Dalby and an additional record on the Warrego Highway approximately 19 km north of Dalby, and in a small remnant of *Eucalyptus populnea* on alluvium (RE11.3.2) approximately 25 km northwest of Dalby on the Warrego Highway (EHP 2013). There is a high potential for the species to occur in grassland and poplar box woodlands on alluvium as well as intact vegetation contained within stock routes and road reserves. The species was not recorded during field surveys. **Table A61** provides an indication of the extent of Austral toadflax habitats within the project development area with broad distribution indicated in **Figure A27.**

**Table A61**. Extent of habitat for Austral toadflax within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 77 | 13550 | 0 |
| 3D Detailed Mapping Area** | 0 | 3832 | 7633 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 5399 | 0 |
| Survey area 7 | 0 | 0.85 | 5 |
| Survey area 8 | 0 | 0 | 369 |
| Survey area 9 | 0 | 90 | 70 |
| Survey area F | 0 | 0 | 4.08 |
| Survey area 2 | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** Populations in road reserves are threatened by roadwork and maintenance activities such as spraying, grading, slashing, by inappropriate grazing and burning regimes, and weed infestation (Goodland 2000). The species is known to be susceptible to rabbit, horse and cattle grazing but able to tolerate light, non-continuous cattle grazing. Populations of the species are thought to be declining (EPA 2002). Austral toadflax cannot survive beneath a dense shaded canopy (Griffith, 1992), nor is it likely to be capable of surviving dense infestations of exotic grass.

**Potential project-related Impacts:** Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, changed fire regimes, altered habitat structure along gathering lines, tracks and clearing zones.

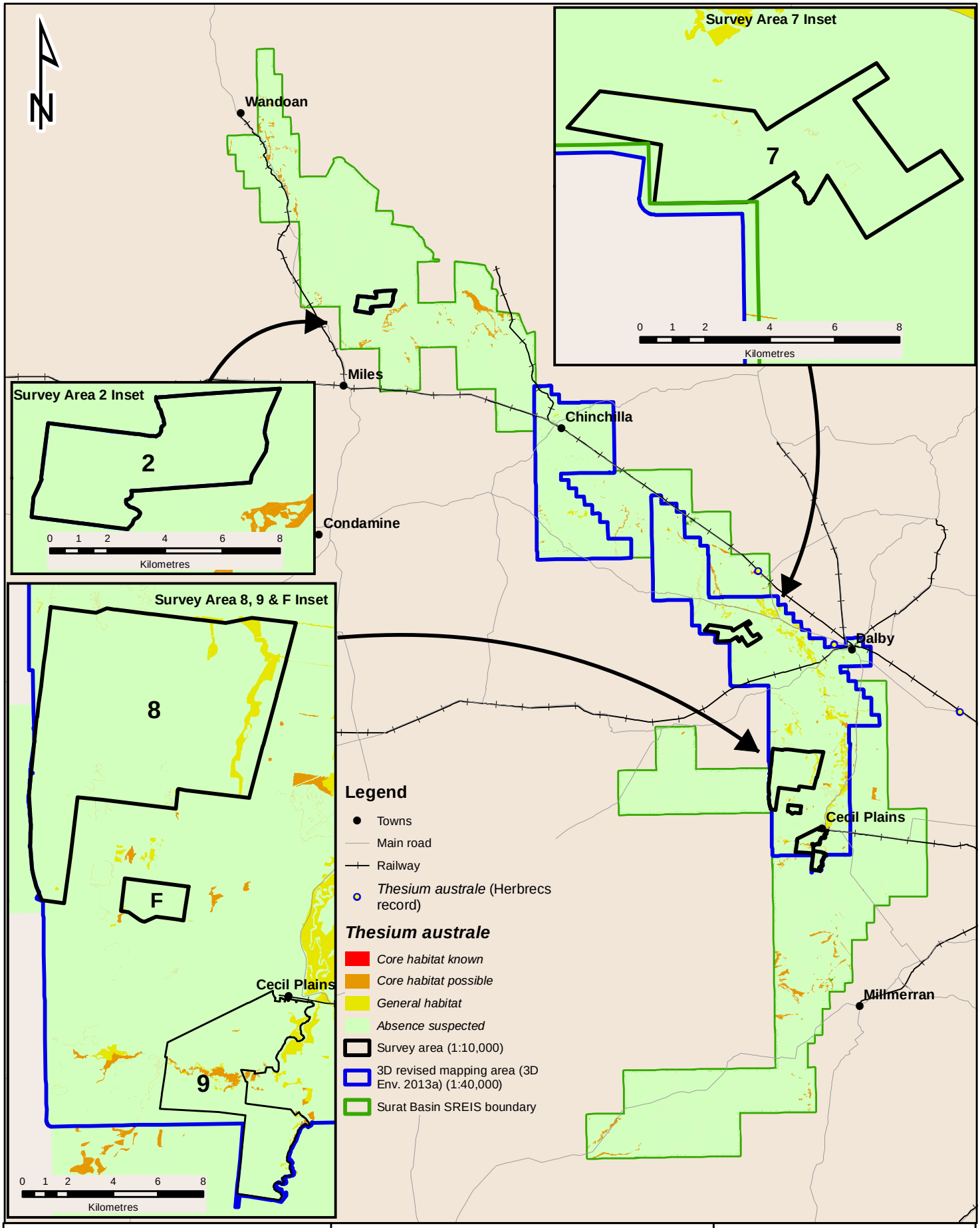
**Significance of project related impacts (unmitigated):** Austral toadflax is known to persist in moderately disturbed areas, such as roadsides. However, it is known to be threatened from smothering by some weeds and there is little information on its ecology or ability to regenerate. It is considered to have a ***High*** sensitivity ranking. The species occurs in roadside grassland and poplar box remnants on alluvium within the project development area. Potential habitat occupies approximately 1% of the project development area, although, stock routes and road reserves supporting habitat are most susceptible to disturbance incurred through construction of linear infrastructure such as pipelines. Two of the three populations contained within the study area are found within the project development area itself, though it is widespread beyond the study area towards the east. The potential magnitude of impact is considered ***Moderate***. Further survey is required to determine the extent of populations in tracts of suitable habitat. The likely significance of unmitigated impact is ***Moderate* (17).**

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied to survey effort. Infrastructure design and site selection that seeks to avoid core habitat known of Austral toadflax will be prioritised.

**Summary Residual Impact Assessment:** In the absence of mitigation, the resultant impact significance will be ***Moderate* (17).** Areas mapped as 'core habitat possible', warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding areas of potential habitat will totally mitigate against impacts and no impact will be incurred. Adjacent habitat remains vulnerable to edge effects (invasion of exotic pasture grasses). Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree, although the effectiveness of translocation is not known to have been demonstrated. The resulting residual impact following employment of a full range of mitigation measures is considered to be ***Moderate* (12)**.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Others# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A27.** Toadflax *(Thesium australe)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rule(s) for habitat mapping:**

1. The confirmed species records (<500 m precision) should be buffered by a 1 km circumference and any remnant RE (including mature regrowth in EHP 2012b) treated as "core habitat known" (high confidence levels apply).
2. RE polygons with confirmed records (<500 m precision) should be treated as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. The following regional ecosystems should be classed as "core habitat possible" (confidence levels as in 2 apply:
   - RE11.3.2, RE11.3.21, RE11.3.24
4. Any non-remnant (regrowth) habitats derived from possible habitats (REs 11.3.21, 11.3.24, 11.3.2) and derived grassland should be treated as "general habitat" (high confidence levels apply when applied to refined mapping. Low confidence levels apply when based on RE mapping provided by EHP 2012a).
5. All other remnant vegetation and cleared agricultural land in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A62.** Evaluation of impact significance for Austral cornflower under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, Austral toadflax occurs within 2 locations in the project development area with an additional collection within the broader study area. It does have the potential to occur throughout the entire project development area, most notably grassy woodlands and grasslands in eastern locations.<br>The project development area would represent the western limits of the species distribution in the Darling Downs with only a few scattered collection to the northwest near Carnarvon. Hence, under the guidelines of DEWHA 2008, any population that occurs within the study area would be considered an 'important population'. Populations would also provide genetic diversity and contribute to dispersal of seed within a fragmented landscape.<br>Habitat for the species is indicated in survey areas 7, 8, 9. Field survey within these properties did not locate the species. Other properties are not considered to host suitable habitat. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey areas 7, 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of Austral toadflax exists within these properties and hence no decrease in the size of an important population is likely. Pre-clearance survey once discrete development footprints are known will be required to verify this assessment and mitigate impacts to undiscovered populations.<br><br>Survey areas 2 and F do not present suitable habitat for the species.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur. |
| Criteria 3: fragment an existing important population | **Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |
| Criteria 7: result in the establishment of an invasive species | **Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of exotic species within tenements are proposed (commitment C099, C179, C188, C183).<br><br>In accordance with **Criteria 7**, a significant impact is |

| Criteria | Evaluation |
|---|---|
| | not expected to occur. |
| Criteria 8: introduce a disease | Diseases which impact Austral toadflax are not known to occur.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 9**, a significant impact is not expected to occur. |

**Conclusions:** For Austral toadflax (*Thesium australe)* no impact is expected from development activities provided preclearance surveys employ methods appropriate to detection of the species within areas mapped as potential habitat (survey areas 7, 8 and 9). This assessment assumes that appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** Austral toadflax, being a short lived perennial, should be detectable throughout most of the year although will be most visible during its flowering period which occurs from September to May (Spring to Autumn). The use of 1 x 1 m quadrats as recommended for assessment of herbaceous groudcovers. Methods are broadly described in Neldner et al (2012).

**Xerothamnella (*Xerothamnella herbacea)***

**Family**: Acanthaceae

**Status: EPBC Act:** Endangered, **NC Act:** Endangered **BoT:** Not Listed

**Sensitivity:** High

**Recovery plan:** A national species recovery plan has not been developed for *Xerothamnella herbacea*.

**Overview of Xerothamnella**

**Description:** A perennial herb to 30 cm tall. sparse, sprawling, perennial herb growing to a height of 30 cm. Leaves are soft, opposite, linear to narrowly ovate, dark green above paler beneath. The flowers are two lipped, pink to mauve to 6.5 mm long, arising from the upper leaf axils (Barker 1986 cited in TSSC 2008n).

**Plate 25.** *Xerothamnella herbacea.* Photograph Copyright © Boobook

**Ecology:** Little is known in regard to the ecology of *Xerothamnella herbacea* although it can live for a few years and establish vegetatively by rooting from nodes along stems.

**Habitat:** Occurs in remnant and disturbed brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) dominated communities in shaded situations, often in leaf litter (TSSC 2008n). The species is associated with brigalow (*Acacia harpophylla*) dominated communities, preferring shady locations

where it grows in leaf litter (TSSC 2008n). The plant often occurs in gilgais in vertic clay soils (vertosols) and is known to occur in non-remnant and highly disturbed habitats. Regional ecosystems associated with this species are:

- RE11.3.1; Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains.
- RE11.4.3; Acacia harpophylla and/or Casuarina cristata shrubby open forest on Cainozoic clay plains.
- RE11.9.5; Acacia harpophylla and/or Casuarina cristata open forest on fine-grained sedimentary rocks.

**Distribution:** *Xerothamnella herbacea* is known from seven locations between Goondiwindi and Theodore. Scattered populations occur to the north-east of Chinchilla (between Chinchilla and Boondooma Lake), within Palmgrove and Expedition National Parks to the southwest of Moura. Two isolated populations occur between Goondiwindi and Millmerran.

**Likelihood of occurrence and extent of habitat in the project development area:** There are two previous Herbrecs collection sites within the project development area (EHP 2013). These are from a narrow patch of roadside Brigalow remnant on the Millmerran-Goondiwindi road, and a low precision (± 16000 m) collection approximately 30 km east of Chinchilla from 1980. A record 32 km northeast of Chinchilla (EHP 2013, Chinchilla Field Naturalist Club n.d) is located approximately 8 km east of the project development area boundary. There is potential for *Xerothamnella herbacea* to occur within any brigalow/belah habitat consistent with REs 11.3.1 11.4.3 and 11.9.5, as well as brigalow regrowth on roadsides. **Table A63** provides an indication of the extent of *Xerothamnella herbacea* habitats within the project development area with broad distribution indicated in **Figure A28.**

**Table A63.** Extent of habitat for *Xerothamnella herbacea* within the project development area and associated areas of assessment.

| | **Core Habitat Known (Ha)** | **Core Habitat Possible (Ha)** | **General Habitat (Ha)** |
|---|---|---|---|
| Project development area* | 55 | 8059 | 0 |
| 3D Detailed Mapping Area** | 0 | 1307 | 353 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 1477 | 0 |
| Survey area 7 | 0 | 0.9 | 3 |
| Survey area 8 | 0 | 2 | 0 |
| Survey area 9 | 0 | 5 | 0 |
| Survey area F | 0 | 1 | 0 |
| Survey area 2 | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats:** The species is threatened by competition from invasive grasses such as green panic (*Megathyrsus maximus* var. *pubiglumis*) and to a lesser extent buffel grass (*Cenchrus ciliaris*) either by direct competition or by increasing the fuel load and altering fire regimes. Potential threats include road widening and maintenance activities, surface erosion, and grazing and trampling by cattle and native macropods (TSSC 2008n).

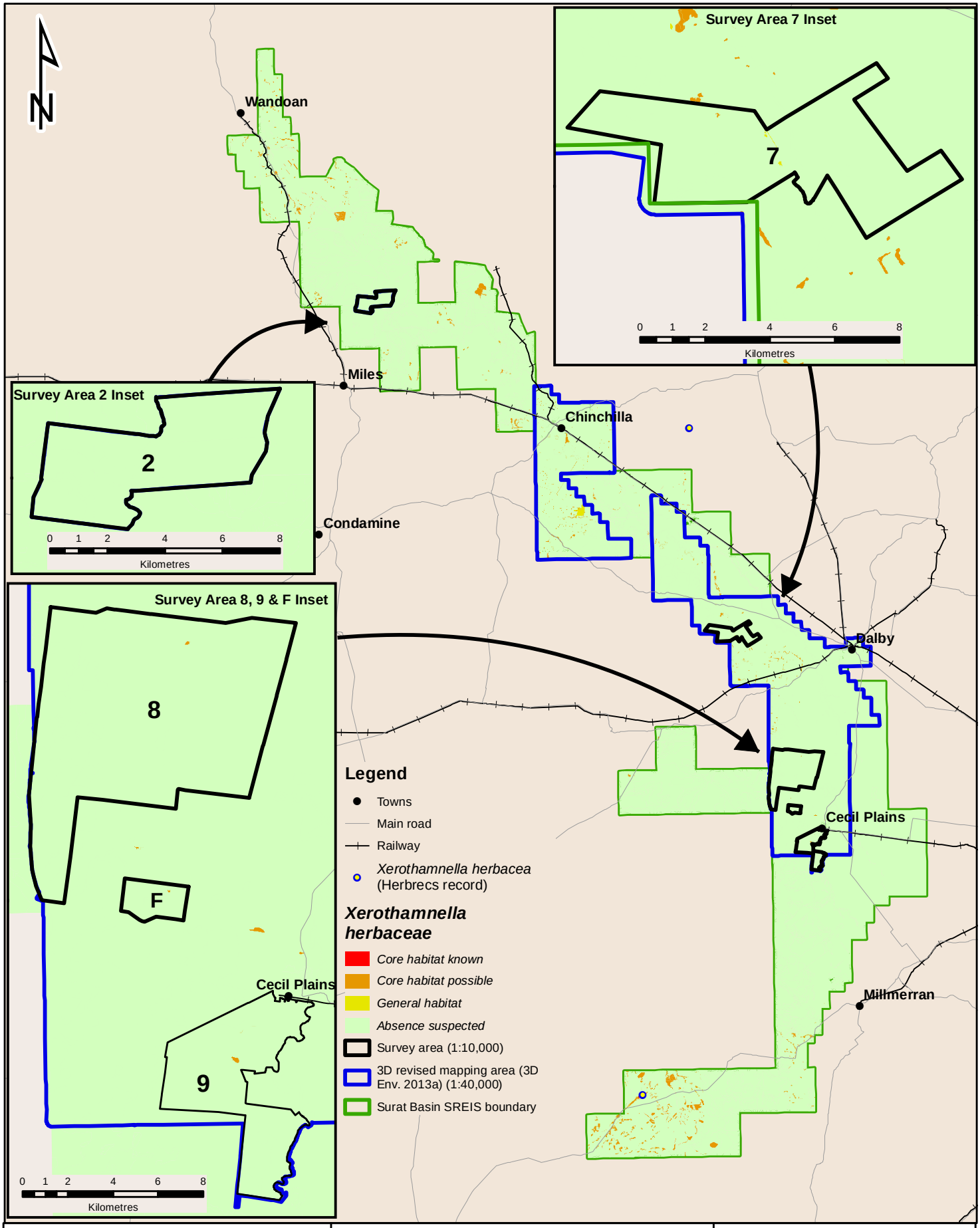
**Significance of project related impacts (unmitigated):** *Xerothamnella herbacea* can spread vegetatively, which provides some resilience to minor disturbances and potential for rehabilitation. However, very little is known of the ecology of this small herb, other than it can persist in areas with some disturbance. The sensitivity of the species is considered ***High***. Potential habitat for *Xerothamnella herbacea* covers approximately 1% of the project development area based on mapping provided by EHP (2012a). However considerable habitat is contained within non-remnant vegetation which is not comprehensively mapped throughout the project development area. The potential magnitude of unmitigated impacts is considered ***High***. The potential significance of unmitigated impacts is therefore considered ***High* (21).**

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of *Xerothamnella herbacea* will be prioritised.

**Summary residual impact assessment:** In the absence of mitigation, impacts of ***High (21)*** significance are possible**.** Brigalow associations on Land zones 3, 4 and 9 constitute the optimal habitat for *Xerothamnella herbacea*. These areas are classed as Category B Environmentally Sensitive Areas and are subject to management buffers as part of project conditioning. Avoiding areas of potential habitat will completely mitigate against impact and no residual impact will be incurred**.** Where brigalow vegetation cannot be avoided, generic mitigation measures may reduce impact to some degree. Although the effectiveness of translocation has not been tested, the plants ability to reproduce vegetatively means that it may be amenable to translocation techniques. The resulting residual impact through alternative mitigation measures would be ***Moderate (17).***

| **Residual Significance Assessment** | | | | | |
|---|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Sensitivity Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | High | Moderate | Moderate (17) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

**Figure A28.** *( Xerothamnella herbaceae)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
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**Rule(s) for habitat mapping:**

1. All confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant REs including mature regrowth (as per EHP 2012b) treated as "core habitat known" (high level of confidence).
2. RE polygons (and mature regrowth) coinciding with the confirmed record (<500 m precision) should be treated as "core habitat known" (high level of confidence).
3. The following regional ecosystems should be classed as "core habitat possible" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a):
   - RE11.3.1, RE11.4.3, RE11.9.5, RE11.9.6
4. Advanced brigalow/belah regrowth on gilgai soils of land zones 3 and 4 and 9 should be classed as "general habitat" (confidence levels as in 3 apply) (3D Environmental 2013 dataset only.
5. All other remnant vegetation in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

**Evaluation under MNES referral guidelines**

**Table A64.** Evaluation of impact significance for *Xerothamnella herbacea* under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and 'distribution of the species in the project development area. | Based on current knowledge, *Xerothamnella herbacea* is scattered throughout remnant and non - remnant brigalow habitats within the study area with two prior records occurring within the project development area. The species has potential to occur throughout the entire project development area.<br><br>Any localised populations are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 7, 8, 9 and F:** Minor representations of potential habitat for xerothamnella occur within small representations of remnant and regrowth brigalow contained within. Due to the confined and isolated nature of these habitats, when considered in the context of intensive search effort, it is unlikely that an important population of *Xerothamnella herbacea* exists within these properties. Hence no decrease in |

| Criteria | Evaluation |
|---|---|
| | the size of an important population is likely.<br><br>Survey area 2 is not considered to provide suitable habitat for the species.<br><br>In accordance with **Criteria 1**, a significant impact is not expected to occur. |
| Criteria 2: reduce the area of occupancy of an important population | **Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 2**, a significant impact is not expected to occur. |
| Criteria 3: fragment an existing important population | **Survey area 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 3**, a significant impact is not expected to occur. |
| Criteria 4: adversely affect habitat critical to the survival of the species | **Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 4**, a significant impact is not expected to occur. |
| Criteria 5: disrupt the breeding cycle of an important population | **Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 5**, a significant impact is not expected to occur. |
| Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species | **Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 6**, a significant impact is not expected to occur. |
| Criteria 7: result in the establishment of an invasive species | **Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1.<br><br>In accordance with **Criteria 7**, a significant impact is not expected to occur. |
| Criteria 8: introduce a disease | Diseases which impact *Xerothamnella herbacea* or its brigalow habitat are not known.<br><br>In accordance with **Criteria 8**, a significant impact is not expected to occur. |
| Criteria 9: interfere with the recovery of the species | The recovery of the species will not be impacted based on detail provided in Criteria 1. |

| Criteria | Evaluation |
|---|---|
| | In accordance with **Criteria 9**, a significant impact is not expected to occur. |

**Conclusions:** For *Xerothamnella herbacea,* no impact is expected from development activities provided preclearance surveys are applied to proposed areas of impact where potential habitat is indicated (survey areas 7, 8, 9 and F). Appropriate mitigation must also be employed to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

**Rule(s) for survey effort required in accordance with survey guidelines:** *Xerothamnella herbacea*, being a short lived perennial, should be detectable throughout most of the year. It will be most visible and readily identified during its flowering period although there is limited information on species lifecycle. Optimal survey period is not known.

# MNES Assessments - Terrestrial Fauna Species

## Collared delma (*Delma torquata*)

**Status: EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT:** High

**Sensitivity:** Extremely High

**Recovery plan:** Recovery plan for the collared legless lizard (*Delma torquata*) (Davidson 1993). The species is also included in the Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012 (Richardson 2006).

**Plate 26.** Collared delma (Delma torquata) (Mark Sanders Photograph)

### Overview of Collared Delma

**Ecology**: Poorly known. Predominantly diurnal, the collared delma (*Delma torquata*) feeds on small arthropods and in captivity favours small cockroaches (S. Peck pers. comm.). It is also possible that subterranean termites will be part of the species' diet (Peck 2003). Movements are not well documented, but limited recapture data suggest that the species is highly sedentary, often repeatedly using the same rock shelter, but will abandon these shelter sites if they are disturbed (Porter 1998). It may therefore be possible for populations to be restricted to very small areas and be highly vulnerable to disturbance.

**Habitat**: The collared delma (*Delma torquata*) is typically associated with west-facing ridgelines with dry open sclerophyll and acacia woodlands with an open midstorey and a ground cover of native grasses, thick leaf litter and abundant loose rocks (Peck 2012b). It has also been recorded from semi-evergreen vine thickets (Ryan 2006) and from *Eucalyptus tereticornis* woodland and brigalow (*Acacia harpophylla*) without abundant rock (Wilson 2005; Peck 2012b). RE 11.3.2 could also be an important habitat for the species (Steve Wilson pers. comm). Individuals typically shelter under fallen debris (e.g., rocks, fallen timber, and leaf litter) but may be found below the ground surface or in soil cracks (Cogger 2000; Richardson 2006; Wilson and Swan 2008). Surface rocks are a significant habitat feature (Peck 2012b).

**Distribution**: The majority of records are from the western suburbs of Brisbane and the Toowoomba ranges in south-east Queensland. The species does also occur north to Blackdown Tablelands National Park and west to the Roma area in Brigalow Belt South (Peck 2012b).

**Likelihood of occurrence and extent of habitat in the project development area**: There are two known records of collared delma (*Delma torquata*) in the project development area[1], both approximately 43 km south-west of Millmerran State Forest 189 (12 km west of Wondul Range National Park). At least one of these specimens was from grey cracking clay with brigalow woodland (T. Reis pers. obs.). Other bioregional records from the Roma area have been from *Eucalyptus tereticornis* woodlands. Both these habitat associations appear atypical based on other records.

**Figure A29** indicates the location of confirmed records of the species (derived from database records) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur 'absence suspected'. The extent of habitat within specific areas of the project development area is summarised within **Table A65**.

**Table A65.** Extent of habitat for collared delma (*Delma torquata*) within the project development area and associated areas of assessment

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 456 | 4761 | 68640 |
| 3D Detailed Mapping Area** | 0 | 1269 | 7200 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 917 | 7330 |
| Survey area 2**** | 0 | 0 | 347 |
| Survey area 7 ****. | 0 | 1 | 100 |
| Survey area 8****. | 0 | 2 | 813 |
| Survey area 9****. | 0 | 5 | 90 |
| Survey area F****. | 0 | 1 | 58 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

[1] Wildnet (EHP's Wildlife Online database) records are not provided with location details and are not included for this or any other species. Such records may, however, be replicated through other sources such as the Queensland Museum and Birds Australia (Birdlife Australia) New Atlas databases.

**Threats**: The collared delma (*Delma torquata*) has apparently always been uncommon and there has not been a documented dramatic decline in numbers or substantial reduction in its distribution that can be attributed to a single threatening process (Peck 2012b). The main threats to the local populations of collared delma (*Delma torquata*) are likely to be:

- Inappropriate roadside management (Richardson 2006).
- Inappropriate fire regimes.
- Modification of habitat by invasion of exotic weed species, particularly *Lantana montevidensis* (BCC 2006; Peck 2012b).

**Potential project-related impacts**: Impacts associated with the proposed project related activities could include:

- Loss of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Collared delma (*Delma torquata*) populations can be restricted to very small areas, smaller than the minimum width required for gas gathering lines and access tracks. It is possible, therefore, that clearing activities could cause the local extinction of populations.
- The species appears to move only small distances, being largely sedentary. There is no known evidence of the species crossing artificial or disturbed surfaces and therefore gas gathering lines are likely to present a considerable barrier for collared delma (*Delma torquata*) movements.
- It is possible, although unlikely (see above), that some individuals could become trapped in open trenches, resulting in mortality.
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for this species. Considering the small extent of some populations, even small weed infestations could cause local extinctions.
- Human induced (deliberate or accidental) impacts could modify fire regimes, leading to changes in habitat structure and suitability.

**Significance of project related impacts (unmitigated)**:.

The species often occurs occurring in very small, restricted populations. Even minor disturbance such as road widening can have serious effects and therefore any clearing activity may cause extinction of a local population. The sensitivity of populations of collared delma *(Delma torquata)* is therefore considered ***Extremely High*** Records indicate that the species is much more common in the South-east Queensland bioregion and therefore project-related impacts are not expected to cause the widespread loss of this species. All known populations in the brigalow belt occur in habitats not typical to the species making predictions regarding its distribution difficult. Further, the collared delma (*Delma torquata*) is a small, secretive species that is easily over-looked. It is therefore feasible that

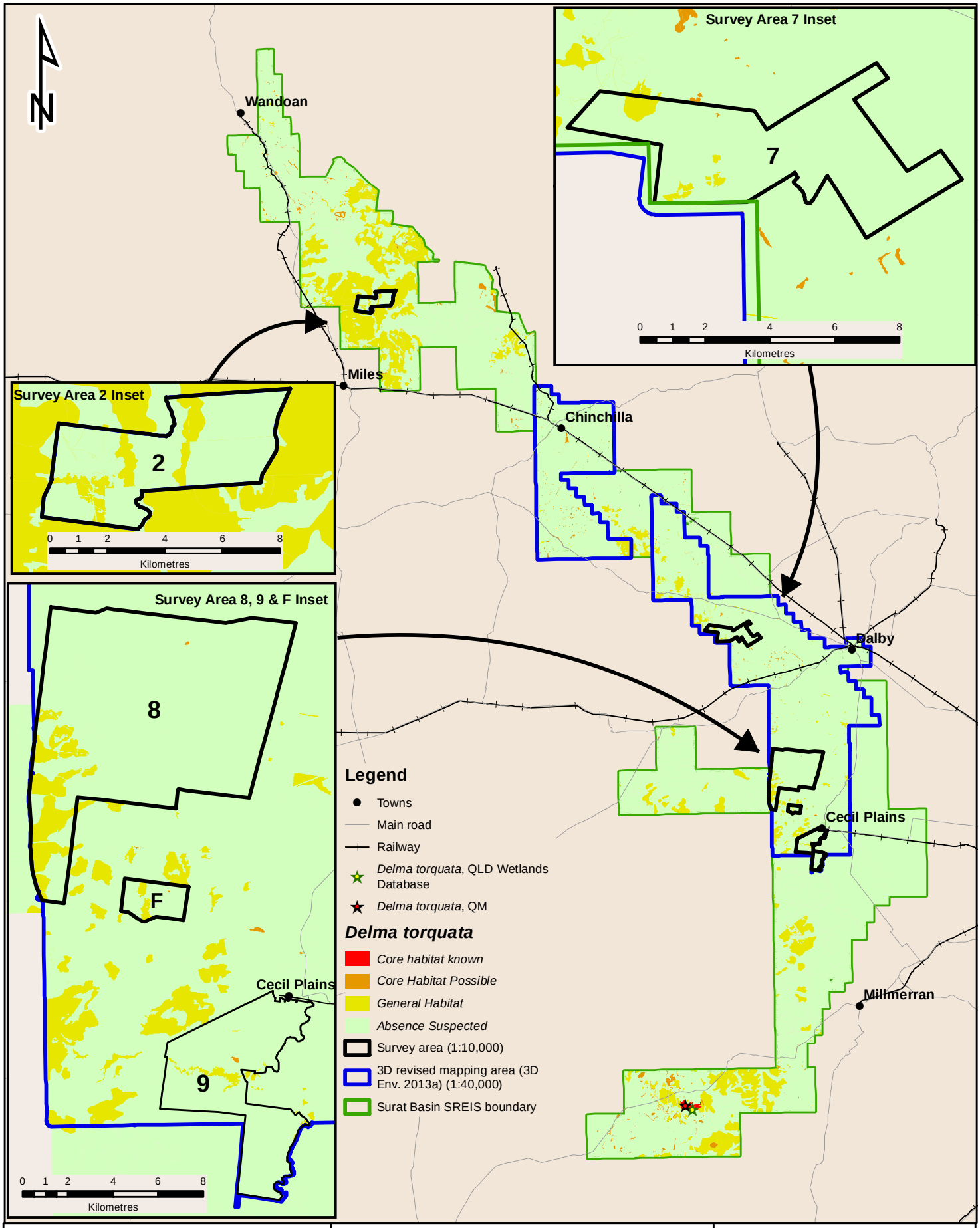
unknown populations could be severely and unknowingly impacted and the magnitude of potential of unmitigated impact is considered ***Major***.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species.

**Summary residual impact assessment**: Unmitigated project related activities may result in impacts of ***Major (25)*** significance to collared delma *(Delma torquata)* populations within the project development area. The avoidance of these populations will result in no residual impact being incurred. Mitigation measures such as trench clearing, rehabilitation and minimising clearing are likely to have only limited success in reducing possible impacts. Avoid areas of ´core habitat known'and undertaking further survey work within areas of 'core habitat possible' that may require clearing to determine the presence of the species.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | High | Ext high (23) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

**Figure A29.** Collared delma *(Delma torquata)* distribution in project development area.

**Client** Arrow

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**Rules for habitat mapping**:

1. The entire regional ecosystem (RE) polygon of the two known records in the project development area is classed as 'core habitat known.'
2. All remnant vegetation within a one km buffer of the two known records in the project development area is classed as 'core habitat known', regardless of RE type.
3. Within the Surat Gas Project area, REs on dark cracking clays with brigalow are classed as 'core habitat possible' (REs 11.3.1, 11.4.3, 11.9.5). This represents the species' habitat based on records in the project development area. mature regrowth as per EHP 2012b is not included in the assessment.
4. Within the Surat Gas Project area, REs typically occurring on stony and rocky substrates (i.e., REs 11.7.2, 11.7.4, 11.7.7, 11.8.2, 11.8.3, 11.10.1, 11.10.1a, 11.10.1d, 11.3.2) are classed as 'general habitat.' This represents the species' typical habitat preferences within south-east Queensland and includes REs identified by the Brigalow Belt Reptiles Workshop (2010).
5. Remaining REs should be classed as 'absence suspected.'
6. Cleared agricultural and grazing land is classed as 'absence suspected.'

For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
For both homogeneous and heterogeneous polygons with stony and rocky substrates, the habitat value refers only to those parts of the polygon that contain surface rocks.

**Mapping confidence:** Records from within the project development area occur well outside the species' normal distribution. However, the species is known to occur in isolated populations, often hundreds of kilometres from its core distribution. Furthermore, these isolated populations often occur in atypical habitats. This makes predicting the species' distribution and habitat *extremely* difficult. The map is considered to have a ***Low*** predictive accuracy.

**Evaluation under MNES Referral Guidelines**

**Table A66.** Evaluation of impact significance for collared delma (*Delma torquata*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | Significant populations, as defined by Peck (2003), are at sites where specimens have been recorded on two consecutive surveys, or multiple specimens were recorded on one survey. Minor populations are those at sites where only a single specimen or slough (shed skin) has been recorded and no further specimens are recorded on subsequent surveys. Many of the minor populations have only been surveyed once and may represent significant populations (Peck 2003).<br><br>There are two known records of this species from the project development area, approximately 1.7 km apart, south-west of Millmerran. Based on current knowledge, the species appears to have a very marginal distribution in the project development |

| Criteria | Evaluation |
|---|---|
| | area. In natural areas where there appears to be extensive habitat, the species appears to be restricted to small areas of habitat in the order of 100 m x 100 m (Peck 2003). Based on Peck (2003), the records within the project development area do not represent significant populations, though that may be due to a lack of survey effort or insufficient documentation of the number of individuals present.<br><br>**Survey area 2**: Intensive field survey failed to locate this species. Some 'general habitat', regional ecosystems (REs) 11.7.4 and 11.7.7, is present. Generally, it is considered that survey area 2 is unlikely to support the species.<br><br>**Survey area 7**: Some 'General Habitat', REs 11.3.2 and 11.10.1d, is present while RE 11.10.1 is mapped (DEHP mapping) for the property but not observed. Generally, this area is considered unsuitable for the species.<br><br>**Survey area 8**: Some 'general habitat', REs 11.3.2 and 11.10.1d, is present. Areas within survey area 8 have similarities with the species typical habitat.<br><br>**Survey area 9:** Some 'core habitat possible', RE 11.3.1, is present although it is fragmented, isolated and disturbed by grazing (sheep). Some 'general habitat', RE 11.3.2, is present. Habitats on survey area 9 do not appear likely to support the species.<br><br>**Survey area F**: Some 'core habitat possible', RE 11.9.5, is present, although this is extremely limited in extent. Some 'general habitat', REs 11.7.4 and 11.10.1d, is present. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F**: All five properties have some REs classed as 'general habitat' for collared delma (*Delma torquata*). Survey area 9 and Survey area F also have some REs classed as 'core habitat possible.' There is no known population on these properties.<br><br>It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance surveys will be required if development footprints include areas of mapped habitat.<br><br>Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |

| Criteria | Evaluation |
|---|---|
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** Based on the assumption that this species is not present on the subject properties (Survey area 2, 7, 8, 9, F ), impact of development is of extremely low magnitude and no significant impact under MNES criteria will be incurred. This assumption has not been tested by targeted survey work on survey area 7, 8, 9 or F. Works should be conducted prior to any clearing on survey area 7 and survey area 9 where habitats appear most suitable. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided and suitable surveys are undertaken in 'core habitat possible' followed by appropriate mitigation (if populations are found to be present), there is little potential for Arrow to contribute to the cumulative impacts associated with the activities of other proponents. Further, appropriate survey and mitigation should ensure that impacts are not unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed as 'core habitat known' or 'core habitat possible' should be avoided but if clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Abundant loose rocks (most important feature);
    - Native grasses;
    - Thick leaf litter;
    - Open midstorey;
    - West-facing ridgelines (non-essential).
- If suitable habitat is present, a combination of hand-searching under rocks and pitfall trapping should be undertaken.

The survey should be conducted between October and February and two surveys should be planned where practical. It is recognised that such surveys will be impractical for all activites, such those where a large number of well sites are proposed. In such cases, habitats representative of those to be impacted should be sampled rather than individual locations.

A lack of records from a single survey will not adequately demonstrate that the species is absent as the species typically has a very low capture rate even in areas that support large populations. For example, Porter (1998) found approximately one lizard per 150–200 rocks turned (or one lizard per 1.75 hours of searching). Significant populations, as defined by Peck (2003), are at sites where specimens have been recorded on two consecutive surveys, or multiple specimens were recorded on one survey. If more than one individual is recorded in a survey a follow up survey is not required. The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

However, even a single individual is sufficient for the location to be classed as 'core habitat known' and, should avoidance and a buffer then be implemented, a second survey is not required.
Despite its comparatively low success rate, hand-searching under rocks has been found to be more successful that pitfall trapping (e.g., Porter 1998; SEWPAC 2011) and should be the primary focus of the surveys. Details of pitfall trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

## Brigalow scaly-foot (*Paradelma orientalis*)

**Status**: **EPBC Act**: Vulnerable (delisted April 29 2013); **NC Act**: Vulnerable; **BoT**: Medium

**Sensitivity:** Moderate

**Recovery Plan:** This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

**Plate 27**. Brigalow scaly-foot (Parade*lma orientalis*) (Photograph Angus McNab)

### Overview of brigalow scaly-foot

**Ecology**: The brigalow scaly-foot (*Paradelma orientalis*) is known to shelter under logs, fallen bark and rocks and in leaf litter and grass tussocks (Ehmann 1992; Schulz and Eyre 1997; Peck 2012a). The species eats invertebrates such as crickets and spiders and plant material has been located in the scats of at least one individual. In addition, sap, particularly from *Acacia* species, constitutes a significant proportion of this species' diet in at least one population. Breeding occurs in spring/summer when two eggs are laid (Tremul 2000).

**Habitat**: The species occurs in land zones 3, 4, 5, 7, 8, 9 and 10 (SEWPAC 2013g) and in a correspondingly wide variety of habitats including woodlands dominated by brigalow (*Acacia harpophylla*) and other *Acacia* spp., spotted gum (*Corymbia citriodora*), poplar box (*Eucalyptus populnea*) and narrow-leaved ironbark (*Eucalytpus crebra*) forests and woodlands, dry sclerophyll forests on sandstone rises and areas of sparse tussock grass and spinifex (*Triodia mitchellii*) (Shea 1987; Schulz and Eyre 1997; Kutt *et al*. 2003). A dense mid-storey layer, such as of cypress pine (*Callitris* spp.), bulloak (*Allocasuarina luehmannii*) or *Acacia* spp., is often present (Kutt *et al*. 2003; Peck 2012a).

Being fossorial in habit, the brigalow scaly-foot (*Paradelma orientalis*) seems to be more prevalent in habitats that have few weeds and that consists of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Most records occur in remnant habitats, but occasionally the species is recorded in young regrowth (two to three years old) (Kutt *et al*. 2003; M.

Sanders pers. obs.) and weed infested habitats such as those dominated by buffel grass (*Cenchrus ciliaris*) (M. Sanders pers. obs.).

**Distribution**: The brigalow scaly-foot (*Paradelma orientalis*) is largely confined to the Brigalow Belt bioregion and, until recently, was thought to be endemic to Queensland (e.g., Tremul 2000; Richardson 2006). The species has now also been found in central inland New South Wales (Peck 2012a). In Queensland, it has been recorded from Ulcanbah Station 200 km southwest of Charters Towers in the north, near Goondiwindi in the south and Idalia National Park in the Mulga Lands bioregion to the west. It also occurs in the Southeast Queensland bioregion at Boyne Island near Gladstone (Schulz and Eyre 1997; Tremul 2000; Kutt et al. 2003; TSN 2008).

**Likelihood of occurrence and extent of habitat in the project development area**: There are eight known records of brigalow scaly-foot (*Paradelma orientalis*) known for the project development area. One record is from Chinchilla. The other seven records are all from south-west of Millmerran. There are also two recent survey records from north of Miles.

**Figure A30** indicates the location of records of the species (derived from survey and database records) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A67**.

**Table A67.** Extent of habitat for brigalow scaly-foot (*Paradelma orientalis*) in the project development area and associated areas of assessment

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 13703 | 162740 | 43359 |
| 3D Detailed Mapping Area** | 444 | 21893 | 20820 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 3458 | 40082 | 17309 |
| Survey area 2**** | 444 | 806 | 914 |
| Survey area 7 ****. | 0 | 151 | 130 |
| Survey area 8****. | 0 | 2350 | 1240 |
| Survey area 9****. | 0 | 462 | 332 |
| Survey area F****. | 0 | 99 | 116 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats**: The main threats to the local populations of brigalow scaly-foot (*Paradelma orientalis*) are:

- Habitat loss due to land clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Degradation of habitat through grazing of livestock (Cogger et al. 1993; Richardson 2006; EHP 2013).
- Predation by foxes (*Vulpes vulpes*), cats (*Felis catus*) and feral pigs (*Sus scrofa*) (Richardson 2006; TSN 2008; EHP 2013)
- Pasture improvement activities (Cogger et al. 1993).
- Inappropriate fire regimes (TSN 2008).
- Inappropriate roadside management (Richardson 2006; TSN 2008; EHP 2013).
- Death by humans due to misidentification with snakes and by being struck by vehicles (EHP 2013).

**Project-related Impacts**: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during vegetation clearing.
- Although the species is known to cross roadways and tracks, gas gathering and access tracks are likely to be less frequently crossed than areas with cover, reducing dispersal and movement.
- As the species is known to move across modified areas, it is highly probable that individuals could become trapped and perish in open trenches.
- Edge effects, particularly weed invasion (including buffel grass (Cenchrus ciliaris)), could significantly modify existing habitats and render them unsuitable for the species. As weed invasion resulting from clearing can extend some distance into previously unmodified habitats, this threat has the potential to alter large areas of potential or known habitat, reducing the abundance or extent of the species.
- Modified fire regimes resulting from increased human activity could affect habitat structure and therefore suitability for the species.
- Drowning or other mortality in steep-sided, plastic-lined dams.

**Significance of project related impacts (unmitigated)**: The sensitivity of populations of brigalow scaly-foot (*Paradelma orientalis*) to unmitigated impacts within the project development area is considered ***Moderate***. The brigalow scaly-foot (*Paradelma orientalis*) may be found in a variety of habitats. Although it may be found in small fragments and areas with heavy weed infestation, it is typically located in larger remnant patches with an intact ground surface structure. Clearing within

large tracts of habitat will result in the loss of some habitat, but is unlikely to significantly affect the long-term survival of populations in these areas.

The brigalow scaly-foot (*Paradelma orientalis*) is a mobile species and has been recorded crossing open roads, suggesting that, while movement may be reduced, some movements are likely to occur across clearings < 60m in width. Gas acquisition pipelines and associated roadways may therefore have a moderate effect on movements. As the species may cross open gas acquisition pipelines, they are susceptible to trench death. This short-term impact may result in the capture of a number of individuals but is likely to be restricted in extent.

While clearing may be minor in the context of available habitat, weed invasion associated with disturbance has the potential to alter much larger tracts of vegetation. Weed invasion and other edge effects reducing the integrity of existing habitats do pose a threat to populations.

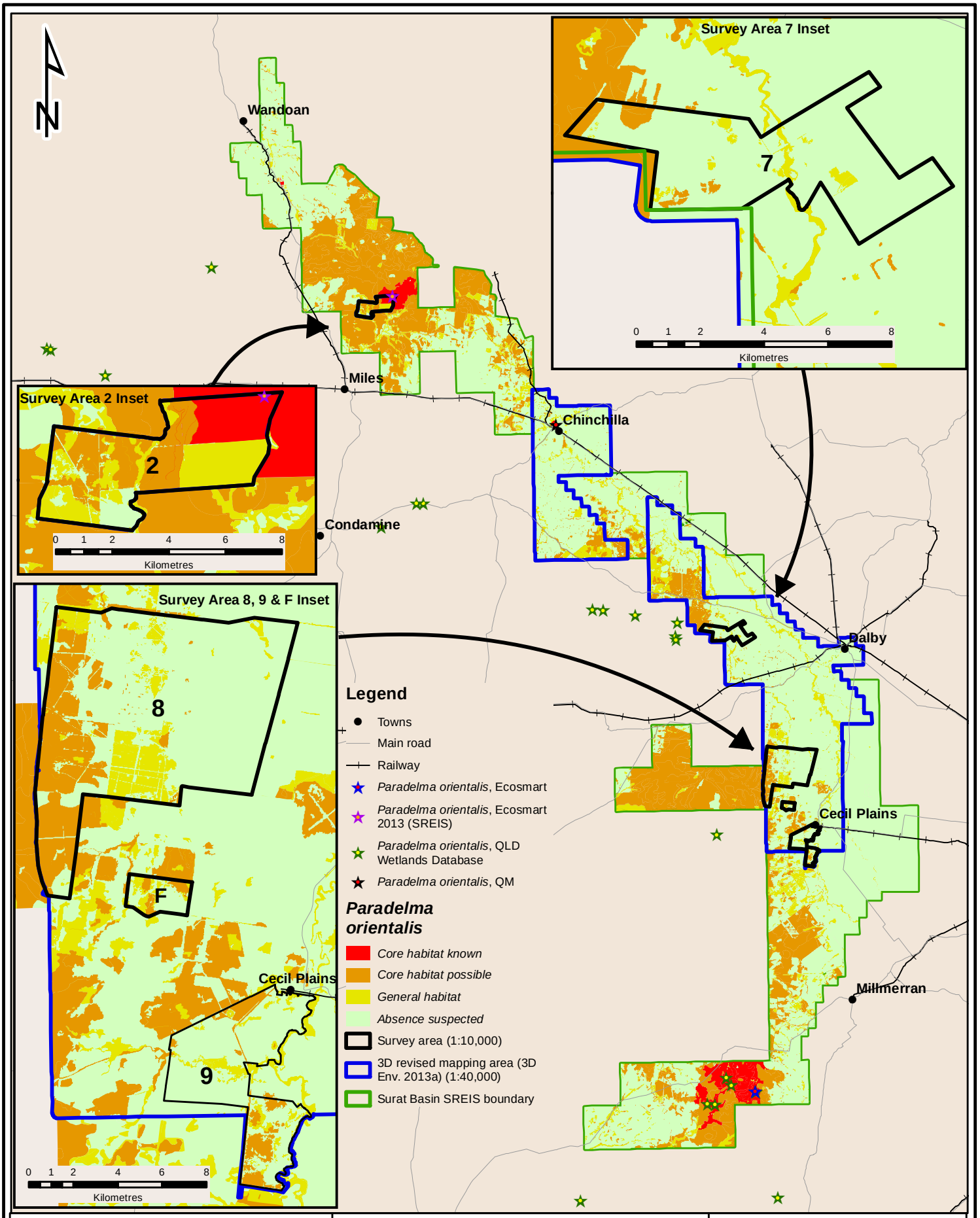
The magnitude of potential of unmitigated impact is considered ***Moderate***. The overall impact significance is ***Moderate* (13).**

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of brigalow scaly-foot will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Moderate (13)*** significance to brigalow scaly-foot (*Paradelma orientalis*) populations within the project development area. This species has broad habitat preferences and is widespread. Populations will therefore have some resilience to habitat disturbance. It is not anticipated that complete avoidance of suitable habitat will be possible, although minimising clearing should be a priority. Controlling impacts through rehabilitation and trench clearing will be beneficial and substantially reduce short-term and long-term impacts with residual impact of ***low (8).***

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Low (8) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Ecosmart 2013 (SREIS)
Ecosmart

**Figure A30.** Brigalow scaly-foot *(Paradelma orientalis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |

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**Rules for Habitat Mapping:**

1. The known distribution of this species encompasses the entire project development area.
2. Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
3. All contiguous remnant vegetation within a one km buffer of recent (1980+), accurate (with confirmed locations) records in the area is classed as 'core habitat known', regardless of RE type.
4. Within the Surat Gas Project area, the REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a and 11.10.1d are classed as 'core habitat possible' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
5. Patches of the REs listed above that are less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation are classed as 'general habitat.'
6. Within the Surat Gas Project area, REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'general habitat' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
7. REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'absence suspected' if less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
8. Regrowth vegetation (3+ years) within 200 m of remnant vegetation classed as 'core habitat possible' is considered to be 'general habitat.'
9. All mapped 'mature regrowth (EHP 2012b)' that includes RE attributed polygons is classed 'general habitat' for REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a and 11.10.1d unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation. Ground-truthing of mature regrowth may result in it being elevated to 'core habitat possible.'
10. Cleared agricultural and grazing land is classed as 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present. For rules 4 to 9, these are applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

**Mapping Confidence:** This species has very broad habitat requirements and may be found in a large number of regional ecosystems. As the species' distribution is more easily predicted based on *ground strata condition*, prediction based only on aerial mapping is difficult. Unless evidence suggests otherwise, most areas of remnant vegetation should be considered as possible habitat.

The map is considered to have a ***Moderate*** predictive accuracy.

**Evaluation under MNES Referral Guidelines**

**Table A68.** Evaluation of impact significance for brigalow scaly-foot (*Paradelma orientalis*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | Important populations of brigalow scaly-foot (*Paradelma orientalis*) occur in large contiguous areas of suitable remnant vegetation, such as the Central Queensland sandstone rises, the Blackwater/Blackdown Tablelands, the Moura/Theodore region and Boyne Island. Such areas of remnant vegetation are considered important strongholds for the species. Any populations found in such habitats are, therefore, important (Brigalow Belt Reptiles Workshop 2010).<br>There are eight known records of brigalow scaly-foot (*Paradelma orientalis*) known for the project development area. One record is from Chinchilla and the other seven records are all from south-west of Millmerran. There are also two recent survey records from north of Miles.<br>**Survey area 2**: Field surveys trapped two individuals of this species. The species could occur in all remnant and regrowth (3+ years old) vegetation on the property. This vegetation is part of a large contiguous area of suitable remnant vegetation and, as such, these records indicate that all remnant and regrowth vegetation on the property should be considered to support an 'important population' of brigalow scaly-foot (*Paradelma orientalis*) based on the above definition.<br>**Survey area 7**: Some 'core habitat possible, regional ecosystems (REs) 11.9.7, 11.9.9 and 11.10.1d, is present. In particular, areas of these habitats in the west of the property are connected too much larger tracks of vegetation in the adjacent State Forest, and therefore have greater potential to provide habitat for this species.<br>**Survey area 8**: Some 'core habitat possible, REs 11.5.1, 11.5.1a, 11.5.20 and 11.7.4, is present. Habitat structure and conditions in many areas of remnant vegetation on survey area 8 look highly suitable for this species, and is connected too much larger tracks of vegetation in the adjacent State Forest.<br>**Survey area 9**: Some 'core habitat possible', REs 11.3.1, 11.3.18, 11.5.1, 11.5.1a and 11.9.9, is present. Areas of these REs with a dense ground-cover of grass and fallen debris is not consistent with ideal habitat while locations such as RE 11.5.1 in the very north (adjacent Cecil Plains-Tara Rd) and south (adjacent Millmerran-Cecil Plains Rd) have microhabitats consistent with good habitat.<br>**Survey area F**: Some 'core habitat possible', REs 11.3.18, 11.7.4, 11.9.5, 11.9.9 and 11.10.1d, is present. Generally, these habitats appear less suitable for the species. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2**: Survey records indicate that all remnant and regrowth vegetation on the property should be considered to support an important population of brigalow scaly-foot (*Paradelma orientalis*). Clearing of these areas will lead to a decrease in the size of an important population, although these impacts are expected to be localised and not lead to a significant long-term decrease of the broader population.<br>Under Criteria 1, a significant impact to brigalow scaly-foot is expected based on an assumption that core habitat known or core habitat possible will be impacted.<br>**Survey area 7, 8, 9, F**: All four properties have some REs classed as 'core habitat possible' for brigalow scaly-foot (*Paradelma orientalis*). There is no known population for these properties. |

| Criteria | Evaluation |
|---|---|
| | Should a population be present on survey area 9 and F, the small size and isolation of the suitable habitat would, in most cases (i.e., not including the northern patch of 11.5.1 on survey area 9, which is near contiguous with habitat to the north of the Cecil Plains-Tara Rd), preclude it being considered an 'important population' based on the Brigalow Belt Reptiles Workshop (2010).<br>It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance surveys will be required if project footprints impact on remnant vegetation.<br>Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities.<br>For Survey areas 7, 8, 9 and F, significant impacts are not expected assuming that pre-clearance survey is undertaken and potential habitats are avoided during development. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2**: The project could reduce the area of occupancy of an important population. The impact will however be discrete and not affect habitat in the broader area. Under Criteria 2, a significant impact to brigalow scaly-foot is expected based on an assumption that core habitat known or core habitat possible will be impacted.<br>**Survey area 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2:** Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. The project will not fragment an existing important population if the species occurs in the contiguous habitat beyond the boundaries of survey area 2.<br>Under Criteria 3, a significant impact is not expected in survey area 2.<br>**Survey area 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2:** The project will result in the loss of habitat. However, these impacts will be discrete and localised; other habitats in the surrounding area will not be affected. It is therefore unlikely that activities on survey area 2 will affect habitat critical to the survival of the species in the broader area.<br>Under Criteria 4, a significant impact is not expected in survey area 2.<br>**Survey area 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2:** While the project will affect breeding within survey area 2, it is unlikely to affect breeding within the broader population.<br>Under Criteria 5, a significant impact is not expected in survey area 2.<br>**Survey area 7, 8, 9, F:** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2:** While the project could modify, destroy, remove, or decrease habitat for this species within survey area 2, these impacts are likely to be restricted to survey area 2 and at most the immediate area. It is unlikely that development on survey area 2 will lead to a decline of the species across its broader distribution.<br>Under Criteria 6, a significant impact is not expected in survey area 2.<br>**Survey area 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F** Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |

| Criteria | Evaluation |
|---|---|
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2:** Based on Criteria 1, broadscale clearing of survey area 2 does not comply with Recovery Objective 1 of the *Draft Queensland Brigalow Belt Reptile Recovery Plan* (Richardson 2006) and could interfere with the recovery of the species.<br>Under Criteria 9, a significant impact to brigalow scaly-foot is expected due to actions which are contrary to the species recovery plan, assuming areas of core habitat known or core habitat possible is to be impacted.<br><br>**Survey area 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:**

***Survey area 2*:** Based on current population knowledge, impacts are significant under MNES guidelines for actions on survey area 2. Clearing of remnant and regrowth vegetation on survey area 2 will lead to a decrease in the size and extent of an important population and hence significant impact to brigalow scaly-foot (*Paradelma orientalis)* is expected under Criteria 1 and 2. This assumes that development activities will impact on areas of core habitat known or core habitat possible. The proposed actions are also contrary to objectives of the reptile recovery plans for the Brigalow belt bioregion (Richardson 2006) and hence significant impacts could potentially occur under Criteria 9. Significant impacts are not expected under other criteria.

***Survey areas 7, 8, 9 and F***: Based on the assumption that this species is not present on the subject properties (survey area 7, 8, 9 and F), impact of development is of extremely low magnitude and impacts under MNES criteria area not considered significant This assumption has not been tested by targeted survey work and pre-clearance works should be conducted prior to any clearing on these survey survey areas. The potential for significant impacts under MNES criteria should be reconsidered once detailed survey works have been completed.

Arrow impacts in survey area 2 will be localised in extent and not likely to lead to the long-term decline, or reduce viability, of the broader population. Provided appropriate rehabilitation works are undertaken following decomission, habitat areas have the potential for re-establishment and impacts are not therefore irreversible. Impacts on these descrete properties are not unknown or unpredictable, although the extent of cumulative impacts remain unclear.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed 'core habitat possible' should be avoided but, given the wide habitat use of the species, this is unlikely. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover dominated by native species, particularly tussock grasses;
    - Fallen debris, i.e., timber, bark;
    - Rocks (non-essential);
    - Dense leaf litter (non-essential);
    - Soil cracks (non-essential).
- Landscape interpretation, including:
    - Is the habitat part of contiguous remnant or mature regrowth at least 10 ha in size;
    - If less than 10 ha, is the habitat within 200 m of a large area of contiguous remnant vegetation of suitable regional ecosystems for the species;
    - If less than 10 ha, is the habitat part of a EHP mapped discontinuous wildlife corridor of State or regional significance.

If suitable habitat and landscape features are present, the following survey methods should be deployed:

- Actively search suitable microhabitat.
- Pitfall traps.
- Funnel traps.
- Spotlight on warm nights (Brigalow Belt Reptiles Workshop 2010).
- Spotlight sap-exuding Acacia species (SEWPAC 2011).

Details of pitfall and funnel trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Trapping should be supplemented with active searching and spotlighting. A single survey conducted over four trap nights during October to February should be sufficient, provided ground temperatures are generally above 19$^{o}$C and preferably above 24$^{o}$C (SEWPAC 2011). Multiple surveys with good spatial and habitat representation may be required in very large habitat patches. It is recognised that such surveys will be impractical for all activites, such those where a large number of well sites are proposed in close proximity. In such cases, habitats representative of those to be impacted should be sampled rather than individual locations.

Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

Important populations of brigalow scaly-foot (Paradelma orientalis) occur in large contiguous areas of suitable remnant vegetation. Such areas of remnant vegetation are considered important strongholds for the species. Any populations found in such habitats are, therefore, important (Brigalow Belt Reptiles Workshop 2010).

If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

## Five clawed worm-skink (*Anomalopus mackayi*)

**Status**: **EPBC Act**: Vulnerable; **NC Act**: Endangered; **BoT:** H

**Sensitivity**: Extremely High

**Recovery plan:** This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

*Anomalopus mackayi* is known as both the five clawed worm-skink (*Anomalopus mackayi*) and the long-legged worm-skink.

**Plate 28.** Five clawed worm-skink (*Anomalopus mackayi*) (Photograph Scott Eipper)

**Overview of five clawed worm-skink**

**Ecology**: Little is known of this species' biology, but it is adapted to burrowing and can be found under logs, rocks and in loose soil (Hobson 2012b), under clumps of slashed grass (T. Reis pers. obs.) and presumably in soil cracks (Ehmann 1992). Nothing is known of its breeding biology, except that it is an egg-laying species. Its diet is assumed to consist of small arthropods (e.g., insects, spiders). Captive animals remained beneath the upper surfaces of soil during the day, emerging only to capture mealworms from the surface.

No movement data has been recorded. The species has not been recorded crossing roadways or tracks; however, related species are known to occasionally cross open artificial surfaces. This suggests that the species, while very reluctant, may cross open ground for short distances.
**Habitat**: The five clawed worm-skink (*Anomalopus mackayi*) is found in open grasslands on heavy cracking soil (Wilson 2005) in areas with closely spaced tussock grass that may be prone to inundation (Ehmann 1992). Scattered eucalypts may be present or adjacent (Ehmann 1992; Cogger *et al*. 1993). It also occurs in open eucalypt woodland, cypress pine (*Callitris* spp.) woodland with a grassy groundcover and in grassland on loam or sandy soils (Hobson 2012b). Suitable habitats on the Darling Downs remain a stronghold (Fitzgerald 1996; Hobson 2002; EPA 2003), particularly low (typically <40 cm) native grasslands with or without sparse trees and also derived native grasslands

created by land clearing. In Queensland the species is now largely confined to relict roadside verges (Wilson 2005).

**Distribution**: The five clawed worm-skink (*Anomalopus mackayi*) has a small distribution, being confined to the eastern Darling Downs region of the southern Brigalow Belt in Queensland and the western slopes of the Great Dividing Range in north-east New South Wales (Richardson 2006; Hobson 2012b). Its range appears to have contracted eastwards (Cogger *et al*. 1993). Records in the past 20 years have come only from Oakey and the Dalby regions of Queensland, and from the Wallangra, Mungindi and Wee Waa regions of New South Wales. The Wallangra specimens link what were previously thought to be disjunct Queensland and New South Wales populations. Localities for museum specimens collected prior to 1970 include a number on the plains south and west of Moree, and as far west as Goodooga, New South Wales (SEWPAC 2013a).

**Likelihood of occurrence and extent of habitat in the project development area**: There are three known records of five clawed worm-skink (*Anomalopus mackayi*) known for the project development area. Two records from Dalby (to which the record may have been attributed based on it being the nearest town) and one from approximately 19 km east of Cecil Plains.
**Figure A31** indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A 69**.

**Table A69.** Extent of habitat for five clawed worm-skink (*Anomalopus mackayi*) in the project development area and associated areas of assessment.

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 0 | 12703 | 0 |
| 3D Detailed Mapping Area** | 0 | 7776 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 7215 | 0 |
| Survey area 7 ****. | 0 | 16 | 0 |
| Survey area 8****. | 0 | 292 | 0 |
| Survey area 9****. | 0 | 125 | 0 |
| Survey area 2, F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General threats to the species**: The main threats to the local populations of five clawed worm-skink (*Anomalopus mackayi*) are:

- Habitat loss due to land clearing.
- Degradation of habitat through grazing of livestock, soil compaction and erosion due to grazing and/or ploughing.
- Loss of ground litter and other cover such as fallen timber, modification of habitat through agriculture and irrigation (Cogger et al. 1993; Richardson 2006; Hobson 2012b).
- Inappropriate fire regimes.
- Inappropriate roadside management.
- Weed invasion (Richardson 2006).
- Feral predators (SEWPAC 2013a).

Very little pristine native grassland now remains within its known range, and much of the area is heavily modified and regularly cropped (Fitzgerald 1996). A threatening process of ploughing bluegrass has also been noted (EPA 2003).

**Project-related impacts**: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Loss of suitable habitat, reducing the extent of populations. In cases where disturbance is extensive, local extinctions may occur.
- Fragmentation and isolation of previous contiguous or connected populations by gas gathering lines and access tracks.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Increased surface water leaking from gas bores may alter the soil structure, closing ground cracks and facilitating weed or exotic grass growth.
- Edge effects, particularly weed invasion, pose a significant threat to grasslands dominated by native species. Exotic species alter habitat structure, potentially rendering large areas unsuitable.

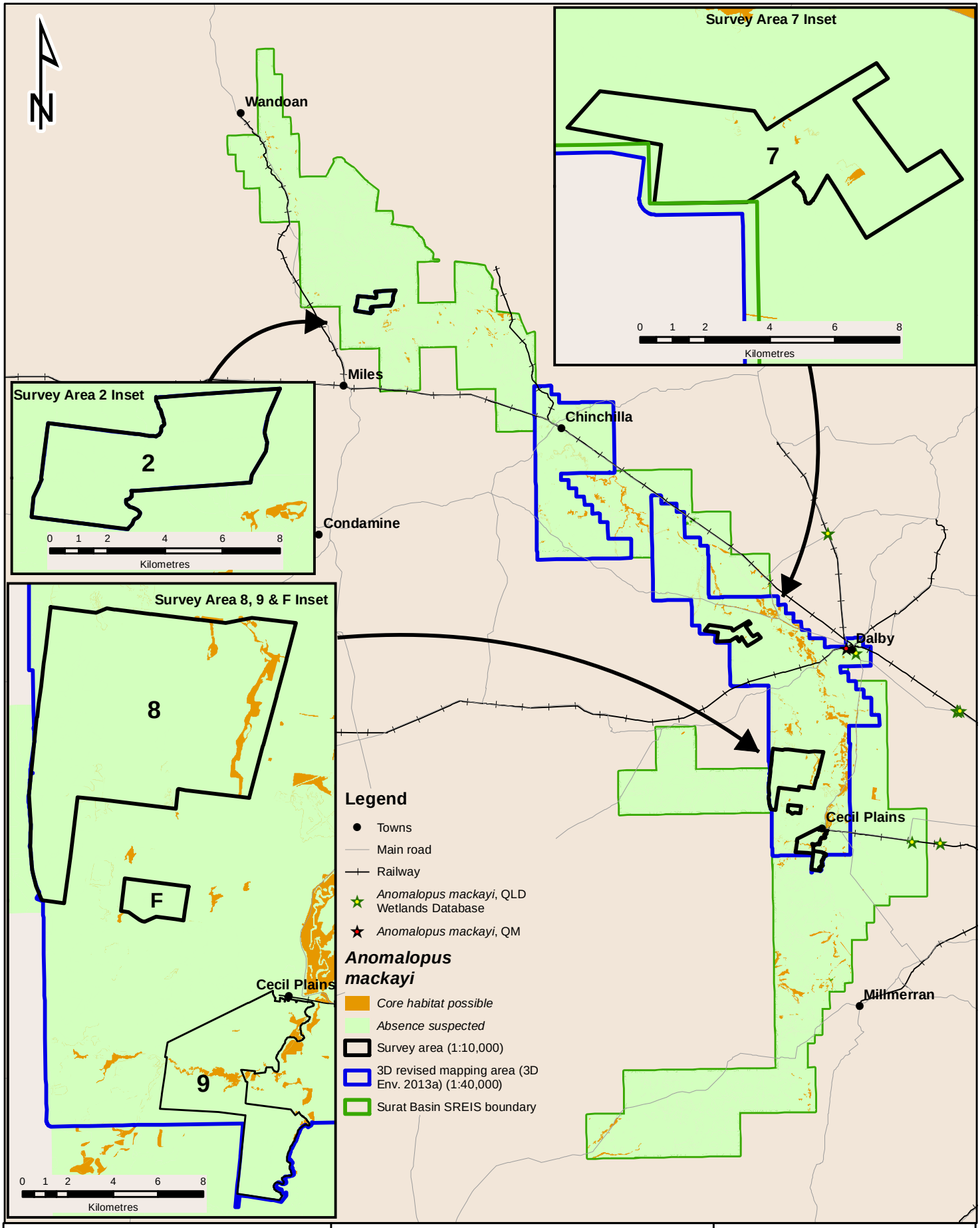
**Significance of project related impacts (unmitigated):** The sensitivity of populations of five clawed worm-skink (*Anomalopus mackayi*) to unmitigated impacts within the project development area is considered ***Extremely High***. Darling Downs grasslands remain the stronghold for this species in Queensland. However, remaining populations are restricted to minor fragments such as roadside reserves. Due to the minor extent and linear nature of these areas, even small clearing actions can have serious impacts. Remaining populations are highly important. Remnant grasslands are fragile communities and highly susceptible to disturbance and modification. Clearing, fragmentation, increased mortality due to trench deaths and weed invasion pose significant threats to the species and impact magnitudes could be ***Major***. In the absence of appropriate mitigation, the the impact significance to this species is ***Major* (25)** as populations may be lost and populations are unlikely to recover through remedial actions.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of five clawed worm skink will be prioritised.

**Summary Residual Impact Assessment:** Unmitigated project related activities may result in impacts of ***Major (25)*** significance to five clawed worm-skink (*Anomalopus mackayi*) populations within the project development area. This species has a narrow distribution in Queensland and remaining stronghold populations within the Brigalow Belt are centred on grasslands in the Darling Downs. If potential habitats are avoided, no residual impact will be incurred. Other measures such as minimising disturbance, trench checking and weed control may achieve only limited success.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | High | Major (23) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

**Figure A31.** Long legged worm skink *(Anomalopus mackayi)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |

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**Rules for Habitat Mapping:**

1. The species will not occur in the very northern portions of the project development area. It is therefore restricted to habitats south of 260 40' (26.6660).
2. Remnant grasslands and woodlands with native ground cover on dark cracking clays (regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.21, 11.3.24), and derived non-remnant native grasslands (veg code ARG) are classed as 'core habitat possible.' This includes attribution of mature regrowth datasets (EHP 2012b).
3. Any polygon of 'core habitat possible' containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known.'
4. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
5. Remaining regional ecosystems are considered to be 'absence suspected.'

**Mapping confidence:** This species' habitat requirements are relatively well understood and form a discrete set of regional ecosystems. Additional areas of 'core habitat known' are likely to be located with increased survey effort and regional understanding. The habitat map for this species is considered to be ***Highly*** accurate.

**Evaluation under MNES Referral Guidelines**

**Table A70.** Evaluation of impact significance for five clawed worm-skink (*Anomalopus mackayi*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | Important populations in Queensland occur where habitat remains throughout the species' known distribution on the Condamine River Floodplain: the region (including agricultural farming land) between Bowenville/Oakey, Pittsworth and Jimbour (Richardson 2006; Brigalow Belt Reptiles Workshop 2010).<br>There are three known records of this species for the project development area, two from Dalby and one from approximately 19 km east of Cecil Plains. However, the records attributed to Dalby may be based on it being the nearest town, rather than the specimens actually being collected at Dalby.<br>**Survey area 2**: Intensive field survey failed to locate this species. No 'core habitat possible' is present. Survey area 2 is north of the known distribution of the species.<br>**Survey area 7**: Some 'core habitat possible', regional ecosystem (RE) 11.3.2 and derived non-remnant native grassland, is present.<br>**Survey area 8**: Some 'core habitatp, REs 11.3.2 and 11.3.21 and derived non-remnant native grassland, is present.<br>**Survey area 9**: Some 'core habitat possible', RE 11.3.2 and derived non-remnant native grassland, is present.<br>**Survey area F**: No 'core habitat possible' is present. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F**: Survey area 2 has no habitat classed as 'core habitat possible' and is outside the known distribution of the species. Survey area F has no 'core habitat possible.' The species is not expected to occur on survey area 2 or survey area F based on a combination of known distribution and habitat requirements.<br>Survey area 7, 8 and 9 have some REs and some derived grasslands classed as 'core habitat possible' for long-legged worm-skink. There is no known population for these properties, however further survey in these habitats is required. As such, it is not possible to totally discount occurrence of the species on the survey area 7, 8 and 9. Further survey on these properties will be required if suitable habitats are within proposed clearance zones.<br>Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations on any of the five survey areas. Some small areas of suitable habitat (derived grasslands) are known from survey area 8 and 9, which should be the subject of survey if disturbance to these areas is expected. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' and 'core habitat possible' is not disturbed and appropriate pre-construction survey efforts are undertaken, broader project scale activities are unlikely to result in a significant impact and Arrow will not contribute to

cumulative impacts associated with other proponents. Further, appropriate survey and mitigation should ensure that impacts are not unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed as 'core habitat known' are to be avoided and do not require survey work on this basis. Areas mapped as 'core habitat possible' should be avoided where possible. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation that the location is south of 260 40' (26.6660) and part of the Condamine River Floodplain.
- Confirmation that the location is remnant grassland or woodland with native ground cover on dark cracking clays (REs 11.3.2, 11.3.3, 11.3.21, 11.3.24), and derived non-remnant native grasslands (veg code ARG).
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Presence of native grasses;
    - Closely spaced grass tussocks;
    - Woody debris (non-essential);
    - Rocks (non-essential);
    - Clumps of slashed grass (non-essential).

If suitable habitat and landscape features are present, at least three of the following survey methods should be deployed:

- Actively search suitable microhabitat. Searching may not be possible where movable sheltering sites are not present.
- Establishment and monitoring of artificial shelter sites, such as hay bales, canite, particle boards and old carpet (Brigalow Belt Reptiles Workshop).
- Pitfall traps.

During dry periods, the five clawed worm-skink (*Anomalopus mackayi*) may be in deep soil cracks, which makes them difficult to find through active searching. The deployment and regular monitoring of artificial shelter sites is likely to be the most effective method of detecting the species as it is likely to shelter at or near the soil surface in such locations (Spark 2010, DEWSPaC 2011).

The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. The survey should be a minimum of three days and nights and should be replicated if unsuccessful (Brigalow Belt Reptiles Workshop 2010). If the patch of suitable habitat is sufficiently large, a different location should be surveyed to achieve greater spatial representation. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations

Details of pitfall trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.
Important populations in Queensland occur where habitat remains throughout the species' known distribution on the Condamine River Floodplain: the region (including agricultural farming land) between Bowenville/Oakey, Pittsworth and Jimbour (Richardson 2006; Brigalow Belt Reptiles Workshop 2010). If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

## Yakka skink (*Egernia rugosa*)

**Status**: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT:** Medium

**Sensitivity:** High

**Recovery Plan:** This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

**Plate 29.** Yakka skink (*Egernia rugosa*) (Photograph Mark Sanders).

**Overview of yakka skink**

**Ecology**: Yakka skinks (*Egernia rugosa*) live in communal burrow systems, often under timber and in deep rock crevices. The species also uses abandoned rabbit (*Oryctolagus cuniculus*) warrens and shelters in hollow logs. Burrows may be under buildings and other solid structures, such as concrete slabs and piles of felled timber (Ehmann 1992; Wilson 2005). Yakka skinks (*Egernia rugosa*) can occur in highly degraded sites especially where there are heaps of dead timber and rabbit warrens. The species may be more common than previously thought (EPA 2003). Yakka skinks (*Egernia rugosa*) eat soft plant material, invertebrates and small vertebrates and foraging occurs by day and on warm nights (Ehmann 1992). However, no detailed study on the distribution and ecology of this species has been published. They are secretive animals, retreating to their burrows when disturbed. Their presence is often indicated by their defecation sites (Eddie 2012).

**Habitat**: The species occurs in land zones 3, 4, 5, 7, 9 and 10, and possibly in land zone 8, though the latter is not considered to be representative of core habitat. Within these land zones it occurs in a wide variety of habitat types, particularly woodland and open forest dominated by brigalow (*Acacia harpophylla*), mulga (*A. aneura*), bendee (*A. catenulata*), lancewood (*A. shirleyi*), belah (*Casuarina cristata*), poplar box (*Eucalyptus populnea*), ironbark (*Eucalyptus* spp.), and white cypress pine (*Callitris glaucophylla*). Yakka skinks (*Egernia rugosa*) usually occur on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Ehmann 1992; Cogger 2000; Wilson 2005; Richardson 2006; Brigalow Belt Reptiles Workshop 2010) but are also found on loam and clay soils (Eddie 2012). The core habitat of yakka skink (*Egernia rugosa*) is within the Mulga Lands and Brigalow Belt South bioregions (TSN 2008).

**Distribution**: The yakka skink (*Egernia rugosa*) is endemic to eastern Queensland and is patchily distributed in sub-humid to semi-arid dry open forest, woodland and rocky areas. Its distribution is highly fragmented due to land clearing (SEWPAC 2012c). Isolated populations occur from St George north to Coen on Cape York Peninsula. In 2002, new populations were discovered in Culgoa Floodplain and Thrushton National Parks, and the species extends further west to Chesterton Range National Park (Richardson 2006).

**Occurrence in the project development area and extent of habitat**: There is no known record of yakka skink (*Egernia rugosa*) in the project development area. However, there are two records within proximity to the project development area, one approximately 30 km to the southwest of Chinchilla (no date) and one 20 km west of Chinchilla (1987). **Figure A32** indicates the location of confirmed records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table 71**.

**Table A71.** Extent of habitat for yakka skink (*Egernia rugosa*) in the project development area and associated areas of assessment.

| | Core Habitat Known (ha) | Core Habitat Possible (ha) | General Habitat (ha) |
|---|---|---|---|
| Project Development Area* | 0 | 20654 | 181559 |
| 3D Detailed Mapping Area** | 0 | 3101 | 24720 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 3634 | 23891 |
| Survey area 7 ****. | 0 | 231 | 35 |
| Survey area 8****. | 0 | 0 | 2016 |
| Survey area 9****. | 0 | 90 | 647 |
| Survey area 2, F****. | 0 | 228 | 1149 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats**: The main threats to the local populations of yakka skink (*Egernia rugosa*) are:

- Habitat loss due to land clearing.
- Predation by foxes (*Vulpes vulpes*) and cats (*Felis catus*) (Drury 2001; Richardson 2006; TSN 2008).
- Trampling of burrows by livestock.
- Pasture improvement activities such as ploughing.
- Inappropriate fire regimes (Drury 2001).
- Ripping of rabbit warrens (TSN 2008).
- Removal of fallen timber and rocks.
- Inappropriate roadside management (Richardson 2006; TSN 2008).
- Mortality by being struck by vehicles (Drury 2001).

**Potential project-related impacts**: Impacts associated with the proposed project related activities could include:

- Loss of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Wide infrastructure corridors with little cover may inhibit movement, leading to increased fragmentation of existing populations.
- Individuals may become trapped in open trenches, resulting in mortality.
- Creation and maintenance of gas gathering lines and access tracks may increase access to habitats for feral predators.
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for this species. Considering the small extent of some populations, even small weed infestations could have significant impacts.
- Drowning or other mortality in steep-sided, plastic-lined dams.

**Significance of project related impacts (unmitigated)**: The sensitivity of populations of yakka skink (*Egernia rugosa*) to unmitigated impacts within the project development area is considered ***High***. All known yakka skink (*Egernia rugosa*) records occur outside the project development area, although two occur within close proximity (≤ 30 km) and the the species' persistence within the area is unclear. The species is communal, meaning that the animals in any given area are likely to be concentrated in one location. Apparently minor disturbance such as road widening can have substantial impacts on a local population. The species is tolerant of some disturbance and provided adequate alternative habitat is available, is capable of recovery. The species is considered to be highly sensitive and impact magnitudes could be ***High***. This species has an unmitigated impact significance of ***High (21).***

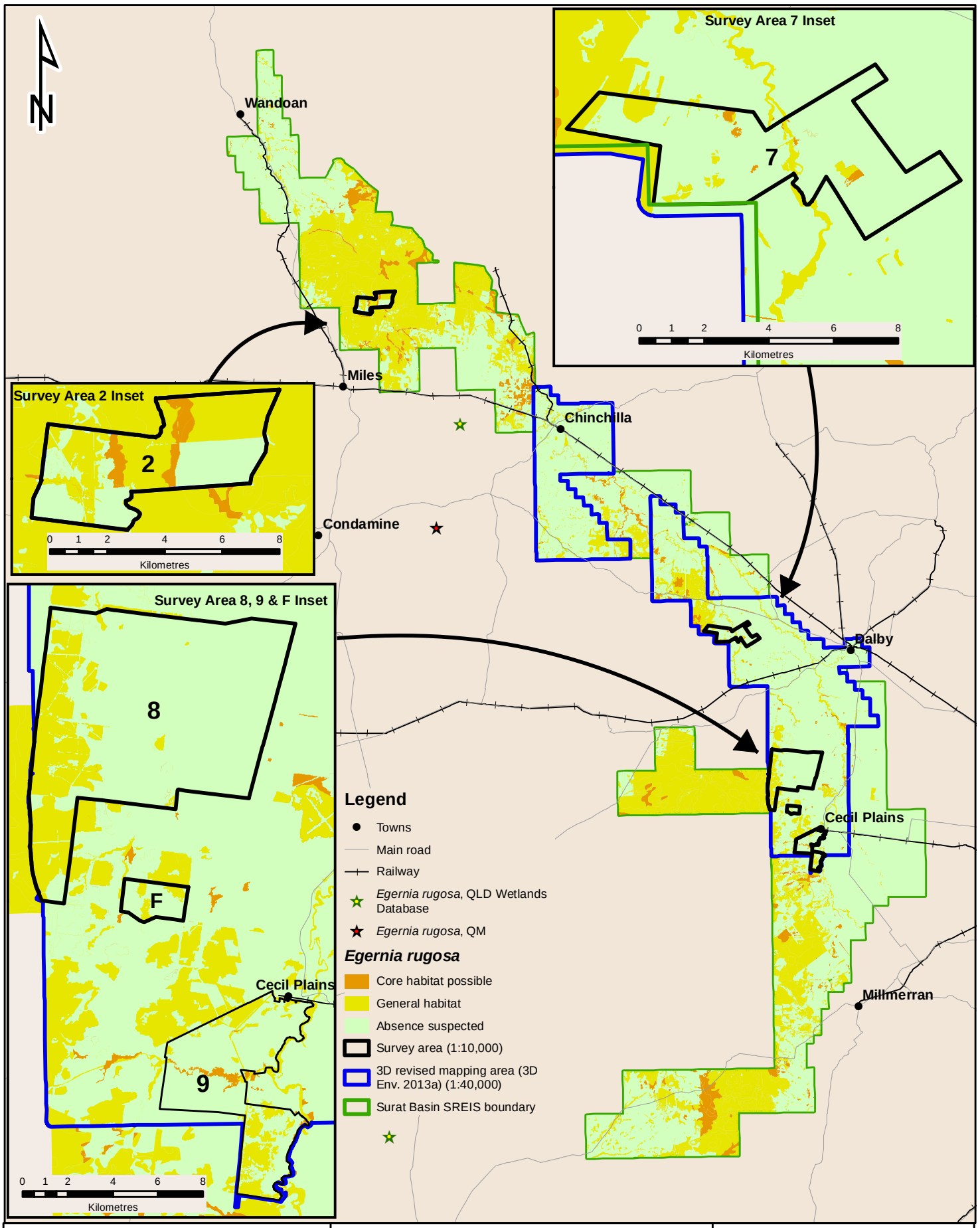
**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts

to the species. Infrastructure design and site selection that seeks to avoid core habitat known of yakka skink wattle will be prioritised.

**Summary Residual Impact Assessment:** Unmitigated project related activities may result in impacts of ***High (21)*** significance to yakka skink (*Egernia rugosa*) populations within the project development area. Avoiding habitat is the most effective mitigation measure for this species and no impact will be incurred. Where core habitat cannot be avoided, further survey work should be undertaken to ascertain their presence and/or distribution. Important habitat for the species includes REs 11.3.2, 11.3.3, 11.3.14 and 11.7.7, though other regional ecosystems should not be discounted as possible habitat. Further survey work will allow the likely level of impact to be clarified. Other mitigation measures such as rehabilitation, translocation may have some success and resulting residual impact significance will be ***Moderate (12)***.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

**Figure A32.** Yakka skink *(Egernia rugosa)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 6/05/2013 | A4 |

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**Rules for Habitat Mapping:**

1. Map regional ecosystems 11.3.2, 11.3.3, 11.3.14 and 11.7.7 as 'core habitat possible.'
2. Map all other remnant vegetation on land zones 3, 4, 5, 7, 9 and 10 as 'general habitat.'

**Mapping Confidence:** This species is poorly represented within the project development area. It is unlikely that the species will occur with any regularity and the map is considered to be of ***Low*** accuracy.

**Evaluation under MNES Referral Guidelines**

**Table A72.** Evaluation of impact significance for yakka skink (*Egernia rugosa*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | Important populations of yakka skink (*Egernia rugosa*) occur where colonies are identified or within five km of known records of the species. Any contiguous patch of vegetation suitable for the long-term persistence of a population, or for maintaining genetic diversity across the landscape, is important habitat for the species (Brigalow Belt Reptiles Workshop 2010).<br>There is a no known record of this species from the project development area.<br>**Survey area 2**: Intensive field survey failed to locate this species. Some 'core habitat possible', regional ecosystem (RE) 11.7.7, is present.<br>**Survey area 7**: Some 'core habitat possible', REs 11.3.2 and 11.3.14, is present. However this property is well east of any known record and it seems unlikely the species will occur.<br>**Survey area 8**: Some 'core habitat possible', RE 11.3.2, is present. However this property is well east of any known record and it seems unlikely the species will occur.<br>**Survey area 9**: Some 'core habitat possible', RE 11.3.2, is present. However this property is well east of any known record and it seems unlikely the species will occur.<br>**Survey area F**: No 'core habitat possible' is present. However this property is well east of any known record and it seems unlikely the species will occur. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F**: Survey area 2, 7, 8 and 9 all have some remnant vegetation classed as 'core habitat possible' for yakka skink (*Egernia rugosa*). There is no known record within five km of any of the five properties that would identify an 'important population.'<br>It is not possible to totally discount occurrence of the species on the properties, although their occurrence on all but survey area 2 seems quite unlikely. Pre-clearance surveys on survey area 2 should be undertaken once project footprints have been identified.<br>Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |

| Criteria | Evaluation |
|---|---|
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of yakka skink (*Egernia rugosa*) on any of the subject five properties. It also seems unlikely that the species could occur in most properties as all those except survey area 2 are well east of its known range. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and there is little potential for cumulative impacts to be reinforced by Arrow related activities. Further, appropriate survey and mitigation should ensure that impacts across survey areas and the broader SREIS assessment area are not unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Where areas classed 'core habitat possible' cannot feasibly be avoided, if clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. Yakka skinks (*Egernia rugosa*) usually occur on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Ehmann 1992; Wilson 2005; Richardson 2006) but are also found on loam and clay soils (Eddie 2012). Important habitat for the species includes regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.14 and 11.7.7, though other REs should not be discounted as possible habitat.

Survey work should include:

- Initial visual assessment to determine if several of the below habitat features are present:
    - Animal burrows, including rabbit (*Oryctolagus cuniculus*) burrows.
    - Hollow logs.
    - Cavities under or between rocks, logs, tree stumps and tree roots.
    - Log piles.
    - Deep gullies.

If suitable habitat features are present, the following survey methods should be deployed:

- Actively search for communal defecation sites (surveyors must be familiar with latrine sites as they may not be immediately obvious).
- Actively search for burrow systems.
- Elliott style box traps set close to burrow entrances or other suspected shelter sites such as hollow logs.
- Observation of potential shelter sites at a distance with binoculars.

The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. Optimal survey times for active searching are early morning (two hours either side of dawn) and during the evening on warm nights (Brigalow Belt Reptiles Workshop 2010). Minimum survey effort should be three survey days and nights. If the presence of the species is suspected but not confirmed, a second survey should be conducted. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations.

Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval. Important populations of yakka skink (*Egernia rugosa*) occur where colonies are identified or within five km of known records of the species. Any contiguous patch of vegetation suitable for the long-term persistence of a population is important habitat for the species (Brigalow Belt Reptiles Workshop 2010). If yakka skink (*Egernia rugosa*) is located then work should cease in all parts of any contiguous habitat. Evaluation under MNES guidelines will be required.

## Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*)

**Status**: **EPBC Act**: Endangered; **NC Act**: Endangered; **BoT:** High
**Sensitivity**: Extremely High
**Recovery Plans**: *The Recovery Plan for the Grassland Earless Dragon* Tympanocryptis lineata pinguicolla *2000–2004* (Robertson and Cooper 2000). *National Recovery Plan for the Grassland Earless Dragon Tympanocryptis pinguicolla* (Robertson and Evans 2009). This species is also included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006) (as *T. pinguicolla*).

**Plate 30 .** Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) (Photograph Mark Sanders).

**Alternative Nomenclature:** EHP's Wildnet database refers to the species as Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). SEWPAC's Species Profile and Threats (SPRAT) Database refers to the species as grassland earless dragon (*Tympanocryptis pinguicolla*) but acknowledges that the Queensland (Darling Downs) population is more closely related to *Tympanocryptis tetraporophora* (SEWPAC 2013i) as per Melville *et al*. (2007). Melville *et al.* (2007) found that the Darling Downs population is not closely related to *Tympanocryptis pinguicolla*, but were unable to establish whether they are an undescribed species of *Tympanocryptis* or a population of *Tympanocryptis tetraporophora*. Given this taxonomic uncertainty this report will refer to the species as the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). Where the literature does not clearly differentiate between populations, reference will be made to grassland earless dragon.

### Overview of Darling Downs earless dragon

**Ecology**: The few ecological studies undertaken of Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) in Queensland suggest that they are more prevalent in sorghum crops (average of 8.686 individuals per 100 trap-days) than grass verges (0.725/100 trap-days) or native grasslands (0.572/100 trap-days). Individuals predominantly shelter beneath sorghum litter (85.7%), but soil cracks are also used (9.5%) (Starr and Leung 2006).

**Habitat**: Unlike the southern grassland earless dragon (*Tympanocryptis pinguicolla*), the Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) is regularly recorded in sorghum crops,

usually adjacent to native grassland verges that may be only minor in extent (Starr and Leung 2006). These minor grassland areas may act as vital refugia when active farming of sorghum prevents inhabitation. Despite the use of crops, native grasslands (regional ecosystems 11.3.2 and 11.3.21) are listed as Essential Habitat for the Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) (EPA 2003). Native grasslands within the Darling Downs have been reduced to 1.34% of their original extent by 1993 (Fensham 1997). Remaining areas are typically located in stock routes and road reserves.

**Distribution**: Until 2001, the grassland earless dragon (*Tympanocryptis pinguicolla*) was known only from native grasslands around Cooma and Canberra. Historically, the species was also known from grasslands on the Darling Downs, Queensland. Undetected for more than 30 years despite survey efforts (Covacevich *et al.* 1998), the Darling Downs population was rediscovered in 2001 (Melville *et al.* 2007). It is now known from a handful of locations on the Darling Downs, all between Dalby, Toowoomba, Millmerran and Cecil Plains (Hobson 2002).

**Likelihood of occurrence and extent of habitat in the project development area** There is one known record of Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) in the project development Area, approximately 20 km east south-east of Cecil Plains. **Figure A33** indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A73**.

**Table A73.** Extent of habitat for Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) in the project development area and associated areas of assessment

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 0 | 7727 | 0 |
| 3D Detailed Mapping Area** | 0 | 7230 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 3463 | 0 |
| Survey area 7 ****. | 0 | 1 | 0 |
| Survey area 8****. | 0 | 293 | |
| Survey area 9****. | 0 | 126 | 0 |
| Survey area 2, F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General Threats to the Species**: The main threats to the local populations of Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) are:

- Habitat loss caused by agricultural and urban development.
- Processes that modify and degrade remaining habitat including:
- Irrigation.
- Changed fire regimes.
- Changed grazing regimes.
- Invasion of weeds.
- Introduced animals (Cogger et al. 1993; Brereton and Backhouse 2003; Robertson and Evans 2006).

Darling Downs earless dragons (*Tympanocryptis cf. tetraporophora*) occur in crop paddocks on private property. In the absence of further information, existing cropping practices should be continued.

**Project-related Impacts**: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during construction. Depending on the extent of clearing, displaced animals are unlikely to persist due to increased competition with existing resident animals.
- Loss of habitat reducing the extent of populations, or in the cases where disturbance is extensive, causing local extinctions.
- Fragmentation and isolation of previous contiguous or connected populations by gas gathering lines and access tracks.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Increased surface water leaking from gas bores may alter the soil structure, closing ground cracks and facilitating weed or exotic grass growth.
- Edge effects, particularly weed invasion, pose a significant threat to grasslands dominated by native species. Exotic species alter habitat structure, potentially rendering large areas unsuitable.
- Drowning or other mortality in steep-sided, plastic-lined dams.

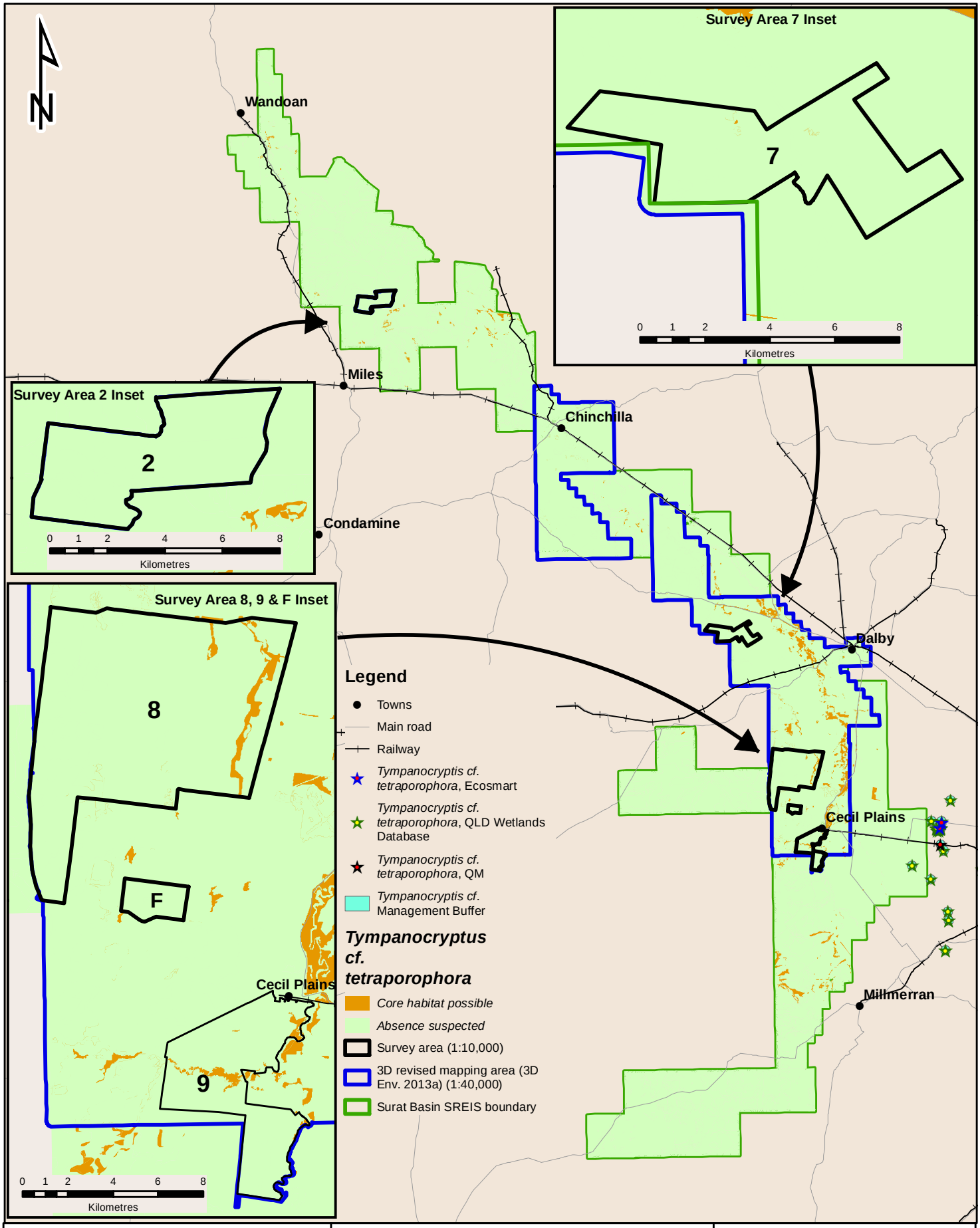
**Significance of Project Related Impacts (Unmitigated)**: The sensitivity of populations of Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) to unmitigated impacts within the project development area is considered ***Extremely High***. This species possibly only occurs within the Darling Downs in Queensland (see Alternative Nomenclature above). The project development area includes a large portion of the western Darling Downs and the loss of populations in the area could have significant deleterious impacts on the overall survival of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). The species occurs in small isolated populations making them susceptible to clearing. Movement of the species over artificial surfaces is not documented. However, the species inhabits modified sorghum fields suggesting that narrow gas gathering lines or access tracks are unlikely to create significant movement barriers. Any such willingness to move over disturbed ground places them at risk of becoming captured in trenches. Given the small extent of some populations, open trenches adjacent or through communities may affect a significant number of individuals. Native grasslands are particularly prone to weed infestation. Weed infestations can alter habitat structure, rendering previously suitable areas unsuitable. These factors indicate that impacts could have a ***High*** magnitude and the species has an impact significance of ***Major (23).***

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Darling Downs earless dragon will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Major (23)*** significance to Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) populations in the project development area. Aoidance of 'core habitat known' or 'core habitat possible' is the most effective and efficient impact mitigation measure and if undertaken, no impact will be incurred. Other measures such as minimising disturbance, trench checking and weed control may achieve limited success.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Extremely High | NA | NA | High | Major (23) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Ecosmart

**Figure A33.** Darling Downs earless dragon *(Tympanocryptis cf. tetraporophora)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
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**Rules for Habitat Mapping:**

1. The species will only occur within the Darling Downs regions associated with the Condamine Floodplain (-27.00˚ to -28.00˚; 151.18˚ to 151.90˚).
2. All remnant grasslands and woodlands with native ground cover (regional ecosystems (REs) 11.3.2, 11.3.21, 11.3.24), and derived non-remnant grasslands dominated by native grasses are classed as 'core habitat possible.' A 100 m buffer around these communities regardless of land-use should be included as 'core habitat possible' for management purposes to account for the species ability to occur in tilled crops (e.g., sorghum).
3. All land, irrespective of land-use, within one km of a recent (1980+), accurate (± 500 m) record is treated as 'core habitat known.' This is represented and a 1 km management buffer as habitats such as cultivated paddocks are not likely to be subject to offset requirements.
4. All remaining areas are considered to be 'absence suspected.'

**Mapping Confidence:** The species is known to inhabit artificial land causing difficulties in using REs to predict its occurrence. Remaining populations are isolated and fragmented, further compounding predictions. However, survey work to identify remaining populations of this species has been undertaken by EHP on the Darling Downs. These surveys have added to the overall knowledge of the species' distribution. The habitat map for this species is considered to be of ***Moderate*** accuracy.

**Evaluation under MNES Referral Guidelines**

**Table A74.** Evaluation of impact significance for Darling Downs earless dragon (*Tympanocryptis cf. tetraporphora*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| Populations of the species in the project development area. | All extant populations are extremely important for the survival of the species. All currently known and subsequently discovered populations should be considered in conservation strategies for this species (Robertson and Evans 2006).<br>There is a single known record of this species from the project development area, approximately 20 km east south-east of Cecil Plains. The majority of known records lie further to the east.<br>**Survey area 2**: Intensive field survey failed to locate this species. No 'core habitat possible' is present. Survey area 2 is north and west of the known distribution of the species.<br>**Survey area 7**: Some 'core habitat possible', regional ecosystem (RE) 11.3.2 and derived non-remnant native grassland, is present. Survey area 7 is west of the known distribution of the species.<br>**Survey area 8**: Some 'core habitat possible', REs 11.3.2 and 11.3.21 and derived non-remnant native grassland, is present. Survey area 8 is west of the known distribution of the species.<br>**Survey area 9**: Some 'core habitat possible', RE 11.3.2 and derived non-remnant native grassland, is present.<br>**Survey area F**: No 'core habitat possible' is present. Survey area F is west of the known distribution of the species. |

| Criteria | Evaluation |
|---|---|
| Criteria 1: lead to a long-term decrease in the size of a population. | **Survey area 2, 7, 8, 9, F**: Survey areas 2 and F have no habitat classed as 'core habitat possible' and are outside the known distribution of the species. Survey areas 7 and 8 have some 'core habitat possible' but are outside the known distribution for the species. Survey area 9 has some 'core habitat possible' and is on the western edge of the known distribution of the species. There is no known population on these properties.<br>The species is not expected to occur on survey area 2 and F based on a combination of known distribution and habitat requirements. It is not possible to totally discount occurrence of the species on the survey area 7, 8 and 9. Pre-clearance survey will be required once project footprints have been identified.<br>Based on current knowledge of habitat and distribution, a population is not present on the properties, hence no long term decrease in population size will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of a population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of a population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing population into two or more populations. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of a population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease the availability of quality of habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) on any of the subject five survey areas. Some small areas of suitable habitat (derived grasslands) are known from survey area 8 and 9, although all properties are west of the species known range, and as such it seems unlikely that the species could occur. Targeted survey works focused on derived grasslands on survey area 8 and 9 should occur if disturbance of these areas is expected.

Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided, and adequate survey of 'core habitat

possible' is undertaken prior to disturbance to evaluate the species presence (and subsequent impacts), there is little potential for the cumulative impacts associated with Arrow activities to be reinforced. Further, appropriate survey and mitigation should ensure that impacts across survey areas and the broader SREIS project development area are not unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Core habitat possible should be avoided, these areas including critcally endangered native grasslands. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken.

Darling Downs earless dragons (*Tympanocryptis cf. tetraporophora*) are only found on the Condamine flood plain (-27.00° to -28.00°; 151.18° to 151.90°) in, or within proximity to (including on tilled land), remnant grasslands (REs 11.3.2, 11.3.21, 11.3.24) and derived non-remnant native grasslands (veg code ARG). Works outside this area, or not within 100 m of a remnant grassland, need not consider this species.

If works are to coincide with the above parameters, the following survey methods should be deployed:

- Pitfall trapping using several arrays of 10L buckets.
- Actively search using an endoscope of spider burrows for sheltering individuals.
- The creation and monitoring of artificial burrows using:
- PVC tubing inserted near vertically into the ground with the opening level the ground surface. An inner tube is placed into this to allow the removal of sheltering individuals.
- A metal roof is placed over each trap to shelter animals from sun and rain, increasing the value of these as sheltering opportunities for the species.
- Ground cover vegetation is slashed within one meter of the artificial burrow to improve visibility of the burrow for dragons.
- Active searching using binoculars of habitats in a systematic grid during the morning period (7am-9am).

The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. Optimal survey times for active searching are early morning. Minimum trap effort should include four days and nights trapping. If the presence of the species is suspected but not confirmed, a second survey should be conducted. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

All extant populations of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) are significant populations. If the dragon is located, work should seas and evaulation under MNES guidelines will be required.

## Dunmall's snake (*Furina dunmalli*)

**Status**: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable **BoT:** Medium

**Sensitivity:** Moderate

**Recovery Plan:** This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

**Plate 31.** Dunmall's snake (*Furina dunmalli*) (Photograph Mark Sanders)

**Overview of Dunmall's snake**

**Ecology**: Dunmall's snake (*Furina dunmalli*) is a nocturnal, cryptic, secretive species that is possibly genuinely scarce and very rarely encountered (Wilson 2005; Hobson 2012a). The species has been found sheltering under fallen timber and ground litter (Cogger *et al*. 1993; Brigalow Belt Reptiles Workshop 2010) and may use cracks in alluvial clay soils (Ehmann 1992). Little is known of its ecology, but it reportedly preys on lizards and geckos (Gow and Swanson 1977; Shine 1981). Nothing is known of its breeding biology other than that it lays eggs (Wilson and Swan 2010).

**Habitat**: The species has been found in a wide range of habitats, including forests and woodlands dominated by brigalow (*Acacia harpophylla*) and other acacias (*A. burowii*, *A. deanii*, *A. leioclyx*), cypress (*Callitris* spp.) or bulloak (*Allocasuarina luehmannii*) on black alluvial cracking clay and clay loams (Covacevich *et al*. 1988; Stephenson and Schmida 2008; Brigalow Belt Reptiles Workshop 2010; Hobson 2012a). It also occurs in spotted gum (*Corymbia citriodora*), ironbark (*Eucalyptus crebra* and *Eucalyptus melanophloia*), white cypress pine (*Callitris glaucophylla*) and bulloak open forest and woodland on sandstone-derived soils and there is a record from the edge of dry vine scrub (Stephenson and Schmida 2008, TSN 2008; Brigalow Belt Reptiles Workshop 2010). However, preferred habitat appears to be brigalow growing on cracking black clay and clay loams (Cogger *et al*. 1993), with the majority of records from between 200 to 500 m above sea level (Hobson 2012a).

**Distribution**: Dunmall's snake (*Furina dunmalli*) is confined to the Brigalow Belt bioregion of south-eastern Queensland and north-eastern New South Wales, occurring north to Clermont and near Rockhampton. Most records are from the Dalby-Tara area of the Darling Downs (Hobson 2012a).

**Occurrence in the project development area and extent of habitat**: There is no known record (post 1979) of Dunmall's snake (*Furina dunmalli*) in the project development area. **Figure A34.** indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A75**.

**Table A75.** Extent of habitat for Dunmall's snake (*Furina dunmalli*) in the project development area and associated areas of assessment.

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 0 | 7727 | 0 |
| 3D Detailed Mapping Area** | 0 | 7230 | 0 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 0 | 3463 | 0 |
| Survey area 7 ****. | 0 | 1 | 0 |
| Survey area 8****. | 0 | 293 | |
| Survey area 9****. | 0 | 126 | 0 |
| Survey area 2, F****. | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General Threats to the Species**: The rarity and secretive nature of Dunmall's snake (*Furina dunmalli*) means that it is not known if it has actually declined in numbers, though records suggest a decline in eastern parts of its range. Its distribution, however, is confined to the Brigalow Belt bioregion, an area that has been highly modified for agriculture, the timber industry, natural gas and coal extraction and urban development. Much of its habitat has been cleared or fragmented, particularly in its core area on the Darling Downs (Hobson 2012a). The main threats to the local populations of Dunmall's snake (*Furina dunmalli*) are thought to be:

- Predation by feral animals.
- Pasture improvement practices.
- Livestock grazing.
- Inappropriate roadside management, because much of its core habitat now only exists as linear fragments along roads and in stock routes (Richardson 2006; Hobson 2012a).

Other possible threats include loss of fallen timber and ground litter (e.g., fuel reduction burns, firewood collection), weed invasion and drainage of swamps (SEWPAC 2013d).

**Project-related Impacts**: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during construction. Those displaced by clearing may face increased competition with nearby existing resident animals.
- Loss of habitat, which may reduce population extent.
- While the species is known to cross roads and tracks, it is not known if movement frequency is reduced by these structures. The construction of gas gathering lines and access tracks could affect movement.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Modified fire regimes from increased human activity can cause mortality and lead to long-term changes in vegetation/habitat structure.
- Edge effects, particularly weed invasion, may alter the ground surface structure of existing habitats, rendering large areas unsuitable.
- Drowning or other mortality in steep-sided, plastic-lined dams.

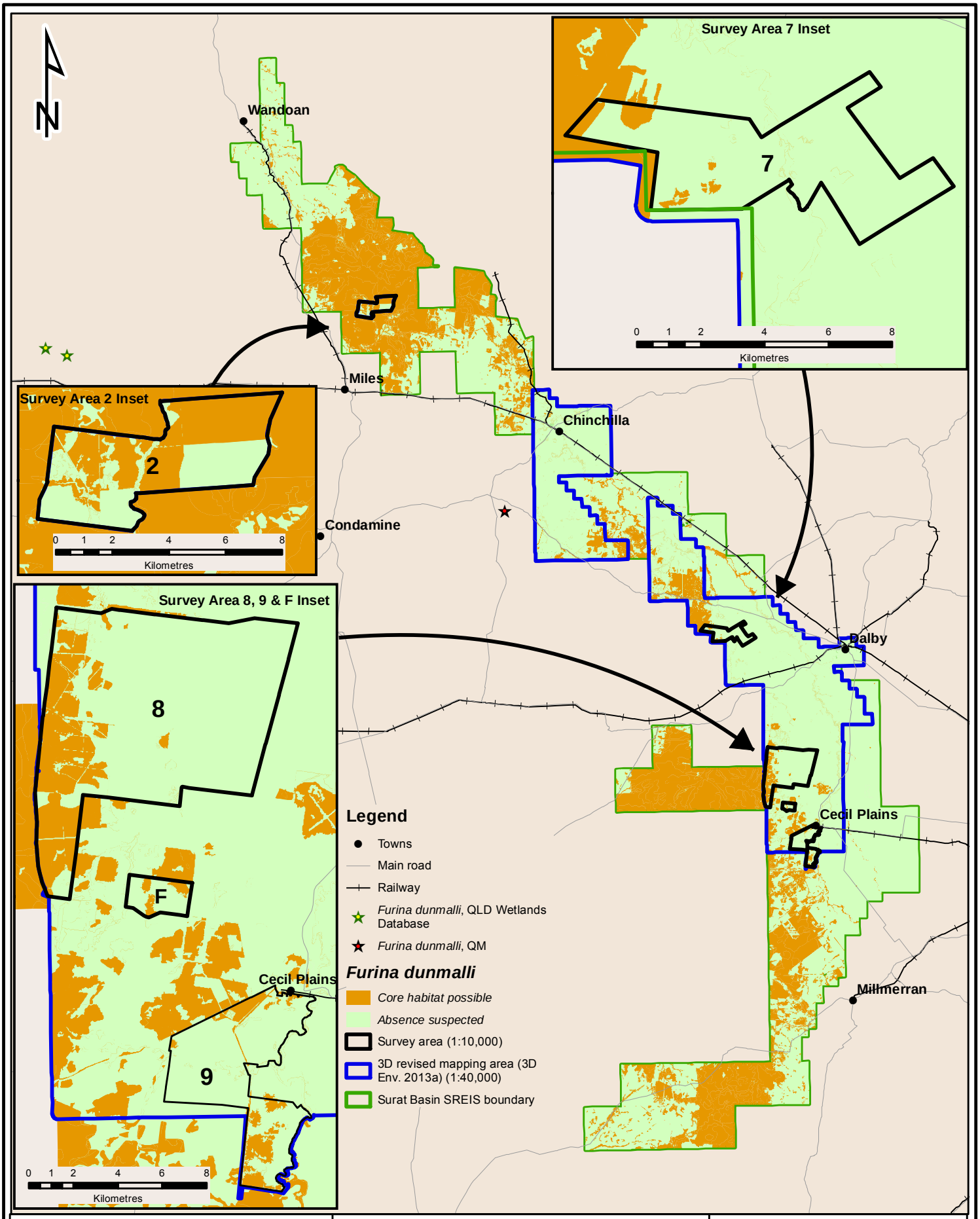
**Significance of project related impacts (unmitigated)**: The sensitivity of populations of Dunmall's snake (*Furina dunmalli*) to unmitigated impacts within the project development area is considered ***Moderate***. This species is widely distributed and the SREIS area forms only a portion of its distribution. However, the species is very uncommon and encountered very sporadically. Consequently, the loss of individuals from populations may affect this species more than those that are locally common. Deaths resulting from clearing and trench capture will have short-term consequences, but the species' ability to recover population numbers is unknown.
Clearing native vegetation will promote edge effects, including weed invasion. The response of this species to habitat modification is unknown, but most records occur in large natural areas, or patches that have not been historically disturbed. Edge effects and subsequent weed invasion has the potential to produce long-term impacts over a large area. The sensitivity of this species this poorly known and difficult to assess, but has been estimated as ***Moderate***. The magnitude has also been estimated as ***Moderate***, giving an overall impact significance of ***Moderate (13)***.

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species.

**Summary Residual Impact Assessment:** Unmitigated project related activities may result in impacts of ***Moderate (13)*** significance to Dunmall's snake (*Furina dunmalli*) populations within the project development area. This species has broad habitat preferences and is widespread, though at apparently very low densities. It could occur in regional ecosystems 11.3.1, 11.3.17, 11.3.25, 11.4.3, 11.4.3a, 11.5.1, 11.5.4, 11.9.4a, 11.9.5 and 11.9.6. It is therefore anticipated that complete avoidance of suitable habitat will not be possible, although minimising clearing should be a priority. Deaths associated with vegetation clearing may be unavoidable if the animal is present, and cannot be completely mitigated. Consequences from the loss of individuals from existing populations remain unknown, but would be dependent on the number of animals removed. Controlling indirect impacts through rehabilitation, trench clearing and weed suppression will be beneficial and assist in reducing short-term and long-term impacts. Application of a full range of mitigation committments will result in residual impact that is ***Low (8)***.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Low | Low (8) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

**Figure A34.** Dunmall's snake *(Furina dunmalli)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rules for Habitat Mapping:**

1. The known distribution of this species encompasses the entire project development area.
2. All remnant vegetation >100 ha in extent or within 500 m of a remnant vegetation patch >100 ha should be classed as 'core habitat possible.'
3. Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known' except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5.
4. All contiguous remnant vegetation within a one km buffer of recent (1980+), accurate (± 500 m) records in the area is classed as 'core habitat known', except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5.
5. All mapped 'mature regrowth' that includes RE attributed polygons is classed 'general habitat' except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5. Ground-truthing of regrowth may result in it being elevated to 'core habitat possible.'
6. Cleared farmland or tilled crops are classed 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present (i.e., excluding REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5). For rule 1 this is applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

**Mapping Confidence:** This species is very poorly understood and records are scarce. Prediction of its occurrence based on habitat preferences is therefore uncertain. The habitat map for this species is considered to be of ***Low*** accuracy.

**Evaluation under MNES Referral Guidelines**

**Table A76.** Evaluation of impact significance for Dunmall's snake (*Furina dunmalli*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | *Given the rarity and difficulty in detecting this declining species, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats. Similarly, any suitable remnant vegetation or vegetation corridors within the range of Dunmall's Snake* (*Furina dunmalli*) *is considered important habitat for the species (Brigalow Belt Reptiles Workshop 2010)* (taken from the SPRAT database (SEWPAC 2013d)).<br>No definition of an 'important population' is provided.<br>There is no known record (post 1979) of this species from the project development area.<br>**Survey area 2**: Intensive field survey failed to locate this species. Habitat suitable for the species is present and widespread, connecting to larger areas of intact habitat. Without further survey effort this species cannot be discounted and should be assumed present.<br>**Survey area 7**: While most areas of vegetation on survey area 7 have marginal value for this species, areas of RE 11.9.7 and 11.9.9a along the western border |

| Criteria | Evaluation |
|---|---|
| | (immediately adjacent Kumbarilla Ln) which are adjacent nearby State Forest are suitable. The species should be assumed as present in these areas.<br>**Survey area 8**: Sizeable areas of remnant vegetation on survey area 8 are suitable for this species, and furthermore, connected to adjacent habitat within the nearby State Forest. The presence of this species within these areas of vegetation should be assumed.<br>**Survey area 9** and **F**: While some suitable habitat is present, most areas are relatively minor in extent and have marginal value for Dunmall's snake (*Furina dunmalli*). |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F**: Survey areas 2, 7, and 8 all have some remnant vegetation suitable for Dunmall's snake (*Furina dunmalli*). By the definition provided above there is 'important habitat' on all these three properties.<br>An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties.<br>It is not possible to totally discount occurrence of the species on Survey area 2, 7 and 8. Pre-clearance survey will be required once project footprints have been identified.<br>Based on no known population on the properties, the project will not lead to a long-term decrease in the size of an important population. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of Dunmall's snake (*Furina dunmalli*) on any of the subject five properties. However, the species is reclusive and difficult to detect and its presence cannot be discounted from

Survey area 2, 7 and 8 where habitats appear suitable. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided, and adequate survey of 'core habitat possible' is undertaken prior to disturbance to evaluate the species presence (and subsequent impacts), then there little potential for cumulative impacts to be reinforced. Furthermore, application of a range of mitigation measures including pre-clearance survey will ensure that impacts are not unknown, unpredictable or irreversible and Arrow's contribution to cumulative impact will be minimal.

**Rule(s) for survey effort required in accordance with survey guidelines:** Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed 'core habitat possible' should be avoided but, given the wide habitat use of the species, this is unlikely to be practical. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover dominated by native species;
    - Fallen debris, i.e., timber, bark;
    - Rocks (non-essential);
    - Dense leaf litter (non-essential);
    - Soil cracks (non-essential).
- Landscape interpretation, including:
    - Is the habitat part of contiguous remnant or mature regrowth at least 10 ha in size;
    - If less than 10 ha, is the habitat within 200 m of a large area of contiguous remnant vegetation of suitable regional ecosystems for the species;
    - If less than 10 ha, is the habitat part of a EHP mapped discontinuous wildlife corridor of State or regional significance.

If suitable habitat and landscape features are present, the following survey methods should be deployed:

- Actively search suitable microhabitat.

- Pitfall traps.
- Funnel traps.
- Spotlight on warm nights (Brigalow Belt Reptiles Workshop 2010).

Details of pitfall and funnel trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). The species is extremely difficult to detect and one-off surveys are unlikely to be sufficient. Surveys should be conducted between October to February, provided ground temperatures are generally above 20$^{o}$C and preferably above 24$^{o}$C. Multiple surveys with good spatial and habitat representation may be required in very large habitat patches. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations

If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a population and work should not proceed without evaluation under MNES guidelines.

## Squatter pigeon – southern subspecies (*Geophaps scripta scripta*)

**Status**: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable **BoT:** Medium

**Sensitivity:** High

**Recovery Plan:** No recovery plan is available.

**Plate 32**. Squatter pigeon - southern subspecies (*Geophaps scripta scripta*) (Photograph Angus McNab).

### Overview of squatter pigeon

**Ecology**: Squatter pigeons (*Geophaps scripta scripta*) are largely terrestrial, foraging and breeding on the ground. Seeds make up the bulk of their diet and can include grass, legume, herb, tree and shrub seeds. Occasionally insects may be taken (Higgins and Davies 1996). Food is mostly picked from the ground, but may be occasionally taken directly from low seed heads (M. Sanders pers. obs.). This feeding strategy is most effective in grass areas that have a mosaic of vegetation and open areas. As a result, the species is absent from thick rank grasslands (e.g., areas dominated by exotic grasses), which also restricts movement of the ground. However, individuals and small groups are often located along roads and tracks surrounded by thick grasslands. Breeding is poorly known but does appear to be greatly influenced by rainfall. The nest is a shallow depression on the ground lined with dry grasses. Often nests are located beside or beneath a tuft of grass, log or low bush (Frith 1982; Higgins and Davies 1996; Beruldsen 2003). Movements are poorly documented, but birds appear to be locally nomadic (Frith 1982; Higgins and Davies 1996).

**Habitat**: The southern subspecies of the squatter pigeon (*Geophaps scripta scripta*) occurs mainly in dry grassy eucalypt woodlands and open forests and also inhabits cypress pine (*Callitris* spp.) and acacia woodlands (Frith 1982). It mostly occurs on sandy sites near permanent water (Blakers *et al*. 1984). Birds will forage along roads and railway lines and are often found around homesteads and cattle yards (Pizzey 1980; Reis 2012). Squatter Pigeons (*Geophaps scripta scripta*) dust-bathe and are frequently encountered on dirt tracks and in areas of bare soil denuded of ground cover by livestock (Crome 1976; Frith 1982; Higgins and Davies 1996).

**Distribution**: The squatter pigeon (*Geophaps scripta scripta*) is endemic to Australia and is now largely, if not wholly, restricted to Queensland. The species formerly occurred as far south as 34$^{o}$S (Blakers *et al*. 1984) but there has been no record in New South Wales since the 1970s (NSW NPWS 2003), though there was an unconfirmed sighting in 1989 (Morris 1993). In Queensland, the southern subspecies occurs north to the Burdekin River (Frith 1982) with an intergrade zone with the northern subspecies *G. s. peninsulae* around the Burdekin-Lynd Divide (Crome 1976; Ford 1986; Schodde and Mason 1997), though there is some doubt over the identification of hybrid forms (Higgins and Davies 1996). The southern subspecies extends west to Longreach, Barcaldine and Charleville and east to Townsville, Proserpine, Warwick and Esk (Storr 1973; Frith 1982; Schodde and Mason 1997). It is now very localised in southern Queensland but is still recorded in low numbers around Inglewood and Warwick (Birds Queensland 2011) and Esk (Reis 2012).

**Likelihood of occurrence and extent of habitat in the project development area**: There are three known records of squatter pigeon (*Geophaps scripta scripta*) from the project development area, two from north of Miles and one from Chinchilla. The latter is likely to be of low spatial accuracy, possibly being attributed to the nearest town. **Figure A35** indicates the location of known records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A77**.

**Table A77.** Extent of habitat for squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) in the project development area and associated areas of assessment

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 17765 | 154992 | 0 |
| 3D Detailed Mapping Area** | 512 | 19162 | 0 |
| 3D Detailed Mapping Area based on EHP*** | 12479 | 34559 | 0 |
| Survey area 2 | 0 | 1030 | 324 |
| Survey area 7 ****. | 0 | 114 | 0 |
| Survey area 8****. | 0 | 1401 | 936 |
| Survey area 9****. | 0 | 621 | 3 |
| Survey area F****. | 0 | 41 | 58 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**Threats**: The main threats to the local populations of squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) are:

- Habitat loss.
- Degradation of habitat by livestock and feral herbivores (Baptista et al. 1997; Reis 2012), declines occurs before the land-clearing era (Franklin 1999).
- Predation by feral predators, particularly foxes (*Vulpes vulpes*) (Garnett and Crowley 2000).
- Some pasture improvement activities, particularly the propagation of buffel grass (Cenchrus ciliaris) (Reis 2012).

Overgrazing degrades habitat, reduces food resources, limits or eliminates vegetation used as cover or for breeding, and subjects nests to trampling (Blakers *et al*. 1984; Garnett 1993; Higgins and Davies 1996). Close-grazing by sheep and rabbits (*Oryctolagus cuniculus*) in particular replaces perennial bushes, herbs and grasses with ephemeral herbs and annual grasses (Frith 1982).

**Potential project-related impacts**: Squatter pigeons (*Geophaps scripta scripta*) are highly mobile and able to easily cover large distances over modified land. It is unlikely that dispersal or movement patterns will be affected by gas field activities. Impacts associated with the proposed project related activities could include:

- Loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure.
- Decreased habitat quality due to invading exotic grasses associated with inappropriate revegetation or surface soil disturbance.
- Loss of breeding potential should clearing, by coincidence, impact nesting pairs.
- Modified fire regimes, affected by human activities, can affect ground strata composition (i.e., grass diversity) and structure rendering previously suitable habitats unsuitable.

Increased availability of surface water for drinking may reduce distance to permanent water from foraging habitats, thereby increasing the use of areas. However, as squatter pigeons (*Geophaps scripta scripta*) are highly mobile and able to cover large distances, this benefit is likely to be of minor or negligible consequence.

**Significance of project related impacts (unmitigated)**: The sensitivity of populations of squatter pigeon (*Geophaps scripta scripta*) to unmitigated impacts within the project development area is considered ***High***. Historically the southern subspecies of the squatter pigeon (*Geophaps scripta scripta*) ranged south from the Burdekin River to northern central New South Wales. While encompassing only a portion of this range, the project development area is in an area of decline and any populations (if present) are of importance. However, the species is not regularly recorded in the

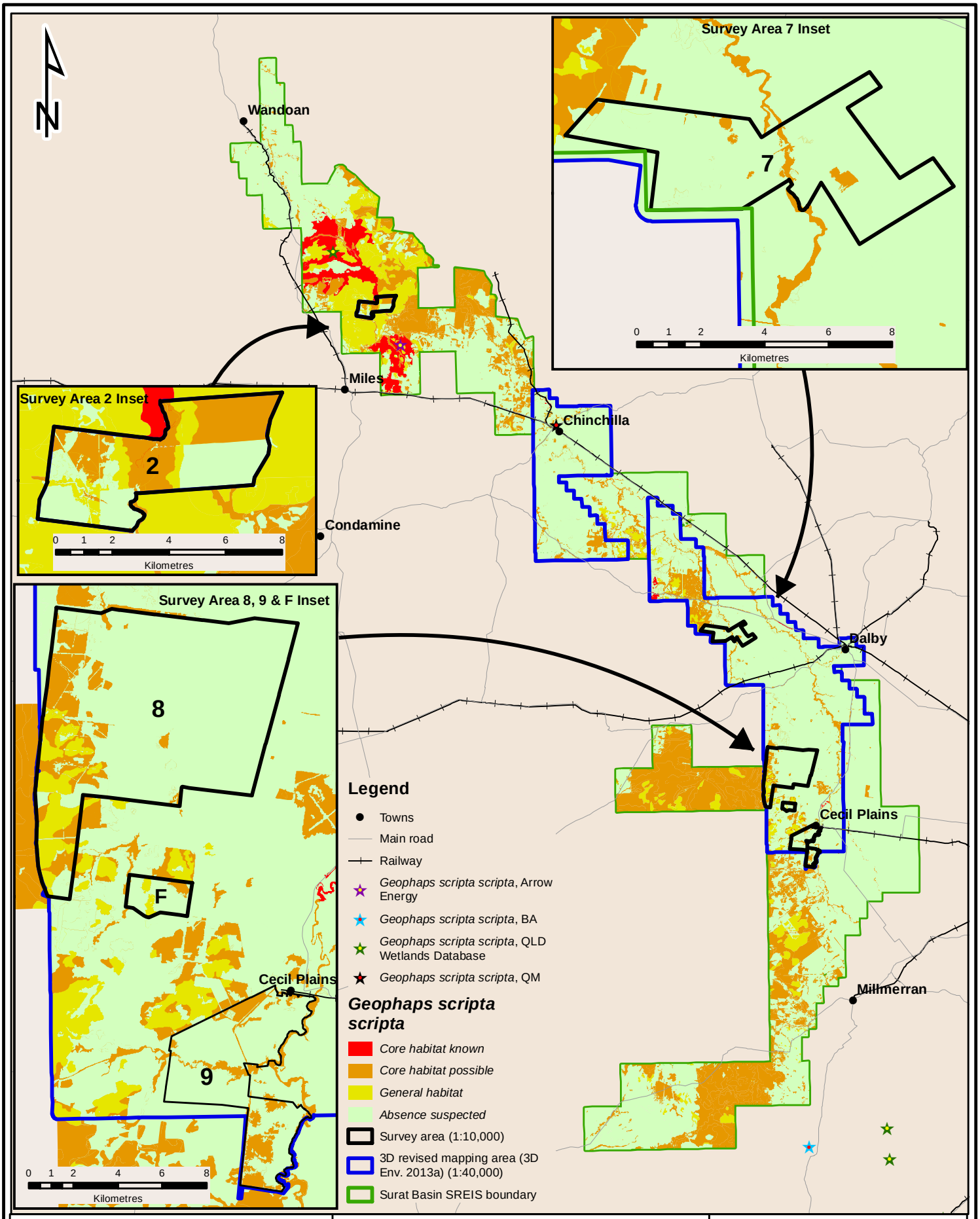
area and the presence of permanent populations seems unlikely. Existing records probably reflect either historical observations prior to declines or transient individuals that have not taken residence. Suitable squatter pigeon (*Geophaps scripta scripta*) habitat has been substantially reduced or modified by agriculture and areas of open woodlands with native understories are restricted to minor remnants. In many cases, even these minor fragments have been affected by grazing and altered fire regimes. The species has been estimated to have a ***High*** sensitivity to disturbance and magnitude of impact is ***Low*** as the species occurs in extremely low numbers, possibly extirpated from some areas. The unmitigated impact significance is therefore ***Moderate (12).***

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of squatter pigeon will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Moderate*** significance to squatter pigeon (*Geophaps scripta scripta*) populations within the project development area. Project-related impacts have the potential to affect squatter pigeon (*Geophaps scripta scripta*) habitat, particularly through weed infestations. However, when assessing the possible severity of these impacts it should be considered that squatter pigeons (*Geophaps scripta scripta*) are possibly locally extinct. Should this be the case it negates any consideration of high importance for existing habitats with regard to this species. Nonetheless, habitats should be protected where possible. Application of a range of generic mitigation measures will result in impacts that are of ***Low (8)*** significance.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | Low | Moderate (12) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database
Arrow Database

**Figure A35.** Squatter pigeon *(Geophaps scripta scripta)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
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**Rules for habitat mapping:**

1. The known distribution of this species encompasses the entire project development area.
2. Woodlands, native grasslands and derived native grasslands (regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.21, 11.3.25, 11.3.26, 11.4.12, 11.5.1, 11.5.4, 11.5.20, 11.7.4c, 11.8.2a, 11.9.9, 11.9.10) are considered to be 'core habitat possible.' mature regrowth (EHP 2012b) are also included in the mapping assessment.
3. 'General habitat' that might be used by this species includes REs 11.3.18, 11.7.4, 11.7.7, 11.7.9 and 11.10.1.
4. All remaining REs are 'absence suspected.'
5. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
6. All land (remnant or non-remnant), except tilled land, within one km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known' for management purposes.

**Mapping confidence:** This species' occurrence within the region is highly sporadic and it may not occur within all areas of designated 'core habitat possible.' Furthermore, where this species is still relatively common (e.g., Bowen Basin), it may occur in artificial habitats including areas dominated by exotic grasses. It could therefore occur in the project development area outside of mapped habitat. Consequently, the habitat map for this species is considered to be of ***Low*** accuracy.

**Evaluation under MNES referral Guidelines**

**Table A78** Evaluation of impact significance for squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development area. | *No populations have been identified as being especially important to the long-term survival or recovery of the Squatter Pigeon (southern)* (*Geophaps scripta scripta*) SEWPAC 2013e).<br>There are three known (post 1979) records of this species from the project development area, two from north of Miles (see below) and one from Chinchilla, which may be of low spatial accuracy.<br>**Survey area 2**: Intensive field survey failed to locate this species. Some 'core habitat possible', regional ecosystems (RE) 11.3.4, 11.3.25, 11.5.1 and 11.5.4, is present. There are two database records of the species in the general area, approximately 9 km to the south-east and 12 km to the north-west of the property.<br>**Survey area 7**: Some 'core habitat possible', REs 11.3.2, 11.3.4, 11.3.14, 11.3.25 and 11.9.9 is present.<br>**Survey area 8**: Some 'core habitat possible', REs 11.3.2, 11.3.21, 11.3.26, 11.5.1 and 11.5.20, is present.<br>**Survey area 9**: Some 'core habitat possible', REs 11.3.2, 11.3.4, 11.3.18, 11.3.25, 11.5.1 and 11.9.9, is present.<br>**Survey area F**: Some 'core habitat possible', REs 11.3.18 and 11.9.9, is present. |

| Criteria | Evaluation |
|---|---|
| | There is no known record of squatter pigeon (*Geophaps scripta scripta*) (post 1979) within 50 km of survey areas 7, 8, 9 and F. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F**: All five properties have some remnant vegetation classed as 'core habitat possible' for squatter pigeon (*Geophaps scripta scripta*). There is no known population on these properties.<br>It is not possible to totally discount occurrence of the species on the properties. Pre-clearance survey may be required once project footprints have been identified.<br>An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties. No long-term decrease in the size of an important population will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2**: Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. It will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.<br>**Survey area 2, 7, 8, 9, F**: will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** While there is suitable habitat on all five subject properties, squatter pigeons (*Geophaps scripta scripta*) are scarce in the region and local records probably represent transient individuals. No know or breeding populations occur, or are considered likely to occur. Therefore, based on current population knowledge, impacts are not considered significant when assessed under MNES criteria, both for survey areas and also on a broader project scale. The species is highly mobile and tolerant of some disturbance .As such, there is little potential for cumulative impacts to be

reinforced through Arrow development actions and impacts are unlikely to be unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** The following recommendations for survey are made:
If suitable habitat and landscape features are present, then area searches concentrating on roadways, tracks and around waterbodies should be undertaken. DEWHA (2010b) guidelines recommended undertaking a total of 25hrs (15 hrs for area searches/transects and 10 hrs for flushing surveys) over three days for each 50 ha area. It is recognised that searches of this intensity cannot be acheived given the scale of the project. Appropriate survey requirements for this species are as follows:

Areas classed as 'core habitat known' should be avoided, with a 100 m buffer, and do not require survey work on this basis. Areas classed 'core habitat known' and 'core habitat possible' should be avoided but, given the wide habitat use of the species, this is unlikely. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover includes a matrix of bare ground/leaf litter and clumps of native grasses;
    - A open (at most barely overlapping) canopy;
    - Nearby water (can include ephemeral waterbodies);

**Australian painted snipe (*Rostratula australis*)**

**Status**: **EPBC Act**: Vulnerable (updated to Endangered, April 29 2013), Migratory (as *R. benghalensis* [*sensu lato*]); **NC Act**: Vulnerable; **BoT:** Medium

**Sensitivity:** Moderate

**Recovery Plan**: A brief recovery outline for the species is featured in the *Action plan for Australian birds 2000* (Garnett and Crowley 2000).


**Plate 33**. Australian painted snipe (*Rostratula australis*)

**Alternative Nomenclature**: *Rostratula australis* was considered to be a subspecies of *Rostratula bengalensis* until Baker *et al*. (2007) raised it to species level. The Australian painted snipe (*Rostratula australis*) is endemic to Australia. It is often referred to in previous literature as *Rostratula. bengalensis* (*sensu lato*).

**Overview of painted snipe**

**Ecology**: The Australian painted snipe (*Rostratula australis*) appears to be crepuscular and nocturnal, feeding on mudflats or in shallow water during the morning and evening and throughout the night (Geering *et al.* 2007). A variety of foods are eaten, including vegetation, seeds, insects, worms, molluscs, crustaceans and other invertebrates including beetles (Marchant and Higgins 1993; Johnstone and Storr 1998).

Nesting occurs in spring and summer in southern Australia and during the wet season in northern Australia (Geering *et al.* 2007). Nests consist of a simple scrap in the ground lined by dry grasses, fine twigs and other vegetation. These nests are located in specific positions such as on a small island surrounded by shallow water, or occasionally on small mounds of purpose-built vegetation surrounded by water (Berudlsen 2003; Rogers *et al.* 2005). Breeding occurs only in suitable temporary wetlands with low relief and complex shorelines after an influx of water (Rogers *et al.* 2005).

Migration patterns are poorly known for Australian painted snipe (*Rostratula australis*) (Pringle 1987). They are possibly dispersive or migratory. It is possible that such movements are due to local conditions, moving to flooded areas from drying wetlands (Marchant and Higgins 1993).

**Habitat**: Birds may be recorded singly or in small groups in freshwater marshes. They are extremely nomadic, coming and going in response to local rainfall and flooding. Although its occurrence in a location is often erratic, with the bird absent some years and common in others (Marchant and Higgins 1993) there is indication of some regular seasonal migration, e.g., to central and north coastal Queensland in autumn and winter (Black *et al*. 2010). Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Rogers *et al.* 2005; Geering *et al.* 2007). During non-breeding periods they may be found in a wider range of habitats including dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant and Higgins 1993).

**Distribution**: Most records of the Australian painted snipe (*Rostratula australis*) occur east of a line between Eyre Peninsula and the Gulf of Carpentaria, excluding Cape York Peninsula where they appear to be absent (Marchant and Higgins 1993). However, scattered individuals occur west as far as Western Australia, where they may have once been common in the Kimberley and Swan Coastal Plain (Johnstone and Storr 1998). Recent records mostly centre on the Murray-Darling basin of eastern Queensland and New South Wales (Marchant and Higgins 1993; Rogers *et al.* 2005). Lake Broadwater is considered to be important habitat for this species within Brigalow Belt South, although there is no known breeding record from this location (EPA 2003).

**Occurrence in the project development area and extent of habitat**: There are six known records of Australian painted snipe (*Rostratula australis*) for the project development area. Five of these are from Lake Broadwater and in immediate surrounding area. The other is from Dalby. However, the record attributed to Dalby may be based on it being the nearest town, rather than the specimen being collected, or observation being made, at Dalby. **Figure A36** indicates the location of known records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as ‘core habitat known’, ‘core habitat possible’, ‘general habitat’ and areas where the species is considered unlikely to occur, ‘absence suspected.’ The extent of habitat within specific areas of the project development area is summarised within **Table A79**.

**Table A79**. Extent of habitat for Australian painted snipe (*Rostratula australis*) in the project development area and associated areas of assessment

| | Core Habitat Known (ha) | Core Habitat Possible (ha) | General Habitat (ha) |
|---|---|---|---|
| Project Development Area* | 275 | 0 | 3389 |
| 3D Detailed Mapping Area** | 255 | 230 | 257 |
| 3D Detailed Mapping Area based on EHP (2012)*** | 268 | 0 | 2870 |
| Survey area 2**** | 0 | 0 | 4 |
| Survey area 7**** | 0 | 0 | 0 |
| Survey area 8**** | 0 | 0 | 0 |
| Survey area 9**** | 0 | 0 | 14 |
| Survey area F**** | 0 | 0 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General threats to the species**: Estimations of Australian painted snipe (*Rostratula australis*) population trends have been confounded by its nomadic nature. The species may become absent from historical locations, only to re-appear after decades. Nevertheless, there has been a substantial reduction in the reporting rate for the species (Johnstone and Storr 1998; Lane and Rogers 2000; Rogers *et al.* 2005). The main threats to the local populations of Australian painted snipe (*Rostratula australis*) are:

- Loss or alteration of wetland habitats and their water regimes, particularly areas of breeding habitat (Rogers et al. 2005; Garnett et al. 2011).
- Degradation of existing wetlands through weed invasion.
- Trampling of habitat by cattle and feral pigs (Sus scrofa) (Rogers et al. 2005; Tzaros et al. 2012).
- Reduced water quality due to a lack of flushing, increased nutrient runoff, pesticide and herbicide runoff, saline discharge and increased erosion and turbidity due to vegetation removal (Tzaros et al. 2012).

The loss of habitat has occurred through drainage of wetlands and diversion of floodwaters for agricultural and irrigation purposes (Rogers *et al.* 2005; Garnett *et al.* 2011). The diversion of floodwaters into permanent deep-water wetlands with dense reed beds, and an absence of islands

and complex shallow margins creates habitat unsuitable for the species (Tzaros *et al*. 2012). Invasion of wetlands by weed species such *Parkinsonia aculeata* (regularly associated with waterways and wetlands) may also form tall dense thickets unsuitable for Australian painted snipe (*Rostratula australis*) and a range of other wetland species (Rogers *et al*. 2005; Tzaros *et al*. 2012).

- Project-related Impacts: It is probable that any local breeding by this species will be restricted to Lake Broadwater, Long Swamp, large farm dams (>5 ha), and wetlands within the flood plains of the Condamine River. Current development plans do not include direct impacts on Lake Broadwater. Impacts are therefore likely to be restricted to impacts at Long Swamp, wetlands within the Condamine flood plain, and indirect impacts on Lake Broadwater. Impacts associated with the proposed project related activities could include:
- The temporary loss of vegetation and hence habitat within Long Swamp for the construction of gas gathering lines.
- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater and Long Swamp.
- Deterioration of water quality within Long Swamp and Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Long Swamp and Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported either directly through clearing practices (Long Swamp) or by surface water flow in Broadwater and Surveyors Gully.
- Loss or modification (including weed invasion), of wetlands or low-lying areas of pooling water within the Condamine River flood plain.

**Significance of project related impacts (unmitigated)**: The sensitivity of populations of Australian painted snipe (*Rostratula australis*) to unmitigated impacts within the project development area is considered ***Moderate***. The use of suitable habitats by this species within the project development area is unclear. It is possible that breeding could occur during prolonged wet periods (e.g., wet seasons between and including the summers of 2009/10 and 2012/13); however, it seems more probable that records represent transient individuals taking advantage of suitable foraging habitat. Mapping and predicting suitable foraging habitat for this species on the Condamine River flood plain is almost impossible given its ability to use areas of pooling water, sometimes small in extent, in both remnant and modified landscapes. No known resident population occurs within the project development area and the importance of potential habitat for the Australian painted snipe (*Rostratula australis*) is difficult to predict. While the species can use temporary flooded areas (locations of which are difficult to predict), the best (and known) habitat is located at Lake Broadwater. Habitat might also occur along Long Swamp during periods of inundation. A 500 m exclusion zone has been established around Lake Broadwater and hence direct impacts are not expected. Unmitigated indirect impacts predominantly relate to alterations in water quality, the most severe of which could be salination due

to ground water intrusion into surface waterways. Water quality could also be affected by increased sedimentation, although this is likely to be short-term as vegetation should return to stabilise disturbed surfaces.

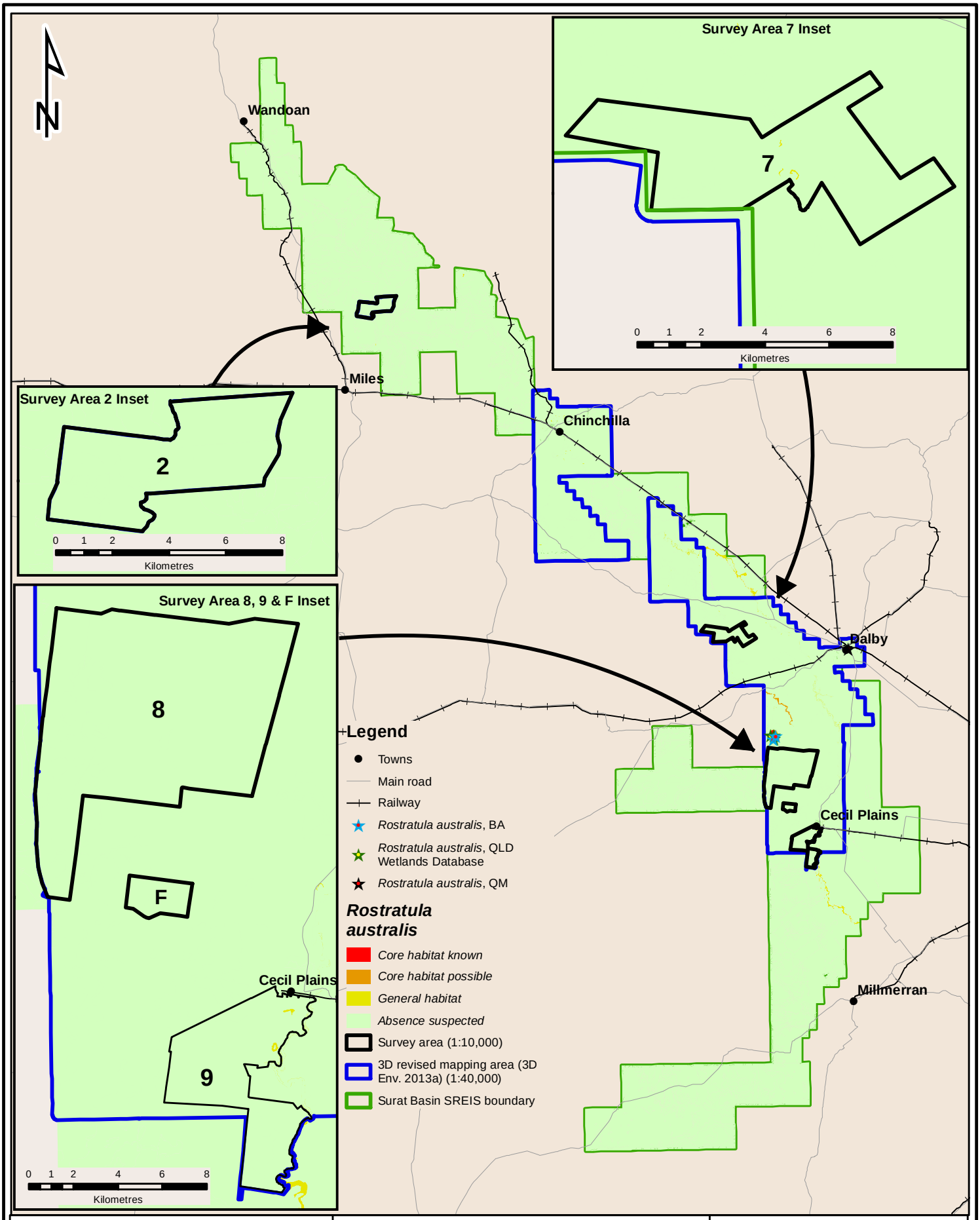
Unlike Lake Broadwater, no exclusion zone has been established around Long Swamp. Disturbance within this area is likely to be restricted to gas gathering lines as infrastructure cannot be placed in flood prone areas. The construction of gas gathering lines through Long Swamp will result in the loss of some vegetation and increased ground disturbance. These impacts will be short term and probably minor in severity given the existing condition of the swamp and surrounding vegetation. Long-term impacts to Long Swamp might occur if weeds are brought in during construction or if saline groundwater is allowed to flow from bores into the swamp. Weed invasions can be difficult to control in low-lying areas where water collects. Given the above uncertainties, it is difficult to estimate the species sensitivity, or impact magnitude. Both are rated ***Moderate*** based on a conservative approach. The overall impact significance is therefore ***Moderate (13).***

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Australian painted snipe will be prioritised.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Moderate*** significance to Australian painted snipe (*Rostratula australis*) populations within the project development area. The most suitable habitat, around Lake Broadwater, is unlikely to be affected. Impacts may occur if avoidance is not possible within less suitable habitat at Long Swamp and in this case, residual impact will remain Moderate (13).

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database

**Figure A36.** Australian painted snipe *(Rostratula australis)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
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**Rules for habitat mapping:**

1. The known distribution of this species encompasses the entire project development area.
2. The water containment area of Lake Broadwater and a buffer of 100 m should be considered 'core habitat known.'
3. Areas within Long Swamp where water collection might occur following surface flow should be considered 'core habitat possible.'
4. All remnant vegetation where surface water could collect within the Condamine and Wilkie Creek Catchments (e.g., RE11.3.27d, f and vegetation communities WA, WA1 and WA2) should be classed as 'general habitat.'
5. Remaining REs or tilled crops are classed 'absence suspected.'

**Mapping confidence:** This species is associated with aquatic and semi-aquatic vegetation, which may be clearly indicated in vegetation maps. However, the species' occurrence is sporadic and may therefore not occur within all areas of 'core habitat possible.' The species may also occur in minor wetlands and flooded non-native grasslands, suggesting that it might occur in areas not indicated on the habitat map. However, these occurrences are likely to be very infrequent and short term. The habitat map for this species is considered to be ***Low*** in accuracy.

**Evaluation under MNES referral Guidelines**

**Table A80.** Evaluation of impact significance for Australian painted snipe (*Rostratula australis*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the Project Development Area. | *The total population size of the Australian Painted Snipe* (*Rostratula australis*) *is effectively unknown, but tentative estimates range from a few hundred individuals to 5000 breeding adults (Garnett & Crowley 2000; Lane & Rogers 2000; Oring et al. 2004; Watkins 1993). The Australian Painted Snipe* (*Rostratula australis*) *is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000)* (taken from SEWPAC 2013h).<br>No definition of an 'important population' is provided.<br>There are six records of this species from the project development area, five from Lake Broadwater and in immediate surrounding areas (within prescribed buffers), and one from Dalby.<br>Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Roger *et al*. 2005; Geering *et al*. 2007). The species may be found in a wider range of habitats including dams, waterlogged grasslands and roadside drains (Marchant and Higgins 1993).<br>**Survey area 2**: Field survey failed to locate this species. The closest known record for the species is approximately 100 km to the south-west. Habitats are unlikely to support this species.<br>**Survey area 7**: The closest known record for the species is approximately 30 km to the east. Access to the Condamine River was restricted due to flooding, however areas of RE 11.3.4 and 11.3.25 *as well as* any non-remnant (but not tilled) land subject to inundation could be inhabited by the species.<br>**Survey area 8**: is within two km of a record at Lake Broadwater. Long Swamp, which flows through the eastern portion of survey area 8 is considered suitable |

| Criteria | Evaluation |
|---|---|
| | habitat for this species.<br>**Survey area 9**: The closest known record for the species is approximately 20 km to the south. There are a number of wetlands supporting remnant habitats (including areas within RE 11.3.27 and 11.3.2) and non-remnant habitats in the northern portion of the property. Access to the Condamine River flood plain was restricted due to flooding, however it is expected that there are a number of suitable habitats along the river.<br>**Survey area F**: The closest known record for the species is approximately 13 km to the east. It is unlikely the species will occur on this property.<br>The closest records with regards to survey areas 7, 8 and 9 are from Lake Broadwater. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2, 7, 8, 9, F** The occasional use of dams, waterlogged grasslands and drains by Australian painted snipe (*Rostratula australis*) means that habitat suitable for sporadic, non-breeding use is present on all five properties, although the species seems unlikely on survey area 2 and F.<br>It is not possible to totally discount occurrence of the species on survey area 7, 8 and 9 and pre-clearance survey may be required once project footprints have been identified.<br>An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties. No long-term decrease in the size of an important population will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, 7, 8, 9, F** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F**: will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** There are no known records of Australian painted snipe (*Rostratula australis*) on any of the five survey areas and, while there is some potential habitat on survey area 8 and 9, the species is unlikely to occur. Local records probably represent transient individuals.

Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and provided core habitat (Lake Broadwater and Long Swamp) are avoided, broader Arrow related activities within the project development area will not have a significant impact and there is little potential for cumulative impacts associated with the actions of other proponents. Actions on these properties are unlikely to be unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** The following mitigation measured should be applied a based on methods of DEWHA (2010b) although adapted based on information collected during EIS and SREIS studies.

The only known habitat for the species, Lake Broadwater, is to be avoided and provided a buffer in accordance with regulatory requirements at the time. This area does not require survey work on this basis.Areas classed 'core habitat possible' should be avoided but, if unavoidable, fauna survey work should be conducted before any gas related work is undertaken. In addition to 'core habitat possible' any areas of non-remnant wetland within the Condamine River flood plain should be surveyed. Surveys should include:

- Initial visual assessment to determine if appropriate habitat is present. The species occurs in ephemeral to semi-ephemeral wetlands with small islands of vegetation or bare ground, or on waterbodies with exposed mud areas.
- If suitable habitat is present, then the species should be targeted using (DEWHA 2010b:
    - Stationary observations for moving/foraging individuals (10hrs over five days/50ha of wetland habitat), and
    - Area or transect searches (10 hrs over three days/50ha of wetland habitat).

Spotlighting for individuals can also be successful (M. Sanders *pers obs*). The species can be extremely difficult to detect, even when present, and single surveys may not be sufficient. If the presence of the species is suspected but not confirmed, a second survey should be conducted.

**Regent honeyeater (*Anthochaera phrygia*)**

**Status**: **EPBC Act**: Endangered, Migratory (as *Xanthomyza phrygia*); **NC Act**: Endangered; **BoT**: Medium

**Sensitivity:** High

**Recovery plan:** Regent Honeyeater Recovery Plan 1994-1998 (Menkhorst 1997). Regent Honeyeater Recovery Plan - 1999-2003 (Menkhorst et al. 1999). The Action plan for Australian birds 2010 (Garnett et al. 2011) identifies types of information required and management actions for the recovery of the species. The Queensland Government (EPA 2008b) recommends actions to assist the recovery of the regent honeyeater.


**Plate 34.** Regent honeyeater (*Anthochaera phrygia*)

**Alternative nomenclature:** Changed from the genus *Xanthomyza* to *Anthochaera* (Christidis and Boles 2008).

**Overview of regent honeyeater**

**Ecology**: Regent honeyeaters (*Anthochaera phrygia*) feed predominantly on nectar and insects (including exudates such as lerp and honeydew). Nectar is taken mainly from eucalypts and often mistletoes (Higgins *et al*. 2001), which when scarce may be substituted by lerps and insects. These resources can become a major component of their diet (up to 90%) when nectar is scarce (Menkhorst 1997; Oliver 2000). Regent honeyeaters (*Anthochaera phrygia*) actively select larger trees for foraging (Oliver 2000).

Breeding typically coincides with peak flowering in local tree populations, i.e., May to March but with a peak from September to November (Franklin *et al*. 1989; Higgins *et al*. 2001). Cup-shaped nests, constructed from strips of bark and dry grass, are usually placed towards the end of large horizontal branches in the crowns of taller trees (Geering and French 1998; Oliver *et al.* 1998; Higgins *et al.* 2001). Studies have found that nesting success is very low, typically less than 50%, but ranging from 14.3% to 73.3% (SEWPAC 2013b). Predation and adverse weather conditions (e.g., hot weather, strong winds, storms) have been suggested as the primary causes of nesting failure (Geering and French 1998; Higgins *et al.* 2001). Regent honeyeaters (*Anthochaera phrygia*) are highly mobile and may be nomadic, eruptive or show some migratory patterns. This makes their movements difficult to predict; however, the population drifts north from southern Australia to northern New South Wales and south-east Queensland during late autumn/early spring. This is followed by an influx of birds into core breeding areas on the inland slopes of the Great Dividing Range (SEWPAC 2013b).

**Habitat**: Although occasionally found in agricultural land with only partial tree cover or in city parks and gardens, the regent honeyeater (*Anthochaera phrygia*) occurs mainly in dry box-ironbark eucalypt woodland and dry sclerophyll forest (Higgins *et al.* 2001). They are particularly fond of vegetation associations that reliably produce nectar such as mugga ironbark (*Eucalyptus sideroxylon*), yellow box (*E. melliodora*), white box (*E. albens*) and yellow gum (*E. leucoxylon*). However, when nectar is scarce they can also be observed in association with grey box (*E. microcarpa*), red box (*E. polyanthemus*), Blakely's red gum (*E. blakelyi*), Queensland blue gum (*E. camaldulensis*), silver-leafed box (*E. melanophloia*), Caley's ironbark (*E. caleyi*) and swamp mahogany (*E. robusta*) (Franklin *et al.* 1989; Geering and French 1998). Within these vegetation associations they are most regularly recorded from the wettest, most fertile sites (Garnett and Crowley 2000).

**Distribution**: The regent honeyeater (*Anthochaera phrygia*) is restricted to south-eastern Australia where it is widespread but extremely patchy in occurrence (Garnett *et al*. 2011). Historically, the species was distributed from Adelaide in South Australia north to Rockhampton in Queensland. However, their range has contracted considerably (Higgins *et al*. 2001). The species have not been recorded in South Australia or western Victoria since the 1970s (Garnett *et al.* 2011). Most records now occur north of the Great Divide in Victoria and south of Pomona in Queensland. They may still be observed within their historical distribution in New South Wales, extending inland to Narrabri, Parkes and Warrumbungle National Park. However, reporting frequency and numbers have declined significantly since the 1940s (Higgins *et al.* 2001; Garnett and Crowley 2000).
Small numbers and individuals are occasionally reported in south-east Queensland from locations such as Pomona, Bribie Island, the Granite Belt, Sundown National Park and around Gore-Karara (e.g., Durikai State Forest). A small breeding population around Gore-Karara may represent the only breeding population in Queensland (Higgins *et al.* 2001; Geering 2012; SEWPAC 2013b).

**Occurrence in the project development area and extent of habitat**: There are five known records of regent honeyeater (*Anthochaera phrygia*) for the project development area. One record from

Chinchilla and four records from Dalby. Regent honeyeater (*Anthochaera phrygia*) has been observed feeding on flowering *Eucalyptus sideroxylon* in parkland along Myall Creek in Dalby, though this is a very infrequent event. **Figure A37** indicates the location of known records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A81**.

**Table A81.** Extent of habitat for regent honeyeater (*Anthochaera phrygia*) in the project development area and associated areas of assessment

| | **Core Habitat Known (ha)** | **Core Habitat Possible (ha)** | **General Habitat (ha)** |
|---|---|---|---|
| Project Development Area* | 33 | 260 | 25105 |
| 3D Detailed Mapping Area** | 512 | 3946 | 6520 |
| 3D Detailed Mapping Area based on EHP*** | 32 | 260 | 8759 |
| Survey area 2**** | 0 | 0 | 0 |
| Survey area 7 ****. | 0 | 18 | 61 |
| Survey area 8****. | 0 | 0 | 409 |
| Survey area 9****. | 0 | 0 | 167 |
| Survey area F****. | 0 | 9 | 9 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General threats to the species**: The main threats to the local populations of regent honeyeater (*Anthochaera phrygia*) are:

- Habitat loss fragmentation (Garnett and Crowley 2000)
- Poor habitat condition of many of the remaining habitat fragments (Garnett et al. 2011).

The decline of the regent honeyeater (*Anthochaera phrygia*) is primarily due to vegetation clearing and fragmentation (Garnett and Crowley 2000), with 75% of its habitat cleared, particularly its most preferred habitat. The poor health of many of the remaining fragments is also likely to be a contributing factor (Garnett *et al*. 2011). Birds using these fragments will be subject to nest failure due to predation and parasitism (Lindenmayer and Fischer 2006), increased adverse abiotic conditions

(e.g., increased temperature and wind) (Saunders *et al*. 1991), reduced foraging resources leading to lowered reproductive success, and an influx of aggressive species (e.g., friarbirds and miners) increasing competition (Franklin *et al.* 1989; Ford *et al.* 1993). Silviculture also removes the larger trees that regent honeyeaters (*Anthochaera phrygia*) favour for foraging and nesting and may therefore reduce resource availability and breeding success.

**Project-related Impacts**: Regent honeyeaters (*Anthochaera phrygia*) are highly mobile and able to easily cover large distances over modified land. Project-related impacts might include loss of foraging habitat for non-breeding birds.

**Significance of project related impacts (Unmitigated)**: The sensitivity of populations of regent honeyeater (*Anthochaera phrygia*) to unmitigated impacts within the project development area is considered ***High.*** No known breeding populations of the regent honeyeater (*Anthochaera phrygia*) occur in the project development area. However, a breeding population is approximately 35-40 km to the south-east of ATP 689. Dispersing and nomadic individuals may occasionally occur in southern portions of the project development area. Although suitable habitats in the area do not support resident populations, the areas could be important for the recovery of the species. Should a population be found to occur in the project development area, the unmitigated impact magnitude has been estimated as ***High***. This species impact significance is therefore ***High (21).***

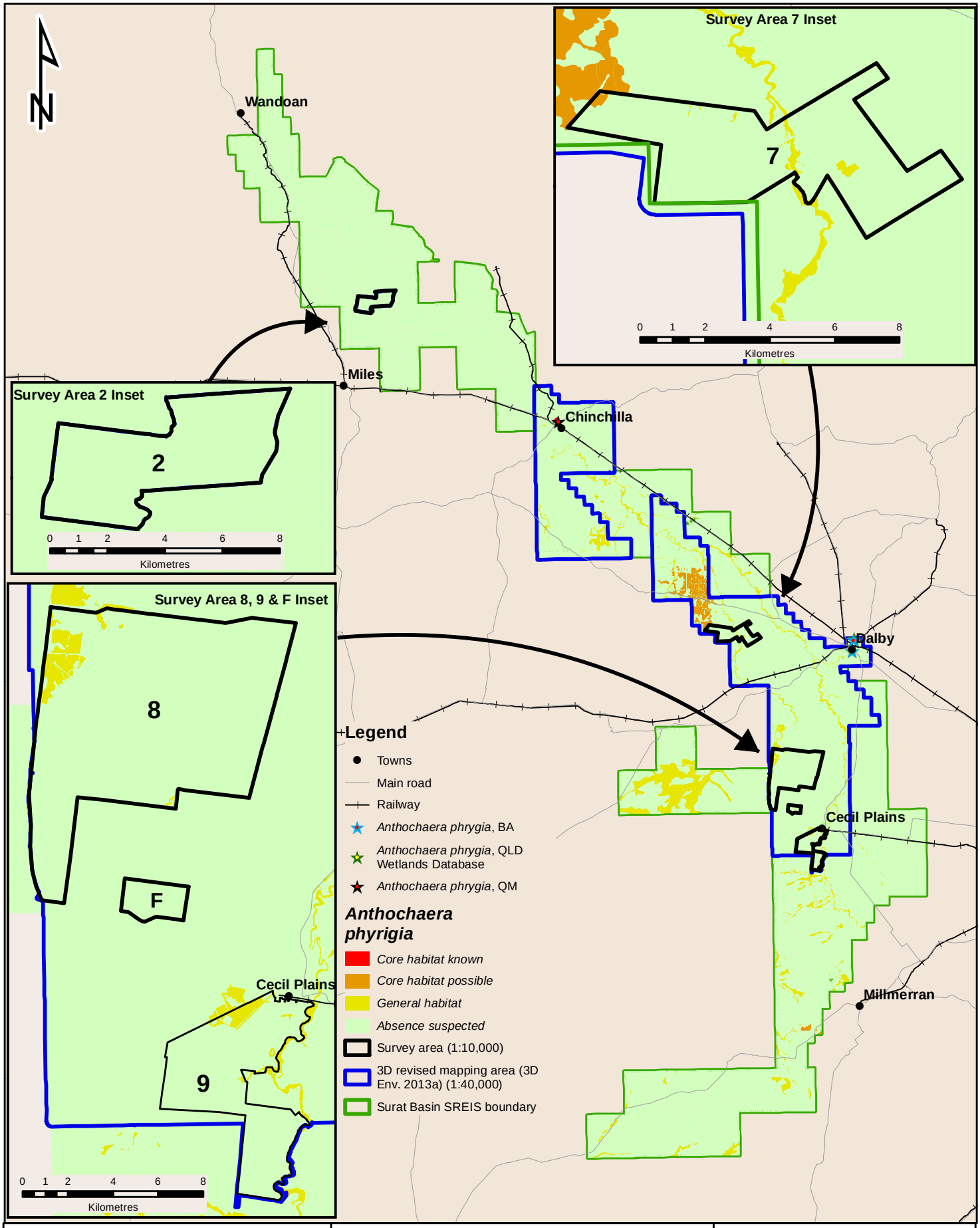
**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of regent honeyeater will be prioritised.

In addition rehabilitation of regent honeyeater (*Anthochaera phrygia*) habitat has been undertaken in other states and presents an opportunity for this project to improve regional biological values. Rehabilitation should focus on returning *Eucalyptus sideroxylon*, *Eucalyptus albens* and *Eucalyptus melliodora* communities to suitable land zones within the southern portions of the project development area.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***High*** significance to regent honeyeater (*Anthochaera phrygia*) populations that may use habitats in the project development area seasonally or sporadically. This assessment is based on the presumption that there is no known resident or seasonal population in the project development area and the species probably occurs very sporadically. Therefore, impact likelihood should not be based only on the disturbance of core habitats. Pre-clearing surveys of 'core habitat possible' are required to ensure that mapped regional ecosystems are accurate. Rehabilitation provides some opportunity for environmental value improvement although in general mitigation measures that do not involve habitat avoidance will have limited affect, therefore the residual impact remains ***High (21)***.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| High | NA | NA | High | High (21) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database

**Figure A37.** Regent honeyeater *(Anthochaera phyrigia)* distribution in project development area.

**Client** Arrow

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**Rules for Habitat Mapping**:

1. The species is highly unlikely to occur north of Chinchilla (approximate latitude -26.7). All vegetation north of this latitude should be classed as 'absence suspected.'
2. The species may occur, albeit very sporadically, between Chinchilla and Millmerran (-26.7 south to -27.8). In this region, 'core habitat possible' should be downgraded to 'general habitat' and 'general habitat 'downgraded to 'absence suspected.'
3. The species is most likely to occur in proximity to known populations south of Millmerran (south of -27.8).
4. Within the above areas, regional ecosystems (REs) with yellow box (*Eucalyptus* melliodora) and white box (*Eucalyptus* albens) (REs 11.8.2a, 11.9.9a) are classed 'core habitat possible.'
5. Communities with other dominant eucalypts such as grey box (*Eucalyptus moluccana*), Queensland blue gum, (*Eucalyptus tereticornis*) (REs 11.3.4, 11.3.14), Queensland blue gum (*Eucalyptus camaldulensis*) (REs 11.3.25, 11.3.26, 11.3.27a, 11.3.27b) and western grey box (*Eucalyptus microcarpa*) (REs 11.4.10, 11.5.20) are classed 'general habitat.'
6. All contiguous remnant vegetation classed as 'core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known.'
7. Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known.'
8. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
9. All remaining remnant communities are considered 'absence suspected.'
10. Open pasture, crops and urban landscapes are classed as 'absence suspected.'

**Mapping Confidence**

Given the uncertainty over the occurrence of the species in the project development area, the map is considered to have a *Low* predictive accuracy.

**Evaluation under MNES referral Guidelines**

**Table A82.** Evaluation of impact significance for regent honeyeater (*Anthochaera phrygia*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| Populations of the species in the Project Development Area. | The regent honeyeater's (*Anthochaera phrygia*) population is estimated at 350-400 birds (Geering 2012). In Queensland, the species has been recorded from 15 sites, primarily south of a line from Chinchilla to the Sunshine Coast (SEWPAC 2013b).<br>*It is suspected that in Queensland, as in NSW, declines in the area of occupancy may have been masked by occasional records of small numbers of birds. However, there is little documentation available to support this assumption (Geering 2005 pers. comm.)* (taken from SPRAT database (SEWPAC 2013b).<br>There are five known records of regent honeyeater (*Anthochaera phrygia*) for the project development area. One record from Chinchilla and four records from Dalby.<br>No 'core habitat possible' is present on the five properties listed below.<br>**Survey area 2**: Some 'general habitat', regional ecosystems (REs) 11.3.4 and 11.3.25, is present. Survey area 2 is north of the known distribution of the species.<br>**Survey area 7**: Some 'general habitat', regional ecosystems (REs) 11.3.4, 11.3.14 and 11.3.25, is present.<br>**Survey area 8:** Some 'general habitat', REs 11.3.26 and 11.5.20, is present.<br>**Survey area 9:** Some 'general habitat', REs 11.3.4 and 11.3.25, is present.<br>**Survey area F:** No 'general habitat' is present. |
| Criteria 1: lead to a long-term decrease in the size of a population. | **Survey area 2, 7, 8, 9, F**: Survey area F has no habitat classed as 'general habitat.' Survey area 2 has 'general habitat' but is north of the known distribution. Survey areas 7, 8 and 9 have some 'general habitat.'<br>There is no known population for these properties on these properties.<br>It is not possible to totally discount occurrence of the species on survey areas 7, 8 and survey area 9. Pre-clearance surveys may be required once project footprints have been identified.<br>Based on current knowledge of habitat and distribution, a population is not present on the properties, hence no long term decrease in population size will occur due to project activities. |
| Criteria 2: reduce the area of occupancy of a population. | **Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of a population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing population into two or more populations. | **Survey area 2, 7, 8, 9, F**: Will not fragment an existing population based on detail provided in Criteria 1. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of a population. | **Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease the availability of quality of habitat leading to the decline of the species. | **Survey area 2, 7, 8, 9, F:** Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |

| Criteria | Evaluation |
|---|---|
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:** There are no known records of regent honeyeater (*Anthochaera phrygia*) on any of the survey areas and all are at the northern limit of, or outside, the species known range. Local records represent transient individuals and all known or possible populations are located well south of the five survey areas. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and cumulative impacts are not expected to be reinforced by Arrow related activities. Actions on these properties are unlikely to be unknown, unpredictable or irreversible.

**Rule(s) for survey effort required in accordance with survey guidelines:**
DEWHA (2010b) guidelines suggest that area searches and targeted searches should be conducted for 20 hrs over ten and five days respectively, based on a 50 ha area. It is recognised that searches of this intensity cannot be acheived given the scale of the project. Appropriate survey requirements for this species are as follows:

Areas classed as 'core habitat known' should be avoided and do not require survey work on this basis. Areas classed 'core habitat possible' should be avoided but, if clearing is required, survey work should be conducted before any gas related work is undertaken. This work should include:

- Area searches of suitable habitat during the morning period (before 9am). Birds can be detected by call and visual observation.
- Targeted searches of flowering trees and around waterpoints such as dams and creeklines. These works are best undertaken when suitable foraging resources are in blossom.
- Call broadcast may also be useful immediately before, or during, the breeding season (May to March, mostly September to November; Higgins et al. 2001).

As surveys can require detection by call, surveys should be undertaken by personnel with previous survey experience and call identication capabilities.

## South-eastern Long-eared Bat (*Nyctophilus corbeni*)

**Status**: **EPBC Act**: Vulnerable (as *Nyctophilus timoriensis sensu lato*); **NC Act**: Vulnerable

**BoT:** Medium

**Sensitivity:** Moderate

**Recovery Plan:** Draft national recovery plan for the south-eastern long-eared bat *Nyctophilus corbeni* (Schulz and Lumsden 2010).

**Plate 35.** South-eastern long-eared bat (*Nyctophilus corbeni*) (Photograph Angus McNab).

**Alternative Nomenclature:** Taxonomic revision of *Nyctophilus timoriensis* has revealed four geographically separated forms (Parnaby 2009). The south-eastern form has been called *Nyctophilus corbeni* (south-eastern long-eared bat) and is protected under legislation as *N. timoriensis sensu lato* (south-eastern form).

### Overview of south-eastern long-eared bat

**Ecology**: Little is known about the ecology of this species and most of what is known comes from research outside of Queensland (Reardon 2012). Roosting has been recorded in hollows of live trees, cracks in tree limbs, occasionally under exfoliating bark and even within foliage (Churchill 2008; Turbill *et al*. 2008; Reardon 2012). With broad, short wings, the south-eastern long-eared bat is highly manoeuvrable and well-adapted to its cluttered habitat. They fly close to vegetation, often through the canopy and can drop suddenly to almost ground level after prey (Churchill 2008). Individuals are

known to fly more than seven km moving between roosts and foraging areas. Roosts may be changed frequently, with an average of 1.3 days in one study (Reardon 2012).
Mating occurs in autumn and winter. Females are able to store spermatozoa until ovulation and conception in early spring. Two young are usually born in late October to November and lactation continues until January (Turbill *et al.* 2008).

**Habitat**: The south-eastern long-eared bat (*Nyctophilus corbeni*) is most common in box/ironbark/cypress pine woodland on sandy soils (Turbill and Ellis 2006; Churchill 2008; Turbill *et al*. 2008), though it also occurs in bulloak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities (Turbill *et al*. 2008), dry sclerophyll forests with *Corymbia citriodora*, and semi-evergreen vine thickets. The species prefers areas with a distinct canopy and a dense understorey (Churchill 2008). Most records are from large tracts of vegetation of approximately 5000+ ha (e.g., Southwood National Park) (EPA 2008a), although the species can be recorded from smaller tracks of 600 ha (e.g., Erringibba National Park; M. Sanders unpub. data).

**Distribution**: The species is largely restricted to the Murray-Darling Basin (Churchill 2008; Turbill *et al*. 2008), with its stronghold in the Pilliga forests of central New South Wales (Turbill and Ellis 2006). In Queensland the species is mainly recorded in Brigalow Belt South, with records from less than 30 locations (Reardon 2012). The distributional limits in Queensland are uncertain. McFarland *et al.* (1999) state that the species is found north to near Duaringa and Venz *et al*. (2002) consider that the Dawson River area is at, or close to, its northern range limit. However, Parnaby (2009), in a taxonomic review of Australian greater long-eared bats previously known as *N. timoriensis*, states that the most northerly record of the species is from 80 km west of Taroom. Forearm length is used extensively in field identifications of *Nyctophilus* species and there is broad overlap between each species for each sex of *N. corbeni* and *N. gouldi*. Larger individuals of *N. gouldi* are the same general size as *N. corbeni* (Parnaby 2009). It is unknown if possible misidentifications of the species have resulted in the uncertainty attached to its distribution.

**Likelihood of occurrence in the project development area and extent of habitat**: There are eight known database records for the project development area. One record is from approximately 25 km north of Miles. Six records are from an area approximately 30 km south-west of Millmerran. There are also two recent survey records one from approximately 18 km north north-east of Miles, the second on survey area F. **Figure A38** indicates the location of known records of the species (derived from databases and survey records) as well as providing representation of the distribution in the project development area of areas classified as ‘core habitat known’, ‘core habitat possible’, ‘general habitat’ and areas where the species is considered unlikely to occur, ‘absence suspected.’ The extent of habitat within specific areas of the project development area is summarised within **Table A83.**

**Table A83.** Extent of habitat for south-eastern long-eared bat (*Nyctophilus corbeni*) in the project development area and associated areas of assessment.

| | Core Habitat Known (ha) | Core Habitat Possible (ha) | General Habitat (ha) |
|---|---|---|---|
| Project Development Area* | 14716 | 185001 | 0 |
| 3D Detailed Mapping Area** | 702 | 23792 | 0 |
| 3D Detailed Mapping Area based on EHP*** | 12947 | 41179 | 0 |
| Survey area 2**** | 702 | 663 | 0 |
| Survey area 7 ****. | 0 | 156 | 0 |
| Survey area 8****. | 0 | 2131 | 0 |
| Survey area 9****. | 0 | 342 | 0 |
| Survey area F****. | 0 | 97 | 0 |

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a) for purposes of comparison. Level of confidence = ***Low***

**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes (3D Environmental 2013). Level of confidence = ***High***.

**General threats to the species**: The main threats to the local populations of south-eastern long-eared bat (*Nyctophilus corbeni*) are:

- Major habitat loss over a large part of its distribution, mostly clearing of brigalow (Reardon 2012).
- Degradation of habitat from grazing.
- Loss of hollows and larger trees from logging and fires (Turbill et al. 2008).
- Increased competition for hollows from other species
- Increased exposure to predators (Reardon 2012).

Survey data suggest that large, intact remnants of suitable habitat are required to support populations (Turbill and Ellis 2006; Turbill *et al*. 2008). With more than 75% of habitat cleared in some parts of its range, land clearing and fragmentation continue to threaten this species (Duncan *et al.* 1999). Increased competition for hollows is an example of a flow-on impact from fragmentation (Reardon 2012).

**Project-related impacts**: Evidence suggests that this species is absent from small patches, occuring only in patches equal to or larger than Southwood National Park in extent (approximately 5,000 ha)

(EPA 2008a). However, the effect of fragmentation and disturbance associated with the construction of tracks and linear clearing is uncertain. Possible project-related impacts include:

- Potential death or injury of roosting bats caused by diurnal clearing of roosts. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- The loss of foraging and roosting habitat due to the construction of infrastructure.
- Fragmentation of existing large, intact and contiguous habitats. The species does occur in large forests that are traversed by management tracks, suggesting that they could be tolerant of some disturbance.
- Increased fire frequency associated with increased human activity and machinery.
- Increased watering points by the creation of surface ponds around gas wells. Flying insect abundance may also be increased around these waterbodies.

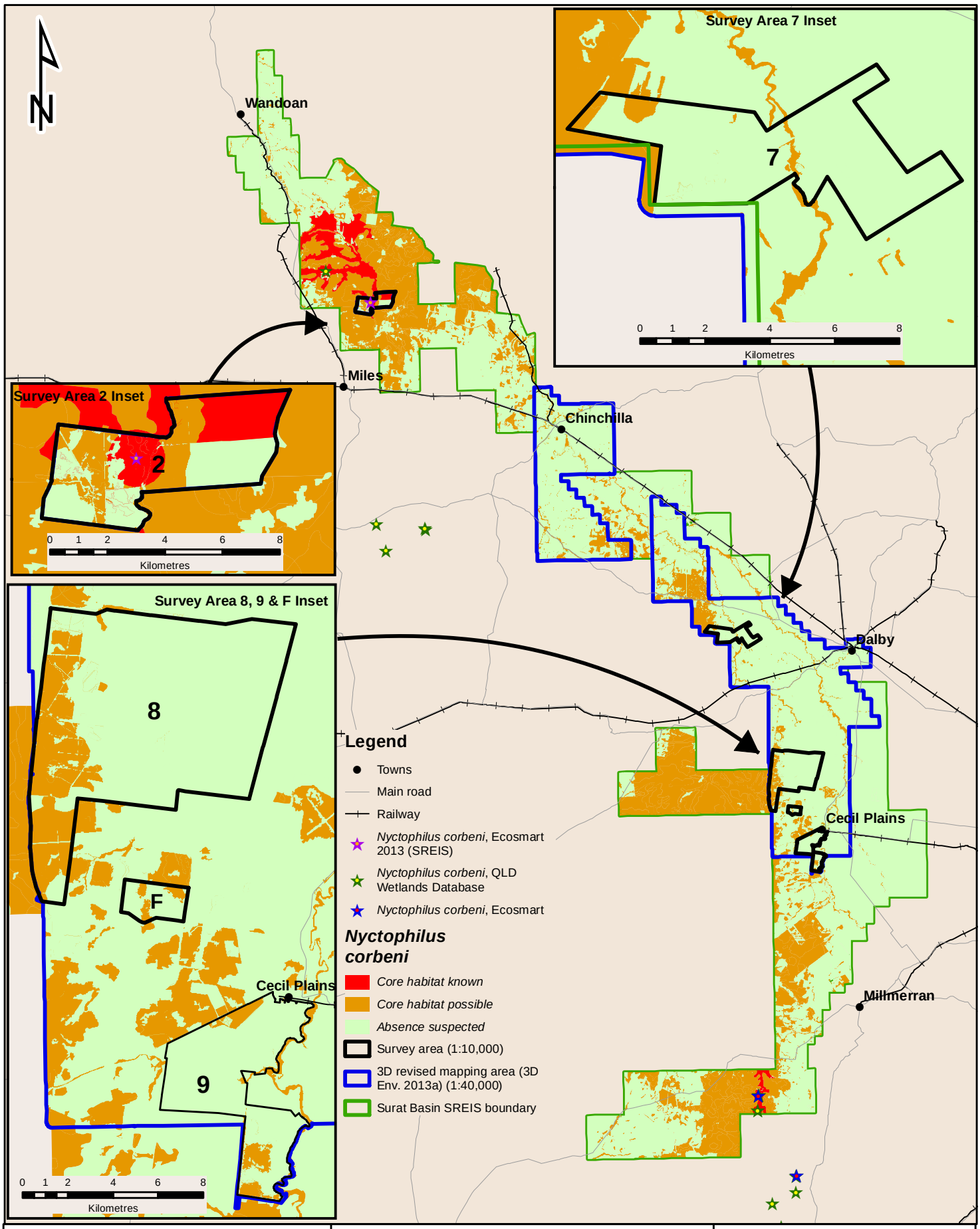
**Significance of project related impacts (unmitigated)**: The sensitivity of populations of south-eastern long-eared bat (*Nyctophilus corbeni*) to unmitigated impacts within the project development area is considered ***Moderate***. The species is highly mobile and may be tolerant of small-scale disturbance associated with activities such as gas acquisition pipelines and bores. More substantial clearing of vegetation associated with larger infrastructure (e.g., power generation plants, groundwater dams, etc) will have greater impacts. While it seems improbable that these activities will result in the extinction of a population, it may reduce available habitat and affect roosting opportunities.
Based on these factors, both the species sensitivity and impact magnitude are evaluated as ***Moderate*** for an overall impact significance of ***Moderate*** (13).

**Species specific management/ mitigation measures:** Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of south-eastern long-eared bat will be prioritised. In addition, any Habitat offsets that may be required under the Queensland Biodiversity Offset Policy (version 1). 3 October 2011 (DERM 2011) and/or the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (SEWPAC 2012b) should be connected to much larger contiguous tracks of vegetation to be successful.

**Summary residual impact assessment:** Unmitigated project related activities may result in impacts of ***Moderate*** significance to south-eastern long-eared bat (*Nyctophilus corbeni*) populations in the project development area. If habitat is avoided, no impact will be incurred. Mitigation measures other than habitat avoidance will not significantly reduce residual impact, remaining at ***Moderate (13)***.

| **Residual Impact Assessment** | | | | |
|---|---|---|---|---|
| Avoidance* | | | Other mitigation measures# | |
| Sensitivity Ranking | Magnitude Ranking | Significance Ranking | Magnitude Ranking | Significance Ranking |
| Moderate | NA | NA | Moderate | Moderate (13) |

*Includes appropriate application of management buffers
# Clearing of core habitat known and possible is unavoidable.
NA - Not applicable as the area will not be subject to impacts.




NOTES:

(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Ecosmart 2013 (SREIS)

**Figure A38.** South-eastern long eared bat *(Nyctophilus corbeni)* distribution in project development area.

**Client** Arrow

0 15 30 45 60
Kilometres

| Scale | Drawn By | Checked | File Path | Date | |
|---|---|---|---|---|---|
| 1:1,083,672 | DG | DS | C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd | 3/05/2013 | A4 |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C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

**Rules for Habitat Mapping:**

1. The known distribution of this species encompasses the entire project development area.
2. All remaining remnant vegetation (except very open communities; regional ecosystems (REs) 11.3.2, 11.3.21) greater in extent than 5000 ha (including cumulative area where patches are separated by less than 100 m) should be considered 'core habitat possible.'
3. All 'core habitat possible' REs within one km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known.'
4. Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known' unless it is a heterogeneous polygon that includes REs 11.3.2 and 11.3.21. Such areas should be excluded.\
5. Regrowth and mature regrowth (as per EHP 2012b) Is excluded.
6. All remaining remnant vegetation is mapped as 'absence suspected.'
7. Cleared non-remnant areas are classed as 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present (i.e., excluding REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5). For rule 2 this is applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

**Mapping Confidence:** Important habitat for this species is reasonably well understood and can be matched to regional ecosystem descriptions. While highest abundance is located within these habitats, the species can occur in other habitats and hence may occur outside of mapped habitats. Consequently, the map is considered to be of ***Moderate*** accuracy.

**Evaluation under MNES Referral Guidelines:**

**Table A84**. Evaluation of impact significance for south-eastern long-eared bat (*Nyctophilus corbeni*) under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| 'Important populations' and distribution of the species in the project development Area. | *The South-eastern long-eared bat* (*Nyctophilus corbeni*) *is rare throughout most of its distribution. In some areas however, it is more commonly recorded. These areas include the Brigalow Belt South and Nandewar Bioregions in north-eastern NSW* (SEWPAC 2013f).<br>No definition of an 'important population' is provided.<br>There are seven known database records for the project development area. One record is from approximately 25 km north of Miles. Six records are from an area approximately 30 km south-west of Millmerran. There is also a survey record from approximately 18 km north of Miles.<br>**Survey area 2**: Field survey trapped one individual of this species. The species could occur in all remnant and mature regrowth vegetation on the property. This vegetation is part of a large contiguous area of suitable remnant vegetation which extends beyond the property boundaries. It is not known if this individual represents an 'important population' but should be treated as such. |

| Criteria | Evaluation |
|---|---|
| | **Survey area 7 and 8**: These properties border much larger tracks of near-contiguous forest associated with State Forest, and as such, may contribute to a larger patch of suitable habitat for the south-eastern long-eared bat.<br>**Survey area 9:** While there is vegetation consistent with this species habitat preference, this patch is probably too minor in extent to support permanent populations. There is no known population for these properties.<br>**Survey area F**: Recent surveys by Ecosure recorded an individual of this species (Coffey *pers.comm*). Habitat within the area is suitable for the species even though the patch is relatively minor in extent. |
| Criteria 1: lead to a long-term decrease in the size of an important population. | **Survey area 2:** The survey record indicates that all remnant and mature regrowth vegetation on the property may support an important population of south-eastern long-eared bat. The project could possibly lead to a long-term decrease in the size of an important population, although the loss of individuals would be localised. Significant impacts under Criteria 1 are to be expected.<br>**Survey area 7 and 8**: It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance survey will be required once project footprints have been identified.<br>**Survey area 9:** The species is not expected to occur and activities will not therefore lead to a decrease in population size.<br>**Survey area F**: The survey record indicates that patches of remnant and mature regrowth vegetation on the property may support an important population of south-eastern long-eared bat. The project could possibly lead to a long-term decrease in the size of an important population. Hence significant impacts under Criteria 1 are expected. |
| Criteria 2: reduce the area of occupancy of an important population. | **Survey area 2 and F:** The project could reduce the area of occupancy of an important population. Although the loss of habitat is minor in the context of surrounding available habitat, significant impacts under Criteria 2 are expected.<br>**Survey area 7, 8, 9:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. |
| Criteria 3: fragment an existing important population. | **Survey area 2:** Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. The project will not fragment an existing important population if the species occurs in the contiguous habitat beyond the boundaries of survey area 2. Hence impacts under Criteria 3 are not expected to be significant.<br>**Survey area 7, 8, 9:** Will not fragment an existing important population based on detail provided in Criteria 1.<br>**Survey area F**: Survey area F is already located within a landscape subject to some degree of fragmentation. Remaining remnant vegetation on the property is separated from much larger contiguous remnant vegetation by short distances (i.e., <500 m) of modified land. On balance, most areas of remnant vegetation occur to the west, while the bulk of land to the east has been subject to agricultural clearing. As such, vegetation on the property is most likely to be near the limit of south-east long-eard bat habitat in the local area. The loss of this habitat is therefore unlikely to fragment the population and impact under Criteria 3 are not expected. |
| Criteria 4: adversely affect habitat critical to the survival of the species. | **Survey area 2** and **F:** The project could adversely affect habitat critical to survival of the species, although impacts are expected to be localised and not affect the broader population/habitat. Hence significant impact is not expected.<br>**Survey area 7, 8, 9**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. |
| Criteria 5: disrupt the breeding cycle of an important population. | **Survey area 2, F:** Impacts to the breeding cycle of this species will be restricted to a small number of individuals within survey area 9. Impacts will not affect breeding in the broader population/habitat and significant impact is not expected.<br>**Survey area 7, 8, 9**: Will not disrupt the breeding cycle of an important population |

| Criteria | Evaluation |
|---|---|
| | based on detail provided in Criteria 1. |
| Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **Survey area 2, F:** The project could modify, destroy, remove, isolate or decrease habitat leading to decline of the species. However impacts are expected to be localised and unlikely to affect the broader population. Hence significant impact under this criteria are not expected.<br>**Survey area 7, 8, 9**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. |
| Criteria 7: result in the establishment of a harmful invasive species. | **Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed. |
| Criteria 8: introduce a disease that may cause the species to decline. | **Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease. |
| Criteria 9: interfere with the recovery of the species. | **Survey area 2, F:** One of the objectives of the *draft National Recovery Plan for the South-eastern Long-eared Bat* (*Nyctophilus corbeni*) (Schulz and Lumsden 2010) is to: Identify key populations and protect these from habitat loss and fragmentation.<br>Broadscale clearing of survey area 2 and F does not comply with this objective and significant impact under Criteria 9 is expected.<br>**Survey area 7, 8, 9**: Will not interfere with the recovery of the species based on detail provided in Criteria 1. |

**Conclusions:**

***Survey area 2 and F:*** The south-eastern Long-eared bat (*Nyctophilus corbeni*) has been recorded in remnant and advanced regrowth on survey area 2 and on survey area F. Assuming the development would result in clearing of core habitat known and core habitat possible within survey areas 2 and F, a decrease in population size and extent is expected. Hence it is likely that there will be a significant impact under the definitions of Criteria 1 and Criteria 2. Whilst significant, these impacts will be localised and are not expected to affect the broader population. Significant impact is also expected under Criteria 9 as any development action which disturbs known habitat for the species is contrary to the draft recovery plan for the species.

***Survey areas 7, 8, 9:*** No known populations occur on survey area 7, 8, or 9, although further work is required to assess this species presence, particularly on survey area 7 and 8. Based on the assumption that the species is not present, the magnitude of impacts from development on these three properties is of extremely low magnitude and significant impact under MNES criteria is not expected. This assumes pre-clearance surveys are undertaken in areas of potential habitat (core habitat possible) and the species is not recorded.

This species inhabits larger patches of vegetation (i.e., >5000 ha); few records occur in fragmented or isolated habitats. While narrow gathering lines and roadways (<50 m wide) may not affect this

species (based on its occurrence in large areas dissected by management tracks), the impacts of wider easements is unknown.

The potential for cumulative impacts remains uncertain although if habitat is cleared, development activities will potentially reinforce cumulative impact to the species incurred across a range of interacting projects. Rehabilitation upon decomission has the potential to establish native vegetation, which over time should progress toward a native vegetation community. The loss of habitat therefore, may be reversible.

**Rule(s) for survey effort required in accordance with survey guidelines:** DEWHA (2010a) guidelines recommend 20 trap nights over five nights using both mist netting and harp trapping for every 50 ha of habitat, although mist netting requires specialised licencing that is impractical. Harp traps should be placed in flyways, amoungst cluttered vegetation and over water pools/creeklines (where possible). It is recognised that acheiving 20 trap nights in every 50 ha is unlikely in all cases given the extent of the project development area. The following mitigation measured should be applied based on methods of DEWHA (2010a) although adapted based on information collected during EIS and SREIS studies:

:

- Areas classed as ‘core habitat known’ should be avoided and do not require survey work on this basis.
- Areas classed ‘core habitat possible’ should be avoided, but if not possible further survey work should be conducted before any gas related work is undertaken.
- This species can only be reliably identified in the hand, acoustic recording (i.e., anabat) is inadequate, and therefore harp trapping and/or mist netting must be undertaken.

Surveys should be conducted between October to April, and as the species can be difficult to detect multiple surveys may be required. If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted) and work should not proceed without evaluation under MNES guidelines. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

# MNES Assessments - Aquatic Fauna Species

## Fitzroy River Turtle (*Rheodytes leukops*)

**Plate 36**. Fitzroy River Turtle (Rheodytes leukops) (Source: WetlandInfo, 2004)

### Background Information

**i. Status**

**NC Act**: Vulnerable, **EPBC Act**: Vulnerable, **Back on Track**: high priority, **ACA Priority**: no

**ii. Sensitivity**

'High'

**iii. Recovery Plan**

The Fitzroy River Turtle is listed in *The Action Plan for Australian Reptiles* (Cogger et al., 1993).

**iv. Ecology**

The Fitzroy River Turtle grows to 25 cm (shell length) and the shell has a medium to dark brown colouring, with some dark spots and blotches on the top of the shell (DSEWPC, 2012). On the underside surface, the shell is yellow or cream and the skin is an olive-grey colour (DSEWPC, 2012). The neck of the Fitzroy River Turtle is covered with *'large, pointed conical tubercles'* (DSEWPC, 2012). The turtle also has long forelimbs, each with five claws, and a large cloacal bursae (DSEWPC, 2012).

The Fitzroy River Turtle has adapted to breathe either using its lungs or its cloaca (DSEWPC, 2012). The turtles are known as 'bottom-breathers' as they can respire by drawing water in

and expelling it from the cloaca at a rate of 15-60 times per minute (DSEWPC, 2012). This function allows the turtle to walk on the streambed and stay underwater without coming to the surface for days or weeks (Limpus, 2007).

The Fitzroy River Turtle is slow to reach sexual maturity, taking up to 15-20 years before reproduction can occur (DSEWPC, 2012). Nesting takes place between September and October annually, with nests being located in river sandbanks 1-4 m above the water level (DSEWPC, 2012). Females typically lay between 46-59 eggs annually in three to five clutches (DSEWPC, 2012).

The Fitzroy River Turtle has a highly diverse diet consisting of algae, macroinvertebrate larvae, macrophytes (including *Vallisneria spp.*), freshwater sponges, terrestrial insects, as well as terrestrial leaves and bark (DSEWPC, 2012).

The Fitzroy River Turtle is thought to have a limited home range (417-679 m), overlapping riffle zones (DSEWPC, 2012). Turtles have been observed to be active mainly during late afternoon and at night, although they can be largely sedentary staying in the same location for several days (DSEWPC, 2012).

**v. Habitat**

The Fitzroy River Turtle occurs in rivers with a rock, gravel or sand substrate, with deep pools that are connected by shallow riffle zones (DEHP, 2007; Limpus et al. 2011). Riffle zones are an important habitat for Fitzroy River Turtles due to the high dissolved oxygen levels in these zones and abundant food sources, including benthic macroinvertebrates and algae (Tucker et al. 2001).

During the dry season this species retracts into large slow flowing pools and/or non-flowing permanent pools (DEHP, 2007; Limpus et al., 2011). The species prefers waterways with high water clarity and areas that contain large macrophyte beds, including *Vallisneria* spp.

**vi. Distribution**

The Fitzroy River Turtle has been identified as occurring in the Fitzroy, Connors, Dawson, Isaac and Mackenzie Rivers, as well as Windah Creek and Develin or Malborough Creek (Limpus et al. 2011 DEHP, 2007; Cogger et al. 1993). Since being described in 1980, the distribution of the Fitzroy River Turtle is not believed to have significantly changed (DEHP, 2007; Limpus et al. 2011).

**vii. Threats**

The Fitzroy River Turtle is threatened by two key factors: excessive loss of eggs and habitat modification (Limpus et al. 2011).

Loss of eggs is related to predation and trampling of the banks by cattle (Limpus et al. 2011). Feral pigs, foxes, dogs, goannas and water rats can disturb the nests and destroy many clutches of eggs (DEHP, 2007; DSEWPC, 2012). Similarly, the trampling by cattle of the sandy/loamy riverbanks where eggs are laid can cause the destruction of many nests (DEHP, 2007; DSEWPC, 2012). Habitat modification through the installation of barrages and weirs has reduced the availability of riffle habitat through flow regulation (DSEWPC, 2012). These structures also act as a physical barrier that restricts the movement of the Fitzroy River Turtle and access to food and nesting areas (DEHP, 2007; DSEWPC, 2012).

Declines in water quality, including increased turbidity levels, has also been associated with increasing agricultural and mining land uses (Venz, 2002). Higher turbidity levels may impact

on cloacal respiration and the availability of food resources, which can cause declines in turtle populations (Cann, 1998).

**Project Relevance**

**i. Recorded Presence within the Project Development Area and Surrounds**

The Fitzroy River Turtle is only known to occur within the Fitzroy Basin, not the Murray-Darling Basin (within which the vast majority of the Project Development Area is situated). A small portion of the Project Development Area falls within the Dawson River catchment of the Fitzroy Basin.

No specimen of Fitzroy River Turtle has been recorded within the Project Development Area. However, database search results returned the species as 'possibly' occurring within the small portion of the Project Development Area occurring within the Dawson River catchment.

Targeted Fitzroy River Turtle surveys (including nesting bank inspection during the breeding season) were not completed for this Project and no individuals were collected by routine turtle sampling methodologies employed.

The Fitzroy River Turtle has previously been recorded within the Dawson River below theOrange Creek Weir (Limpus et al. 2007); which is situated approximately 175 km downstream of the Project Development Area.

**ii. Extent of Habitat within the Project Development Area**

The small portion of the Project Development Area occurring within the Dawson River catchment (Fitzroy Basin) is not expected to support suitable habitat for the Fitzroy River Turtle.

The portion of the Project Development Area occurring within the Murray-Darling Basin is outside of the known range of the Fitzroy River Turtle. Accordingly, no assessment of the suitability of habitat within this area has been completed.

**iii. Potential Project Related Impacts (Unmitigated)**

Unmitigated Project impacts upon the Fitzroy River Turtle potentially include:

- Modification/loss of physical habitat (hydrological, physical macro-habitat and physical micro-habitat) and changes to water quality as a result of soil disturbance activities that occur across the catchment.

The magnitude of project impacts is considered to be 'low'.

**iv. Significance of Project Related Impacts (Unmitigated)**

'Moderate'

**v. Proposed Mitigation Measures and Management**

Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species.

### vi. Residual Impact Assessment

The residual impact for the transfer of water between treatment facilities and general activities across the Project Development Area are considered to be 'moderate'.

### vii. Significance of Project Impact under MNES Referral Guidelines

An evaluation of the significance of potential Project impacts upon the Fitzroy River Turtle in accordance with the MNES referral guidelines is presented in the **Table A85** below. This assessment has been completed assuming that the above specified mitigation measures will be implemented (AMEC [2013] **Section 7**). Additionally, it is assumed that the SREIS survey site situated within the Dawson River catchment (SAQ-1) is representative of aquatic habitat occurring throughout the portion of the Project Development Area occurring within the Dawson River catchment.

**Table A85** Evaluation of Project Impact to the Fitzroy River Turtle (*Rheodytes leukops*) under MNES Guidelines

| Criteria | Evaluation |
|---|---|
| **Criteria 1**<br>Lead to a long-term decrease in the size of an important population* | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 2**<br>Reduce the area of occupancy of an important population* | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 3**<br>Fragment an existing important population* | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 4**<br>Adversely affect habitat critical to the survival of the species | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 5**<br>Disrupt the breeding cycle of an important population* | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 6**<br>Modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |

| Criteria | Evaluation |
|---|---|
| **Criteria 7**<br>Result in the establishment of a harmful invasive species. | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 8**<br>Introduce a disease that may cause the species to decline. | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |
| **Criteria 9**<br>Interfere with the recovery of the species. | **No**<br>This species is not known to inhabit the Project Development Area, or waterways downstream that will be impacted by the Project. Furthermore, there is a complete lack of suitable habitat to support this species within waterways to be impacted by the Project. |

**NOTES:**

* MNES Guidelines (DEWHA 2009, p.11) define an 'important population' as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

1. Key source populations either for breeding or dispersal
2. Populations that are necessary for maintaining genetic diversity, and/or
3. Populations that are near the limit of the species range

## Conclusion

Under MNES criteria, activities with a 'moderate' residual impact (those related to the soil disturbance activities and water transfers) are considered to be of 'low' significance for Fitzroy River Turtle (*Rheodytes leukops*) with none of criteria registering any impacts.

# Murray Cod (*Maccullochella peelii peelii*)

**Plate 37.** Murray Cod (*Maccullochella peelii peelii*) (Specimen collected from the Condamine River at Survey Area 9, source: Camille Percival)

## Background Information

### i. Status

**NC Act**: not listed, **EPBC Act**: Vulnerable, **Back on Track**: critical priority, **ACA Priority**: no

### ii. Sensitivity

'High'

### iii. Recovery Plan

The National Recovery Plan for Murray Cod (*Maccullochella peelii peelii*) was prepared by the National Murray Cod Recovery Team (2010).

### iv. Ecology

Murray Cod can grow up to 1.8 m long and weigh up to 113.5 kg, making it the largest freshwater fish found in Australia (Allen et al. 2003; DSEWPC, 2012; Butcher, 2007). Typically, Murray Cod range from 50 cm to 70 cm in length and weighs less than 10 kg (Allen et al. 2003). The species can live up to 60 years and typically resides within a 10 km stretch of river over their lifetime (Allen et al. 2003).

When compared to other species, Murray Cod has relatively low fertility (DSEWPC, 2012). The species reaches sexual maturing within four to five years of age and females produce around 10,000 eggs to 90,000 eggs depending on the weight of the fish (DSEWPC, 2012). Spawning occurs from late spring to early summer, with breeding taking place just before annual high flow and flood events (Allen et al., 2003; DSEWPC, 2012).

Murray Cod are carnivorous and feed on other fish, turtles, frogs, crustaceans and molluscs, but also have been known to eat terrestrial animals including snakes, birds, mice, and water dragons (Allen et al. 2003; DSEWPC, 2012).

Murray Cod are known to migrate approximately 40 to 120 km upstream to spawn, following a flood event (Butcher, 2007; DSEWPC, 2012). The species then moves downstream to the same territory where they occupied prior to spawning (DSEWPC, 2012).

**v. Habitat**

Murray Cod occurs in a wide range of warm water habitats including slow flowing, turbid waters of lowland rivers and billabongs and upland streams with rocky substrates and high flowing, clear waters (Allen et al., 2003). The species prefers waterways which are up to 5 m deep, with submerged logs and boulders, undercut banks and overhanging vegetation (Allen et al., 2003). Consequently, it is often found in the main river channel and larger tributaries rather than floodplain channels (Butcher, 2007; DSEWPC, 2012).

**vi. Distribution**

Murray Cod occurs within the waterways of the Murray-Darling Basin (MDB) within Queensland, New South Wales, Victoria and South Australia. Within Queensland it is found in the south western boarder lakes and rivers (Butcher, 2007; DAFF, 2012). There have been attempts to translocate the species outside its normal range. Within Queensland it has been previously introduced into the Cooper Creek and Burnett and Fitzroy River systems (DSEWPC, 2012).

**vii. Threats**

The number of Murray Cod has steadily declined since European settlement (DSEWPC, 2012). Current threats to the species include: flow regulation and barriers to fish movement, habitat degradation, water quality declines, commercial, recreational and illegal fishing, disease and loss of genetic diversity associated with alien species and fish stocking, and climate change.

To improve water security and river navigation, over 3,600 dams and weirs have been constructed throughout the MDB (DSEWPC, 2012). These barriers have altered the natural flow regime in these waterways and have created barriers to fish and water movement (DSEWPC, 2012; Butcher, 2007). The regulation of flow has also reduced the number of flood events required for triggering spawning and the habitat available to the Murray Cod (DSEWPC, 2012; Butcher, 2007).

The MDB was historically used for navigation by boat and the removal of snags (i.e. trees or branches found in rivers) occurred throughout waterways (DSEWPC, 2012; Butcher, 2007). Snags provide essential habitat for Murray Cod throughout its lifecycle, from spawning to adulthood (DSEWPC, 2012; Butcher, 2007). The removal of snags has fragmented habitat and populations of Murray Cod (DSEWPC, 2012). Recovery of this habitat continues to be a slow process throughout the MDB.

Water quality has been impacted throughout the MDB in association with the introduction of dams and weirs, as well as urban and agricultural land uses (DSEWPC, 2012; Butcher, 2007). Dams release cold water which can lower overall water temperatures by 15$^{o}$C and influence water temperatures up to 100 to 150 km downstream (DSEWPC, 2012; Butcher, 2007). These impacts on water temperature can significantly reduce the growth rates in juvenile Murray Cod (DSEWPC, 2012). Similarly, irrigation associated with agriculture along the MDB has resulted in increased nutrient runoff and higher salinity levels through the raising of the water table (DSEWPC, 2012). Juvenile fish are more sensitive to higher salinity levels and this could impact on their life expectancy (DSEWPC, 2012).

Commercial, recreational and illegal fishing has had an impact on the numbers of mature fish (greater than 50 cm) (DSEWPC, 2012; Butcher, 2007). The removal of fish at the beginning of their breeding age (50 cm) has an impact on population structure and sustainability, which has been observed in regards to Murray Cod with declines in catch numbers over the last century (DSEWPC, 2012).

The MDB contains 11 species of exotic fish including, Carp (*Cyprinus carpio*), Redfin (*Perca fluviatilis*) and Eastern Gambusia (*Gambusia holbrooki*). The introduction of these species has affected the Murray Cod through exposure to new diseases and parasites, including Epizootic Haematopoietic Necrosis (EHN) virus and Asian fish tapeworm (*Bothriocephalus acheilognathis*) (DSEWPC, 2012). Similarly, the introduction of hatchery bred fish has caused a loss of genetic diversity of wild populations of Murray Cod (DSEWPC, 2012). This loss of genetic diversity could make the species more vulnerable to disease, increasing their chance of extinction.

Climate change is anticipated to have a potential impact on the MDB through the reduction of rainfall levels (DSEWPC, 2012). Flow regulation has already reduced natural flows throughout the basin, restricting habitat available to the Murray Cod. With decline in rainfall, it is anticipated that a higher number of fish kills will occur during drought periods and there will be less opportunities for spawning (DSEWPC, 2012). These impacts will ultimately reduce the sustainability of populations.

**Project Relevance**

**viii. Recorded Presence within the Project Development Area and Surrounds**

Murray Cod is known to occur within the portion of the Project Development Area within the Murray-Darling Basin (Allen et al. 2003; Pusey et al. 2004). The population is known to be endemic, although there is population supplementation from stocking groups. The species was recorded within the Survey Area 2 and Survey Area 9 receiving systems during baseline surveys completed specifically for the Project. This population of Murray Cod is considered an 'important population', as per the definition provided by the EPBC Significant Impact Guidelines, as it forms a portion of the interconnected population of the broader Murray-Darling Basin which is recognised under the Environment Protection and Biodiversity Conservation Act 1999 as 'vulnerable'. This legislation recognises the importance of this population as necessary for a species' long-term survival and recovery.

**ix. Extent of Habitat within the Project Development Area**

The portion of the Project Development Area occurring within the Murray-Darling Basin is generally expected to support suitable habitat for Murray Cod.

**x. Potential Project Related Impacts (Unmitigated)**

Unmitigated Project impacts upon the Murray Cod potentially include:

- Modification/loss of physical habitat (hydrological, physical macro-habitat and physical micro-habitat) and changes in water quality as a result of soil disturbance activities that occur across the catchment and discharge of coal seam gas water

- Disruption of breeding cycles due to alterations in the natural flow regime resulting from the release of coal seam gas water

- Facilitation of the spread and introduction of 'exotic' species known to pose a threat to the species from changes to the natural flow regime from the release of coal seam gas water.

The magnitude of the project impacts from the continuous releases of coal seam gas water into receiving waterways is considered to be 'high'. The magnitude of all other project impacts is considered to be 'low'.

**xi. Significance of Project Related Impacts (Unmitigated)**

'Moderate' to 'Major'.

**xii. Proposed Mitigation Measures and Management**

Commitments made by Arrow documented within Attachment 4, Commitments Update of the SREIS are considered sufficient to mitigate impacts to the species.

**xiii. Residual Impact Assessment**

The residual impact for the transfer of water between treatment facilities and general activities across the Project Development Area not receiving coal seam gas water are considered to be 'moderate'.

The residual impact for the discharge of coal seam gas water under the scenario where discharges mimic, but deviate up to 20% from natural flows for the Survey Area 2 and Survey Area 9 receiving systems, are considered to be 'moderate'.

**xiv. Significance of Project Impact under MNES Referral Guidelines**

An evaluation of the significance of potential Project impacts on Murray Cod in accordance with the MNES referral guidelines is presented in **Table A86** and **Table A87** below. **Table A86** considers the significance of impacts with a 'moderate' residual impact including; general impacts not related to discharges into streams. **Table A87** considers the significance of impacts with a 'moderate' residual impact which relates to the mitigation for the scenario where discharges mimic, but deviate up to 20% from natural flows. For more detailed information see AMEC (2013) **Section 6.1** and the assumptions and limitations outlined in AMEC (2013) **Section 1.4**.

**Table A86** Evaluation of Project Impacts to the Murray Cod (*Maccullochella peelii peelii*) under MNES Guidelines for activities assessed as having 'moderate' residual impacts (excluding discharge of coal seam gas water)

| Criteria | Evaluation |
|---|---|
| **Criteria 1**<br>Lead to a long-term decrease in the size of an important population* | **No**<br>These activities are not considered likely to have a significant impact on Murray Cod and therefore not lead to a long-term decrease in the size of the population. |
| **Criteria 2**<br>Reduce the area of occupancy of an important population* | **No**<br>These activities are not considered likely to have a significant impact on Murray Cod and therefore not lead to a reduction in the area of occupancy for the population. |
| **Criteria 3**<br>Fragment an existing important population* | **No**<br>These activities are not considered likely to create barriers that would impinge on the movement of Murray Cod and hence not fragment the population. |
| **Criteria 4**<br>Adversely affect habitat critical to the survival of the species | **No**<br>These activities are not considered likely to affect habitat critical to the survival of Murray Cod. |
| **Criteria 5**<br>Disrupt the breeding cycle of an important population* | **No**<br>These activities are not considered likely to have a significant impact on the timing and magnitude of flows which are of critical importance to the reproduction of Murray Cod and the ecosystem processes on which they are dependent. |
| **Criteria 6**<br>Modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **No**<br>These activities are not considered likely to have a significant impact on the existing habitat. |
| **Criteria 7**<br>Result in the establishment of a harmful invasive species. | **No**<br>With the appropriate mitigation steps taken to minimise impacts on the transfer of aquatic species between locations these activities are unlikely to facilitate the establishment of harmful invasive species. |
| **Criteria 8**<br>Introduce a disease that may cause the species to decline. | **No**<br>With the appropriate mitigation steps taken to minimise impacts on the transfer of aquatic species between locations these activities are unlikely to introduce a disease that may cause the decline of Murray Cod. |
| **Criteria 9**<br>Interfere with the recovery of the species. | **No**<br>Murray Cod currently exist within vicinity of the project development area. From current knowledge, this population has declined from pre-settlement times but is in a state of recovery from prior disturbance. The activities identified as having a 'low' residual impact are unlikely to interfere with this recovery. |

**NOTES:**

* MNES Guidelines (DEWHA 2009, p.11) define an 'important population' as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

1. Key source populations either for breeding or dispersal
2. Populations that are necessary for maintaining genetic diversity, and/or
3. Populations that are near the limit of the species range

**Table A87** Evaluation of Project Residual Impact to the Murray Cod (*Maccullochella peelii peelii*) under MNES Guidelines for the discharge of coal seam gas water (assessed as having 'moderate' residual impacts)

| Criteria | Evaluation |
|---|---|
| **Criteria 1**<br>Lead to a long-term decrease in the size of an important population* | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water (with appropriate consideration given to breeding requirements) is not considered likely to have a significant impact on Murray Cod reproduction and survivability and therefore not expected to lead to a long-term decrease in the size of the population. |
| **Criteria 2**<br>Reduce the area of occupancy of an important population* | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water is not considered likely to have a significant impact on the area of occupancy for the Murray Cod population. |
| **Criteria 3**<br>Fragment an existing important population* | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water is not considered likely to create barriers that would impinge on the movement of Murray Cod and hence not fragment the population. |
| **Criteria 4**<br>Adversely affect habitat critical to the survival of the species | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water is not considered likely to affect habitat critical to the survival of Murray Cod. |
| **Criteria 5**<br>Disrupt the breeding cycle of an important population* | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water (with appropriate consideration given to breeding requirements) is not considered likely to have a significant impact on the timing and magnitude of flows which are of critical importance to the reproduction of Murray Cod. |
| **Criteria 6**<br>Modify, destroy, remove, isolate or decrease habitat leading to the decline of the species. | **No**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water (with appropriate geomorphological considerations taken into account) is not considered likely to have a significant impact on the habitat of Murray Cod. |
| **Criteria 7**<br>Result in the establishment of a harmful invasive species. | **Yes**<br>Increasing the frequency of high flow events through the discharge of coal seam gas water has the potential to facilitate the establishment of harmful invasive species. |
| **Criteria 8**<br>Introduce a disease that may cause the species to decline. | **No**<br>With the appropriate mitigation steps taken to minimise impacts on the transfer of aquatic species with water between locations these activities are unlikely to introduce a disease that may cause the decline of Murray Cod. |

| Criteria | Evaluation |
|---|---|
| **Criteria 9**<br>Interfere with the recovery of the species. | **Yes**<br>Murray Cod currently exist within vicinity of the project development area. From current knowledge, this population has declined from pre-settlement times but is in a state of recovery from prior disturbance. The activities identified as having a 'moderate' residual impact have the potential to interfere with this recovery. |

**NOTES:**

* MNES Guidelines (DEWHA 2009, p.11) define an 'important population' as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

1. Key source populations either for breeding or dispersal
2. Populations that are necessary for maintaining genetic diversity, and/or
3. Populations that are near the limit of the species range

### Conclusions

Based on the preceding information, the potential impact to Murray Cod inhabiting the Project Development Area depends upon the type of Project activity.

Under MNES criteria, activities with a 'moderate' residual impact (those related to the soil disturbance activities and water transfers) are considered to be of 'low' significance for Murray Cod with none of criteria registering any impacts.

Under MNES criteria, activities with a 'moderate' residual impact (those related to the discharges that mimic, but deviate up to 20% from natural flows) are considered to be of 'moderate' significance for Murray Cod with the majority of criteria not registering any impacts. However, under Criteria 7 there is the potential for facilitating the establishment of harmful invasive species and consequently under Criteria 9 to interfere with the recovery of Murray Cod.

There is potential for cumulative impacts from similar activities undertaken by other proponents (discharge of coal seam gas water) to further exacerbate these impacts.

# MNES Assessments - Migratory Fauna Species

## Migratory Birds

Thirty-five species of bird listed as Migratory under the EPBC Act have been recorded in or near the project development area and/or are predicted to occur by Fielder (2012)and the EPBC Act Protected Matters Report generated from the Protected Matters Search Tool maintained by SEWPaC http://www.environment.gov.au/epbc/pmst/index.html (Appendix D)**.** Species are listed as Migratory under the EPBC Act due to their inclusion under one of more of the following:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- China-Australia Migratory Bird Agreement (CAMBA)
- Japan-Australia Migratory Bird Agreement (JAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Two of these species, painted snipe *Rostratula benghalensis* (*sensu lato*) and regent honeyeater (*Xanthomyza phrygia*) have been dealt with as Australian painted snipe (*Rostratula australis*) and regent honeyeater (*Anthochaera phrygia*) under EPBC Act listed fauna species above. They are listed as Vulnerable and Endangered, respectively, under the EPBC Act and the listing of these two species as Migratory under different common and/or scientific names reflects taxonomic changes. The remaining 33 species are all listed as Special Least Concern under the NC Act.

When assessing the significant impact criteria for Migratory species under the EPBC Act it is appropriate to group species. The 33 species to be assessed (**Table A88**) will be grouped under the headings:

- Migratory terrestrial species.
- Migratory wetland species.
- Migratory shorebirds (waders).

Information on ecology, habitat, distribution, threatening processes and evaluation under MNES referral guidelines will also be provided under these three broad headings.

**Table A88.** Migratory species recorded in or near the project development area and/or predicted to occur.

| **Species Group** | |
|---|---|
| **Species** | **International agreement (s)**<br>**Alternative nomenclature** |
| Terrestrial | |
| white-throated needletail (*Hirundapus caudacutus*) | CAMBA, JAMBA, ROKAMBA; listed under ROKAMBA as *Chaetura caudacuta* |
| fork-tailed swift (*Apus pacificus*) | CAMBA, JAMBA, ROKAMBA |
| eastern osprey (*Pandion cristatus*) | Bonn Convention; listed as *Pandion haliaetus* |
| white-bellied sea-eagle (*Haliaeetus leucogaster*) | CAMBA |
| oriental cuckoo (*Cumulus optatus*) | CAMBA, JAMBA, ROKAMBA; listed as *Cuculus saturatus* |
| rainbow bee-eater (*Merops ornatus*) | JAMBA |
| rufous fantail (Rhipidura rufifrons) | Bonn Convention |
| satin flycatcher (*Myiagra cyanoleuca*) | Bonn Convention |
| black-faced monarch (*Monarcha melanopsis*) | Bonn Convention |
| spectacled monarch (Symposiarchus trivirgatus) | Bonn Convention; listed as *Monarcha trivirgatus* |
| Australian reed-warbler (*Acrocephalus australis*) | Bonn Convention; listed as clamorous reed-warbler (*Acrocephalus stentoreus*) |
| WETLAND | |
| garganey (*Anas querquedula*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| eastern great egret (*Ardea modesta*) | CAMBA, JAMBA; listed as *Egretta alba* |
| cattle egret (*Ardea ibis*) | CAMBA, JAMBA; listed under CAMBA as *Ardeola ibis*, under JAMBA as *Bubulcus ibis* |
| glossy ibis (Plegadis falcinellus) | Bonn Convention, CAMBA |
| Caspian tern (Hydroprogne caspia) | CAMBA, JAMBA |
| white-winged black tern (*Chlidonias leucopterus*) | CAMBA, JAMBA |
| Cotton pygmy goose (*Nettapus coriomandelis)* | CAMBA, JAMBA |
| SHOREBIRDS | |
| Pacific golden plover (*Pluvialis fulva*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| oriental plover (*Charadrius veredus*) | Bonn Convention, CAMBA, JAMBA |
| Latham's snipe (*Gallinago hardwickii*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| black-tailed godwit (*Limosa limosa*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| bar-tailed godwit (*Limosa lapponica*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| little curlew (*Numenius minutus*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| whimbrel (Numenius phaeopus) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| common sandpiper (*Actitis hypoleucos*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA; listed under CAMBA and ROKAMBA as *Tringa hypoleucos* |
| common greenshank (*Tringa nebularia*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| marsh sandpiper (*Tringa stagnatilis*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| wood sandpiper (*Tringa glareola*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| red-necked stint (*Calidris ruficollis*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| sharp-tailed sandpiper (*Calidris acuminata*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |
| curlew sandpiper (*Calidris ferruginea*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |

| **Species Group** | |
|---|---|
| **Species** | **International agreement (s)**<br>**Alternative nomenclature** |
| ruff (*Philomachus pugnax*) | Bonn Convention, CAMBA, JAMBA, ROKAMBA |

**Migratory Terrestrial Birds**

This grouping of species follows the broad headings used by SEWPaC for Migratory species, other than for white-throated needletail, fork-tailed swift and Australian reed-warbler. In this instance the majority of their occurrence is associated with terrestrial habitats and they are included on that basis.

**Ecology:**

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- In Australia, are almost completely aerial species, possibly even sleeping on the wing, though occasionally roost in trees.

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Nest on cliffs and in large trees but eastern osprey also nests on artificial structures such as power poles and towers (Debus 1998; NSW NPWS 2002).

Oriental cuckoo (*Cuculus optatus*):

- Usually only present in Australia between September and May, returning to PNG and Asia during Australian winter

Rainbow bee-eater (*Merops ornatus*):

- Often observed plucking bees and winged insects from above fields, and shrublands. A ground nesting species.

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Very active species, spending muc time foraging in tree tops and along branches for small invertebrates.

Australian reed-warbler (*Acrocephalus australis*):

- Prefers dense vegetation along watercourses. Migratory in southeast Queensland, arriving in spring.

**Habitat and distribution:**

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- In Australia, are almost completely aerial species, possibly even sleeping on the wing, though occasionally roost in trees.
- Found over a wide variety of habitat, including open and highly modified areas, cities, forests and the ocean (Higgins 1999).
- A seasonal visitor to Australia between October and April.

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Occur along the entire Australian coastline and extend far inland, typically along major rivers or on large lakes and reservoirs.

Oriental cuckoo (*Cuculus optatus*):

- Occurs in rainforest, vine thicket and open forest and woodland and sometimes found in mangroves. Often recorded in gardens and plantations (Blakers et al. 1984; Higgins 1999).

Rainbow bee-eater (*Merops ornatus*):

- A common species that occurs in almost any habitat suitable for catching insects, including towns and other highly modified areas (Higgins 1999).

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Occur in moist habitats, including along gullies and near watercourses (Higgins et al. 2006a).
- Satin flycatcher (*Myiagra cyanoleuca*) is virtually confined to east of the Great Dividing Range (Boles 1988).

Australian reed-warbler (*Acrocephalus australis*):

- Prefers dense swamp vegetation in and adjacent to most wetland types (Higgins et al. 2006b).

**Major threats and risks :**

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- No apparent major threat to either species overall, either in Australia or elsewhere (SEWPAC 2013a, c).
- Occasionally killed by collision with man-made structures.
- Fork-tailed swift is occasionally killed by cats (*Felis catus*) (Higgins 1999).
- A potential threat is a reduction in prey due to loss of habitat (Low 1995; SEWPAC 2013a).

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Loss of breeding sites and disturbance at nests (Marchant and Higgins 1993; Debus 1998; NSW NPWS 2002).
- Eastern osprey is threatened by reduction in quality and quantity of fish stocks, collision with or electrocution by power lines, and the use of pesticides (NSW NPWS 2002).
- White-bellied sea-eagle is occasionally illegally shot or poisoned (Marchant and Higgins 1993).

Oriental cuckoo (*Cuculus optatus*):

- Sometimes killed by cats and by collisions with windows and lighthouses (Higgins 1999).

Rainbow bee-eater (*Merops ornatus*):

- Threats to the species are minimal, although cane toads (*Rhinella marina*) have been found to prey on the eggs and nestlings (Boland 2004).

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Loss and fragmentation of moist forest breeding habitat and remnant vegetation and corridors within migration routes (Higgins et al. 2006a).

Australian reed-warbler (*Acrocephalus australis*):

- Loss of habitat due to development (Higgins et al. 2006b). Has benefited from the creation of artificial waterbodies and has extended its distribution in some areas (Blakers et al. 1984).

**Potential project-related impacts (unmitigated):**

- Some loss and fragmentation of foraging and migration habitat for forest species such as rufous fantail (*Rhipidura rufifrons*).

**Mitigation Measures:**

Commitments made by Arrow as documented within Attachment 4, Commitments Update of the SREIS, will minimise impacts on migratory terrestrial birds.

**Evaluation under MNES Referral Guidelines**

Under the MNES referral guidelines there is no clear definition as to the number of individuals, or percentage of the population reguired to define an ‚ecologically significant proportion' of a terrestrial migratory species. To acquire data on migratory terrestrial species, 25 square km WildNet searches were undertaken to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A89**). Survey areas 8,9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated (e.g., white-bellied sea-eagle).

Based on the presented information, no important populations are likely to occur within the subject properties. Evaluation of these species under MNES guidelines is provided in **Table A90**.

**Table A89.** Available records/ population evaluation**

| Species* | Survey area 2 | | | Survey area 7 | | | Survey area 8,9,F | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25km search # | Likely Occurrence | Likelihood of significant population | 25km search # | Likely Occurrence | Likelihood of significant population | 25km search # | Likely Occurrence | Likelihood of significant population |
| white-throated needletail (*Hirundapus caudacutus*) | 4 | Possible | Very low | 25 | Possible | Very low | 27 | Possible | Very low |
| fork-tailed swift (*Apus pacificus*) | 3 | Possible | Very low | 4 | Possible | Very low | 5 | Possible | Very low |
| eastern osprey (*Pandion haliaetus*) | 0 | Unlikely | Very low | 1 | Unlikely | Very low | 1 | Possible | Very low |
| white-bellied sea-eagle (*Haliaeetus leucogaster*) | 0 | Known | Very low | 55 | Possible | Very low | 52 | Likely | Very low |
| oriental cuckoo *(Cuculus optatus)* | 0 | Unlikely | Very low | - | Unlikely | Very low | 0 | Unlikely | Very low |
| rainbow bee-eater (*Merops ornatus*) | 18 | Known | Low | 68 | Known | Low | 66 | Known | Low |
| rufous fantail (*Rhipidura rufifrons*) | 0 | Unlikely | Very low | 6 | Unlikely | Very low | 6 | Unlikely | Very low |
| satin flycatcher (*Myiagra cyanoleuca*) | 1 | Low | Very low | - | Low | Very low | - | Low | Very low |
| black-faced monarch (*Monarcha melanopsis*) | 0 | Unlikely | Very low | - | Unlikely | Very low | - | Unlikely | Very low |
| spectacled monarch (*Monarcha trivirgatus*) | 0 | Unlikely | Very low | - | Unlikely | Very low | 1 | Unlikely | Very low |
| Australian reed-warbler (*Acrocephalus australis*) | 1 | Possible | Very low | 22 | Unlikely | Very low | 18 | Possible | Very low |

* Species listed are derived from the EPBC Protected Matters Report (Appendix D) and from EHP's WildNet database.

** Number of WildNet records within 25 km radius of the centre point of the property.

# Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

**Table A90.** Evaluation of impact significance for Migratory terrestrial birds under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| • Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species. | An area of 'important habitat' for a migratory species is:<br>a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or<br>b. habitat that is of critical importance to the species at particular life-cycle stages, and/or<br>c. habitat utilised by a migratory species which is at the limit of the species range, and/or<br>d. habitat within an area where the species is declining (DEWHA 2009a).<br>**Survey area 2**: There is no evidence to suggest the property supports 'important habitat' for Migratory terrestrial species.<br>**Survey area 7, 8, 9, F**: Other than the common and widespread rainbow bee-eater, the most frequently recorded species for these properties is white-bellied sea-eagle. In the project development area this species is associated with large waterbodies, none of which are present on these properties. Rather, records will be from locations such as Lake Broadwater.<br>There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species.<br>Based on current knowledge, project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory terrestrial species. |
| • Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, | **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of invasive species within the proponent's tenements are proposed |
| • Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. | Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).<br>'Population', in relation to migratory species, means the entire population or any geographically separate part of the population whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia (DEWHA 2009a).<br>**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory terrestrial species known or considered likely to occur. |

## Migratory Wetland Birds

**Habitat:**

Garganey (*Anas querquedula*):

- Sewage ponds, lakes and swamps (Marchant and Higgins 1990).

Eastern great egret (*Ardea modesta*), cattle egret (*Ardea ibis*) and glossy ibis (*Plegadis falcinellus*):

- Eastern great egrets (*Ardea modesta*) occur on rivers, estuaries, tidal mudflats, swamps, man-made dams, sewage farms and wet pasture (Marchant and Higgins 1990; McKilligan 2005).
- Cattle egret (*Ardea ibis*) inhabits grasslands and wetlands, often foraging in pasture and crops.
- Glossy ibis (*Plegadis falcinellus*) prefers inland freshwater wetlands with abundant aquatic flora (Marchant and Higgins 1990).

Caspian tern (*Hydroprogne caspia*) and white-winged black tern (*Chlidonias leucopterus*):

- Mostly coastal, but also inland wetlands including lakes and rivers (Higgins and Davies 1996).

Lake Broadwater contains potential habitat for all five of the listed migratory wetland birds. The Lake and associated muddy shallow pond edges and the lake edge provide suitable foraging and retreat sites for the listed species.

**Threats:**

Garganey (*Anas querquedula*):

- Vagrant to Queensland (Marchant and Higgins 1990). Specific threats unknown.

Eastern great egret (*Ardea modesta*), cattle egret (*Ardea ibis*) and glossy ibis (*Plegadis falcinellus*):

- Loss of breeding habitat through drainage of wetlands, river regulation and groundwater extraction (Marchant and Higgins 1990; Kingsford and Johnson 1998; SEWPAC 2013b).
- Eastern great egret (*Ardea modesta*) and glossy ibis (*Plegadis falcinellus*) are threatened by destruction and modification of freshwater habitats by clearing, livestock, burning, increased salinity and weed invasions (Marchant and Higgins 1990).
- Predation of cattle egret (*Ardea ibis*) nestlings by cats (*Felis catus*) (SEWPAC 2013b) and breeding glossy ibis (*Plegadis falcinellus*) by foxes (*Vulpes vulpes*) (Marchant and Higgins 1990).

Caspian tern (*Hydroprogne caspia*) and white-winged black tern (*Chlidonias leucopterus*):

- Threats to terns are largely confined to breeding colonies. Birds are affected by degradation of feeding areas (Blakers et al. 1984; Higgins and Davies 1996; Garnett and Crowley 2000).

**Project-related Threats:**

- The temporary loss of vegetation and hence habitat within Long Swamp for the construction of gas-gathering lines.

- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater and Long Swamp.
- Deterioration of water quality within Long Swamp and Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Long Swamp and Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported either directly through clearing practices (Long Swamp) or by surface water flow in Broadwater and Surveyors Gully.

**Mitigation Measures:**

When siting production facilities, avoid wetlands and consider the following:

- Stream processes that may result in channel migration (either over time or as a result of project activities) and areas that are highly susceptible to erosion (i.e., dispersive soils).
- Downstream values of nearby watercourses or wetlands.
- Minimising changes to natural drainage lines and flow paths.
- Flooding regimes and areas subject to inundation. [C151]

**Evaluation under MNES Referral Guidelines**

Under the MNES referral guidelines there is no clear definition as to the number of individuals, or percentage of the population reguired to define an ecologically significant proportion' of a wetland migratory species. To acquire data on migratory wetland species, 25 square km WildNet searches were undertaken to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A91**). Survey areas 8, 9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated.

Four of the migratory wetland birds (Gargeney (*Anas querquedula*) excluded) are likely to be consistent visitors at Lake Broadwater. However, none of the properties support 'important habitat' for migratory terrestrial species. Dams and wetlands on properties are likely to be visited by a number of these species at various times although it is considered that project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory wetlands species. Further, there is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory wetlands species known or considered likely to occur. Evaluation of these species under MNES guidelines is provided in **Table A92**.

**Table A91**. Available records/ population evaluation**

| Species* | Survey area 2 | | | Survey area 7 | | | Survey area 8,9,F | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25km search # | Likely Occurrence | Likelihood of significant population | 25km search # | Likely Occurrence | Likelihood of significant population | 25km search # | Likely Occurrence | Likelihood of significant population |
| garganey (*Anas querquedula*) | 0 | Very low | Very low | - | Very low | Very low | - | Very low | Very low |
| eastern great egret (*Ardea modesta*) | 4 | Known | Low | 114 | Possible | Low | 91 | Very high | Low |
| cattle egret (*Ardea ibis*) | 0 | Very high | Low | 8 | Possible | Low | 8 | Very high | Low |
| glossy ibis (*Plegadis falcinellus*) | 0 | Possible | Low | 29 | Possible | Low | 26 | Very high | Low |
| Caspian tern (*Hydroprogne caspia*) | 0 | Possible | Very low | - | Low | Very low | - | Possible | Very low |
| white-winged black tern (*Chlidonias leucopterus*) | - | Possible | Very low | - | Low | Very low | 7 | Possible | Very low |

* Species listed are derived from the EPBC Protected Matters Report (Appendix D) and from DEHP's WildNet database.

** Number of WildNet records within 25 km radius of the centre point of the property.

# Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

**Table A92.** Evaluation of impact significance for Migratory wetlands birds under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species, | An area of 'important habitat' for a migratory species is:<br>a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or<br>b. habitat that is of critical importance to the species at particular life-cycle stages, and/or<br>c. habitat utilised by a migratory species which is at the limit of the species range, and/or<br>d. habitat within an area where the species is declining (DEWHA 2009a).<br>**Survey area 2**: There is no evidence to suggest the property supports 'important habitat' for Migratory wetlands species.<br>**Survey area 7, 8, 9, F**: Eastern great egret is common and widespread, occurring in a wide variety of habitats. There is no evidence to suggest the properties support 'important habitat' for Migratory wetlands species.<br>Based on current knowledge, project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory wetlands species. |
| • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, | **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species based on detail provided in Criteria 1. Measures to control the introduction and spread of invasive species within the proponent's tenements are proposed (see Attachment 4, Commitments Update of the SREIS). |
| • seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. | Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates).<br>'Population', in relation to migratory species, means the entire population or any geographically separate part of the population whose members cyclically and predictably cross one or more national jurisdictional bondaries including Australia.<br>**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory wetlands species known or considered likely to occur. |

**Migratory Shorebirds**

The Protected Matters Report recognises 15 birds (Appendix D) as 'Migratory shorebird species', but 'important habitat' under MNES referral guidelines differs from that of the 'Migratory Wetlands Birds' listed above. The migratory shorebirds discussed below are members of the families Charadriidae (plovers) and Scolopacidae (sandpipers). Guidelines for assessing these species are provided in *Significant impact guidelines for 36 migratory shorebird species: Migratory species. EPBC Act policy statement 3.21* (DEWHA 2009b).

**Habitat:**

Oriental plover (*Charadrius veredus*) and little curlew (*Numenius minutus*):

- Prefer short, dry grasslands. Also occur on claypans, sporting fields, lawns, around the margins of terrestrial wetlands and recently burnt woodland (Lane 1987; Marchant and Higgins 1993; Higgins and Davies 1996; Geering et al. 2007).

Other sandpipers:

- Mostly occur in coastal areas, particularly in the intertidal zone. Many are also found on freshwater and artificial waterbodies such as rivers, swamps, dams and sewage ponds. Latham's snipe (*Gallinago hardwickii*) will also occur in any vegetation around wetlands, including grasslands, heath, woodland and forest (Higgins and Davies 1996).

**Threats:**

Oriental plover (*Charadrius veredus*) and little curlew (*Numenius minutus*):

- In Australia, oriental plover (*Charadrius veredus*) occurs mostly in sparsely settled areas and has no immediate threats to survival. Occasionally killed by vehicles on roads (Marchant and Higgins 1993).
- Little curlew (*Numenius minutus*) is threatened by loss and degradation of wetlands that act as important stop-over sites during migration, particularly in the Northern Territory (Bellio et al. 2006).

Other sandpipers:

- Wetland degradation, pollution, changes to hydrology, drainage and reclamation of wetlands, human disturbance and invasive plants (Garnett et al. 2011).

**Project-related Threats:**

- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater.
- Deterioration of water quality in Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported by surface water flow in Broadwater and Surveyors Gully.

**Mitigation Measures:**

When siting production facilities, avoid wetlands and consider the following:

- Stream processes that may result in channel migration (either over time or as a result of project activities) and areas that are highly susceptible to erosion (i.e., dispersive soils).
- Downstream values of nearby watercourses or wetlands.
- Minimising changes to natural drainage lines and flow paths.
- Flooding regimes and areas subject to inundation. [C151]

**Evaluation under MNES Referral Guidelines**

An estimate of local shorebird populations has been provided in **Table A93**. The data is based on 25 $km^2$ WildNet searches to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A93**). Survey areas 8, 9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated and may include taxa unlikely within the survey areas (e.g., common greenshank).

Total records for the entire project development area have also been provided. It is obvious from this data that the number of birds within the project development area, and therefore almost certaintly within individual properties, is well below the 0.1% *significant portion of the population* threshold (see **Table A93**). There is no evidence to suggest the project area otherwise supports 'important habitat' for migratory shorebird species with the possible exception of Latham's snipe (*Gallinago hardwickii*), which is predominantly associated with Lake Broadwater. As habitat suitability for migratory shorebirds is low it is expected that the project area does not support an 'ecologically significant proportion of the population' of any of the Migratory shorebird species known or considered likely to occur.

The majority of migratory shorebirds are very rare visitors to the project area due to a lack of suitable habitat throughout the area. The presence of Lake Broadwater in proximity to the survey areas dramatically increases the likelihood of migratory shorebirds occuring, and it is thought that the majority of records of migratory wetland species are in association with Lake Broadwater.

No activities will occur at Lake Broadwater, or within a buffer of the wetland, in accordance with regulatory requirements at the time. Lake Broadwater is a Wetland of National Significance where most shorebird records originate, will occur (see **Table A94**). Therefore, based on the MNES impact criteria (policy 3.21), no impacts on shorebirds is expected.

**Table A93.** Available records/ population evaluation**

| Species | PDA** | Survey area 2 | | | Survey area 7 | | | Survey area 8,9,F | | | EIS Area^ | 0.1% threshold## |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25km search# | Likely Occurrence | Likelihood of significant population | 25km search area# | Likely Occurrence | Likelihood of significant population | 25km search area# | Likely Occurrence | Likelihood of significant population | Likelihood of significant population | |
| Pacific golden plover (*Pluvialis fulva*) | - | 0 | Unlikely | Very Low | 1 | Unlikely | Very Low | 1 | Unlikely | Very Low | Very Low | **100** |
| oriental plover (*Charadrius veredus*) | - | 0 | Unlikely | Very Low | 1 | Unlikely | Very Low | 0 | Unlikely | Very Low | Very Low | 70 |
| Latham's snipe (*Gallinago hardwickii*) | 30 | 0 | Unlikely | Very Low | 2 | Unlikely | Very Low | 27 | Likely | Low | High | 36 |
| black-tailed godwit (*Limosa limosa*) | 1 | 0 | Unlikely | Very Low | 1 | Unlikely | Very Low | 2 | Unlikely | Very Low | Very Low | 160 |
| bar-tailed godwit (*Limosa lapponica*) | 1 | 0 | Unlikely | Very Low | 1 | Unlikely | Very Low | 2 | Unlikely | Very Low | Very Low | 325 |
| little curlew (*Numenius minutus*) | - | 0 | Unlikely | Very Low | 0 | Unlikely | Very Low | 0 | Unlikely | Very Low | Very Low | 180 |
| whimbrel (*Numenius phaeopus*) | - | 0 | Unlikely | Very Low | 2 | Unlikely | Very Low | 2 | Unlikely | Very Low | Very Low | 100 |
| common sandpiper (*Actitis hypoleucos*) | - | 0 | Unlikely | Very Low | 1 | Unlikely | Very Low | 1 | Unlikely | Very Low | Very Low | 25 |
| common greenshank (*Tringa nebularia*) | 6 | 0 | Unlikely | Very Low | 10 | Unlikely | Very Low | 10 | Unlikely | Very Low | Very Low | 60 |
| marsh sandpiper (*Tringa stagnatilis*) | 25 | 0 | Unlikely | Very Low | 24 | Unlikely | Very Low | 24 | Unlikely | Very Low | Very Low | 100 |

| Species | PDA** | Survey area 2 | | | Survey area 7 | | | Survey area 8,9,F | | | EIS Area^ | 0.1% threshold## |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 25km search# | Likely Occurrence | Likelihood of significant population | 25km search area# | Likely Occurrence | Likelihood of significant population | 25km search area# | Likely Occurrence | Likelihood of significant population | Likelihood of significant population | |
| wood sandpiper (*Tringa glareola*) | **1** | **0** | Unlikely | Very Low | 1 | Unlikely | Very Low | 1 | Unlikely | Very Low | Very Low | 100 |
| red-necked stint (*Calidris ruficollis*) | **-** | **0** | Unlikely | Very Low | 3 | Unlikely | Very Low | 3 | possible | Low | Very Low | 325 |
| sharp-tailed sandpiper (*Calidris acuminata*) | **38** | **0** | Unlikely | Very Low | 1 | Unlikely | Very Low | 24 | Possible | Moderate | Low | 60 |
| curlew sandpiper (*Calidris ferruginea*) | **3** | **0** | Unlikely | Very Low | 2 | Unlikely | Very Low | 3 | Unlikely | Very Low | Very Low | 180 |
| Ruff (*Philomachus pugnax*) | **-** | **0** | Unlikely | Very Low | 1 | Unlikely | Very Low | 1 | Unlikely | Very Low | Very Low | - |

* Species listed are derived from the EPBC Protected Matters Report (Appendix D), DEHP's WildNet database (post 1979 records) and Birds Australia New Atlas database (1994-2009 records). Searches were conducted of the entire project development area.

** Birds Australia New Atlas database for the entire project development area (WildNet database not available for areas > 25 km radius).

# Number of WildNet records within 25 km radius of the centre point of the property. Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

## 0.1% of the population estimate for the East Asian-Australasian flyway (Bamford et al. 2008).

^Likelihood of significant population occurring across the entire EIS area, with the exclusion of Lake Broadwater.

**Table A94.** Evaluation of impact significance for Migratory shorebirds under MNES Guidelines.

| Criteria | Evaluation |
|---|---|
| • Loss of important habitat | Nationally important habitat for migratory shorebirds is defined as habitat that supports at least:<br>• 0.1% of the flyway population of a single species<br>• 2000 migratory shorebirds, or<br>• 15 shorebird species (DEWHA 2009b).<br>Important habitat for Latham's snipe (*Gallinago hardwickii*) occurs at sites that have previously been identified as internationally important for the species, or sites that:<br>• support at least 18 individuals of the species, and<br>• are naturally occurring open freshwater wetland with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland) (DEWHA 2009b).<br>There is no evidence to suggest the project area supports 'important habitat' for migratory shorebird species with the possible exception of Latham's snipe (*Gallinago hardwickii*). Although 14 species have been recorded for one of the search areas, most of these species have been recorded only once or twice. It seems very unlikely, therefore, that any one location in the area supports 15 species of Migratory shorebird.<br>**Survey area 2**: There is no record of any individual of any of the 15 species for this property. There is no evidence the property supports 'important habitat' for any of the 15 species.<br>**Survey area 7**: Based on the number of records of each species there is no evidence the property supports 'important habitat' for any of the 15 species, as defined.<br>**Survey area 8, 9, F**: The total number of WildNet records for the 25 km search radius for these three properties includes sufficient numbers of Latham's snipe (*Gallinago hardwickii*) for potential 'important habitat' for the species.<br>Most, if not all of these records, are likely to be for Lake Broadwater (WildNet records do not provide location details), which is to the north of survey area 8. The number of records dates back to 1980, suggesting that it is unlikely that a single location in these properties supports 18 or more individuals.<br>Of the 30 Latham Snipe (*Gallinago hardwickii*) records in the Birds Australia database, 20 are from Lake Broadwater and in immediate surrounding areas (within prescribed buffers),. This data was collected over a 16 year period, with maximum counts of four individuals. There is no evidence that Lake Broadwater supports at least 18 individuals of Latham's snipe (*Gallinago hardwickii*).<br>Current development plans do not include direct impacts on Lake Broadwater. A 500 m exclusion zone is planned for Lake Broadwater (see Attachment 4, Commitments Update of the SREIS).<br>Based on current knowledge, project activities are not expected to result in the loss of an area of 'important habitat' for Migratory shorebird species. |
| • Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site. | **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above. Extensive measures to control the introduction and spread of invasive species within the proponent's tenements are proposed (see Attachment 4, Commitments Update of the SREIS). |
| • Increased disturbance leading to a substantial reduction in migratory shorebirds using important habitat. | **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above. An exclusion zone of 500m is placed around the regionally significant Lake Broadwater (see |

| Criteria | Evaluation |
|---|---|
| | Attachment 4, Commitments Update of the SREIS). |
| • Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat | **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above.<br>Overhead powerlines supplying power to wells and facilities has the potential to increase bird strike mortality. However on balance, overhead powerlines will not be placed in areas of high bird activity (e.g., Lake Broadwater). Further, pre-clearence surveys will document potential bird strike risks (e.g., large farm dams) ensuring that appropriate mitigation is employed. Suitable mitigation could include re-routing powerline alignments or the use of line marking devices. |

## References – Threatened Ecological Communities, Flora Species, Terrestrial Fauna Species and Migratory species

References cited in this appendix are contained in Attachment 9, Supplementary Terrestrial Ecology Assessment, Appendicies B-E of the SREIS. References should be sourced from this document.

## References – Aquatic Fauna Species

References cited in this appendix are contained in Attachment 8, Supplementary Aquatic Ecology Assessment, Attachment 2 of the SREIS. References should be sourced from this document.

# Appendix D

## EPBC Search (project development area plus 25 km buffer)

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

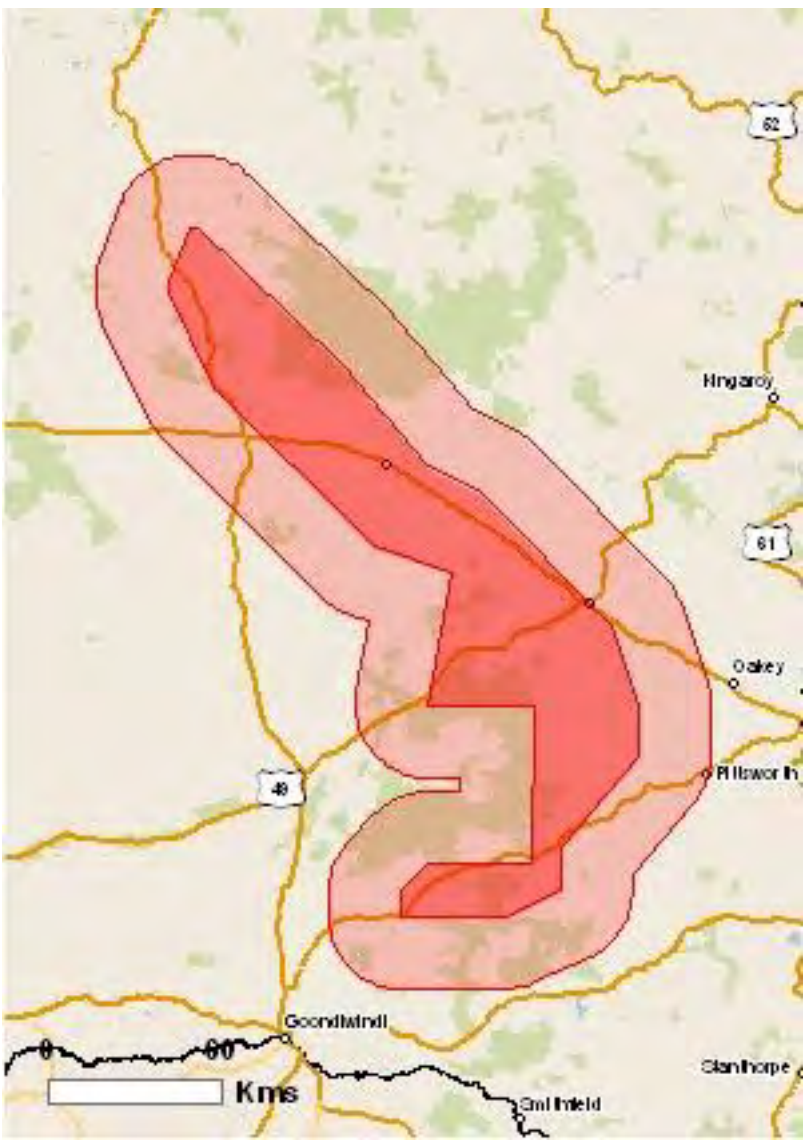
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 13/02/13 12:58:21


Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

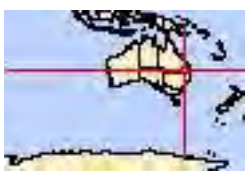
Caveat
Acknowledgements




Coordinates

Buffer: 25.0Km



# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

| | |
|---|---|
| World Heritage Properties: | None |
| National Heritage Places: | None |
| Wetlands of International Importance: | 1 |
| Great Barrier Reef Marine Park: | None |
| Commonwealth Marine Areas: | None |
| Listed Threatened Ecological Communities: | 6 |
| Listed Threatened Species: | 59 |
| Listed Migratory Species: | 19 |

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

| | |
|---|---|
| Commonwealth Land: | 1 |
| Commonwealth Heritage Places: | None |
| Listed Marine Species: | 20 |
| Whales and Other Cetaceans: | None |
| Critical Habitats: | None |
| Commonwealth Reserves: | None |

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

| | |
|---|---|
| Place on the RNE: | 24 |
| State and Territory Reserves: | 9 |
| Regional Forest Agreements: | None |
| Invasive Species: | 19 |
| Nationally Important Wetlands: | 1 |
| Key Ecological Features (Marine) | None |

# Details

## Matters of National Environmental Significance

### Wetlands of International Importance (RAMSAR) [ Resource Information ]

| Name | Proximity |
|---|---|
| Narran lake nature reserve | Upstream from Ramsar |

### Listed Threatened Ecological Communities [ Resource Information ]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

| Name | Status | Type of Presence |
|---|---|---|
| Brigalow (Acacia harpophylla dominant and co-dominant) | Endangered | Community known to occur within area |
| Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions | Endangered | Community likely to occur within area |
| Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland | Critically Endangered | Community likely to occur within area |
| Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions | Endangered | Community likely to occur within area |
| Weeping Myall Woodlands | Endangered | Community likely to occur within area |
| White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland | Critically Endangered | Community likely to occur within area |

### Listed Threatened Species [ Resource Information ]

| Name | Status | Type of Presence |
|---|---|---|
| Birds | | |
| Anthochaera phrygia<br>Regent Honeyeater [82338] | Endangered | Species or species habitat likely to occur within area |
| Botaurus poiciloptilus<br>Australasian Bittern [1001] | Endangered | Species or species habitat known to occur within area |
| Erythrotriorchis radiatus<br>Red Goshawk [942] | Vulnerable | Species or species habitat known to occur within area |
| Geophaps scripta  scripta<br>Squatter Pigeon (southern) [64440] | Vulnerable | Species or species habitat known to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Lathamus discolor<br>Swift Parrot [744] | Endangered | Species or species habitat likely to occur within area |
| Neochmia ruficauda ruficauda<br>Star Finch (eastern), Star Finch (southern) [26027] | Endangered | Species or species habitat likely to occur within area |
| Poephila cincta cincta<br>Black-throated Finch (southern) [64447] | Endangered | Species or species habitat may occur within area |
| Polytelis swainsonii<br>Superb Parrot [738] | Vulnerable | Species or species habitat may occur within area |
| Rostratula australis<br>Australian Painted Snipe [77037] | Vulnerable | Species or species habitat likely to occur within area |
| Turnix melanogaster<br>Black-breasted Button-quail [923] | Vulnerable | Species or species habitat likely to occur within area |
| Fish | | |
| Maccullochella peelii<br>Murray Cod [66633] | Vulnerable | Species or species habitat may occur within area |
| Neoceratodus forsteri<br>Australian Lungfish, Queensland Lungfish [67620] | Vulnerable | Species or species habitat likely to occur within area |
| Mammals | | |
| Chalinolobus dwyeri<br>Large-eared Pied Bat, Large Pied Bat [183] | Vulnerable | Species or species habitat may occur within area |
| Dasyurus hallucatus<br>Northern Quoll [331] | Endangered | Species or species habitat may occur within area |
| Dasyurus maculatus maculatus (SE mainland population)<br>Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184] | Endangered | Species or species habitat may occur within area |
| Nyctophilus corbeni<br>South-eastern Long-eared Bat [83395] | Vulnerable | Species or species habitat may occur within area |
| Petrogale penicillata<br>Brush-tailed Rock-wallaby [225] | Vulnerable | Species or species habitat known to occur within area |
| Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)<br>Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104] | Vulnerable | Species or species habitat known to occur within area |
| Potorous tridactylus tridactylus<br>Long-nosed Potoroo (SE mainland) [66645] | Vulnerable | Species or species habitat may occur within area |
| Pteropus poliocephalus<br>Grey-headed Flying-fox [186] | Vulnerable | Species or species habitat likely to occur within area |
| Other | | |
| Macrozamia conferta<br>[64582] | Vulnerable | Species or species habitat likely to occur within area |
| Macrozamia machinii<br>[64583] | Vulnerable | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Plants | | |
| [Acacia curranii](#)<br>Curly-bark Wattle [3908] | Vulnerable | Species or species habitat likely to occur within area |
| [Acacia handonis](#)<br>Hando's Wattle, Percy Grant Wattle [14928] | Vulnerable | Species or species habitat likely to occur within area |
| [Acacia lauta](#)<br>[4165] | Vulnerable | Species or species habitat likely to occur within area |
| [Acacia wardellii](#)<br>[3916] | Vulnerable | Species or species habitat may occur within area |
| [Bothriochloa biloba](#)<br>Lobed Blue-grass [3153] | Vulnerable | Species or species habitat likely to occur within area |
| [Cadellia pentastylis](#)<br>Ooline [9828] | Vulnerable | Species or species habitat likely to occur within area |
| [Calytrix gurulmundensis](#)<br>[24241] | Vulnerable | Species or species habitat likely to occur within area |
| [Commersonia argentea](#)<br>a shrub [82761] | Vulnerable | Species or species habitat likely to occur within area |
| [Denhamia parvifolia](#)<br>[18106] | Vulnerable | Species or species habitat likely to occur within area |
| [Dichanthium queenslandicum](#)<br>King Blue-grass [5481] | Vulnerable | Species or species habitat likely to occur within area |
| [Digitaria porrecta](#)<br>Finger Panic Grass [12768] | Endangered | Species or species habitat likely to occur within area |
| [Eucalyptus argophloia](#)<br>Queensland White Gum, Queensland Western White Gum, Lapunyah, Scrub Gum, White Gum [19748] | Vulnerable | Species or species habitat likely to occur within area |
| [Eucalyptus virens](#)<br>[10181] | Vulnerable | Species or species habitat likely to occur within area |
| [Haloragis exalata subsp. velutina](#)<br>Tall Velvet Sea-berry [16839] | Vulnerable | Species or species habitat likely to occur within area |
| [Homopholis belsonii](#)<br>[2406] | Vulnerable | Species or species habitat may occur within area |
| [Homoranthus decumbens](#)<br>[55186] | Vulnerable | Species or species habitat known to occur within area |
| [Lepidium peregrinum](#)<br>Wandering Pepper-cress [14035] | Endangered | Species or species habitat may occur within area |
| [Microcarpaea agonis](#)<br>[64933] | Endangered | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| | | habitat likely to occur within area |
| Philotheca sporadica [64944] | Vulnerable | Species or species habitat likely to occur within area |
| Picris evae Hawkweed [10839] | Vulnerable | Species or species habitat likely to occur within area |
| Prostanthera sp. Dunmore (D.M.Gordon 8A) [84115] | Vulnerable | Species or species habitat likely to occur within area |
| Pterostylis cobarensis Cobar Greenhood Orchid [12993] | Vulnerable | Species or species habitat likely to occur within area |
| Rhaponticum australe Austral Cornflower, Native Thistle [22647] | Vulnerable | Species or species habitat likely to occur within area |
| Streblus pendulinus Siah's Backbone, Sia's Backbone, Isaac Wood [21618] | Endangered | Species or species habitat may occur within area |
| Thesium australe Austral Toadflax, Toadflax [15202] | Vulnerable | Species or species habitat likely to occur within area |
| Tylophora linearis [55231] | Endangered | Species or species habitat may occur within area |
| Westringia parvifolia [4822] | Vulnerable | Species or species habitat likely to occur within area |
| Xerothamnella herbacea [4146] | Endangered | Species or species habitat likely to occur within area |
| Reptiles | | |
| Anomalopus mackayi Five-clawed Worm-skink, Long-legged Worm-skink [25934] | Vulnerable | Species or species habitat known to occur within area |
| Delma torquata Collared Delma [1656] | Vulnerable | Species or species habitat known to occur within area |
| Denisonia maculata Ornamental Snake [1193] | Vulnerable | Species or species habitat may occur within area |
| Egernia rugosa Yakka Skink [1420] | Vulnerable | Species or species habitat known to occur within area |
| Elseya belli Bell's Turtle, Namoi River Turtle, Bell's Saw-shelled Turtle [66690] | Vulnerable | Species or species habitat may occur within area |
| Furina dunmalli Dunmall's Snake [59254] | Vulnerable | Species or species habitat known to occur within area |
| Paradelma orientalis Brigalow Scaly-foot [59134] | Vulnerable | Species or species habitat known to occur within area |
| Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy | Vulnerable | Species or species |

| Name | Status | Type of Presence |
|---|---|---|
| Turtle [1761] | | habitat may occur within area |
| [Tympanocryptis pinguicolla](#)<br>Grassland Earless Dragon [66727] | Endangered | Species or species habitat may occur within area |

## Listed Migratory Species

[ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| **Migratory Marine Birds** | | |
| [Apus pacificus](#)<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| [Ardea alba](#)<br>Great Egret, White Egret [59541] | | Breeding likely to occur within area |
| [Ardea ibis](#)<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| **Migratory Terrestrial Species** | | |
| [Haliaeetus leucogaster](#)<br>White-bellied Sea-Eagle [943] | | Species or species habitat likely to occur within area |
| [Hirundapus caudacutus](#)<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| [Merops ornatus](#)<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| [Monarcha melanopsis](#)<br>Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| [Myiagra cyanoleuca](#)<br>Satin Flycatcher [612] | | Breeding known to occur within area |
| [Rhipidura rufifrons](#)<br>Rufous Fantail [592] | | Species or species habitat known to occur within area |
| [Xanthomyza phrygia](#)<br>Regent Honeyeater [430] | Endangered* | Species or species habitat likely to occur within area |
| **Migratory Wetlands Species** | | |
| [Ardea alba](#)<br>Great Egret, White Egret [59541] | | Breeding likely to occur within area |
| [Ardea ibis](#)<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| [Calidris acuminata](#)<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| [Calidris ferruginea](#)<br>Curlew Sandpiper [856] | | Species or species habitat known to occur within area |
| [Gallinago hardwickii](#)<br>Latham's Snipe, Japanese Snipe [863] | | Species or species habitat known to occur within area |
| [Limosa limosa](#)<br>Black-tailed Godwit [845] | | Species or species |

| Name | Threatened | Type of Presence |
|---|---|---|
| | | habitat known to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Vulnerable* | Species or species habitat likely to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Species or species habitat known to occur within area |

## Other Matters Protected by the EPBC Act

### Commonwealth Land [ Resource Information ]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

| Name |
|---|
| Defence - DALBY TRAINING DEPOT |

### Listed Marine Species [ Resource Information ]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

| Name | Threatened | Type of Presence |
|---|---|---|
| Birds | | |
| Anseranas semipalmata<br>Magpie Goose [978] | | Species or species habitat may occur within area |
| Apus pacificus<br>Fork-tailed Swift [678] | | Species or species habitat likely to occur within area |
| Ardea alba<br>Great Egret, White Egret [59541] | | Breeding likely to occur within area |
| Ardea ibis<br>Cattle Egret [59542] | | Species or species habitat may occur within area |
| Calidris acuminata<br>Sharp-tailed Sandpiper [874] | | Species or species habitat known to occur within area |
| Calidris ferruginea<br>Curlew Sandpiper [856] | | Species or species habitat known to occur within area |
| Gallinago hardwickii<br>Latham's Snipe, Japanese Snipe [863] | | Species or species habitat known to occur within area |
| Haliaeetus leucogaster<br>White-bellied Sea-Eagle [943] | | Species or species habitat likely to occur within area |
| Himantopus himantopus<br>Black-winged Stilt [870] | | Species or species habitat known to occur within area |

| Name | Threatened | Type of Presence |
|---|---|---|
| Hirundapus caudacutus<br>White-throated Needletail [682] | | Species or species habitat known to occur within area |
| Lathamus discolor<br>Swift Parrot [744] | Endangered | Species or species habitat likely to occur within area |
| Limosa limosa<br>Black-tailed Godwit [845] | | Species or species habitat known to occur within area |
| Merops ornatus<br>Rainbow Bee-eater [670] | | Species or species habitat may occur within area |
| Monarcha melanopsis<br>Black-faced Monarch [609] | | Species or species habitat known to occur within area |
| Myiagra cyanoleuca<br>Satin Flycatcher [612] | | Breeding known to occur within area |
| Recurvirostra novaehollandiae<br>Red-necked Avocet [871] | | Species or species habitat known to occur within area |
| Rhipidura rufifrons<br>Rufous Fantail [592] | | Species or species habitat known to occur within area |
| Rostratula benghalensis (sensu lato)<br>Painted Snipe [889] | Vulnerable* | Species or species habitat likely to occur within area |
| Tringa glareola<br>Wood Sandpiper [829] | | Species or species habitat known to occur within area |
| Tringa stagnatilis<br>Marsh Sandpiper, Little Greenshank [833] | | Species or species habitat known to occur within area |

## Extra Information

### Places on the RNE [ Resource Information ]

Note that not all Indigenous sites may be listed.

| Name | State | Status |
|---|---|---|
| Natural | | |
| Barakula State Forest Area | QLD | Indicative Place |
| Bendidee National Park | QLD | Indicative Place |
| Dalby / Jandowae Roadside Remnant Grassland | QLD | Indicative Place |
| Dalby Cecil Plains Roadside Remnant Dichanthium sericeum Site | QLD | Indicative Place |
| Dalby Radio Tower Remnant Grassland | QLD | Indicative Place |
| Jondaryan East Roadside Remnant Grassland | QLD | Indicative Place |
| Jondaryan West Roadside Remnant Grassland | QLD | Indicative Place |
| Lake Broadwater Environmental Park | QLD | Indicative Place |
| Waaje Area | QLD | Indicative Place |
| Chinchilla Sands Local Fossil Fauna Site | QLD | Registered |
| Indigenous | | |
| Fernbank Stone Arrangement | QLD | Registered |
| Kogan Stone Arrangement | QLD | Registered |

| Name | State | Status |
|---|---|---|
| Malleroo Stone Arrangement | QLD | Registered |
| Historic | | |
| Club Hotel | QLD | Indicative Place |
| Jondaryan Post Office (former) | QLD | Indicative Place |
| Pittsworth Post Office | QLD | Indicative Place |
| All Saints Church | QLD | Registered |
| Boonarga Cactoblastis Memorial Hall | QLD | Registered |
| Dalby War Memorial and Memorial Park | QLD | Registered |
| Jimbour Station Homestead | QLD | Registered |
| Jondaryan Homestead Outbuildings | QLD | Registered |
| Jondaryan Woolshed | QLD | Registered |
| St Annes Anglican Church | QLD | Registered |
| Yandilla Street Group | QLD | Registered |

## State and Territory Reserves

[ Resource Information ]

| Name | State |
|---|---|
| Ballara Park | QLD |
| Bendidee | QLD |
| Chinchilla Rifle Range | QLD |
| Irongate | QLD |
| Lake Broadwater | QLD |
| Lake Broadwater | QLD |
| Myall Park | QLD |
| Stones Country | QLD |
| Wondul Range | QLD |

## Invasive Species

[ Resource Information ]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

| Name | Status | Type of Presence |
|---|---|---|
| Frogs | | |
| Bufo marinus<br>Cane Toad [1772] | | Species or species habitat likely to occur within area |
| Mammals | | |
| Capra hircus<br>Goat [2] | | Species or species habitat likely to occur within area |
| Felis catus<br>Cat, House Cat, Domestic Cat [19] | | Species or species habitat likely to occur within area |
| Oryctolagus cuniculus<br>Rabbit, European Rabbit [128] | | Species or species habitat likely to occur within area |
| Sus scrofa<br>Pig [6] | | Species or species habitat likely to occur within area |
| Vulpes vulpes<br>Red Fox, Fox [18] | | Species or species habitat likely to occur within area |
| Plants | | |
| Acacia nilotica subsp. indica<br>Prickly Acacia [6196] | | Species or species habitat may occur within area |
| Asparagus asparagoides<br>Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473] | | Species or species habitat likely to occur within area |

| Name | Status | Type of Presence |
|---|---|---|
| Hymenachne amplexicaulis<br>Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754] | | Species or species habitat likely to occur within area |
| Lantana camara<br>Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892] | | Species or species habitat likely to occur within area |
| Lycium ferocissimum<br>African Boxthorn, Boxthorn [19235] | | Species or species habitat may occur within area |
| Nassella neesiana<br>Chilean Needle grass [67699] | | Species or species habitat likely to occur within area |
| Parkinsonia aculeata<br>Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301] | | Species or species habitat likely to occur within area |
| Parthenium hysterophorus<br>Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566] | | Species or species habitat likely to occur within area |
| Pinus radiata<br>Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780] | | Species or species habitat may occur within area |
| Prosopis spp.<br>Mesquite, Algaroba [68407] | | Species or species habitat likely to occur within area |
| Rubus fruticosus aggregate<br>Blackberry, European Blackberry [68406] | | Species or species habitat likely to occur within area |
| Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii<br>Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497] | | Species or species habitat likely to occur within area |
| Salvinia molesta<br>Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665] | | Species or species habitat likely to occur within area |

| Nationally Important Wetlands | [ Resource Information ] |
|---|---|
| Name | State |
| Lake Broadwater | QLD |

# Coordinates

-25.997 150.034,-26.429 150.482,-26.749 150.753,-26.832 150.919,-27.2499 151.332,-27.498 151.418,-27.664 151.414,-27.9481 151.1685,-28.082 151.1687,-28.1629 150.9945,-28.1646 150.6692,-28.0826 150.6688,-27.9977 150.751,-27.9962 151.0807,-27.5018 151.084,-27.5007 150.7525,-27.0823 150.8316,-26.9999 150.583,-26.5012 150.082,-26.1993 149.9363,-26.1646 149.935,-25.998 150.001,-25.997 150.034

# Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.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