PL194 Environmental Authority amendment application EA – P-EA-100464322

Supporting Information Report

EA Amendment Application

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Introduction

1.1 Purpose of supporting report

Arrow Energy (Arrow), as the upstream operator of the Surat Gas Project, has prepared this Supporting Information Report to accompany an application to amend environmental authority (EA) P-EA-100464322.

This EA currently authorises petroleum activities on Petroleum Lease (PL194), which covers an area of approximately 195.8 km^2 from southeast of Brigalow, to just north of Beelbee, in the Brigalow Belt bioregion of Queensland, as shown on Figure 1.

The proposed amendments are set out below and detailed in Attachment 3:

- changes to Prescribed Environmental Matter (PEM) tables to enable field development of PL194;
- to authorise petroleum activities within Environmentally Sensitive Areas (ESA) and ESA buffers, revise Biodiversity 8B (schedule D, Table 2).
- administrative amendments – updates to conditions to reflect current best practice and alignment with Streamline Model Conditions for Petroleum Activities (SMC), and to remove conditions no longer required on PL194.

The purpose of this report is to provide the administering authority with sufficient information to decide the application to amend the PL194 EA, as proposed.

The EA amendment application has been prepared with reference to the Major and Minor amendment guideline ESR/2015/1684 and is made in accordance with Section 226 of the *Environmental Protection Act 1994* and contains the following documents:

- Completed application form;
- This Supporting Information Report; and
- Appended documentation.

1.2 Background

Australian CBM Pty Ltd, herein referenced as Arrow Energy (Arrow), is an integrated coal seam gas (CSG) company that explores and develops gas fields, produces and sells CSG and generates electricity. Arrow's exploration and production tenements cover around 17,000 km2 across the Surat and Bowen basins in central Queensland.

Within the Surat Basin, Arrow holds 23 PLs, authorised under five separate environmental EAs. This EA amendment application relates to P-EA-100464322 for PL194 that was previously part of an amalgamated EA which covered the following PLs – PL194, PL198, PL230, PL238, PL252, PL258, and PL260. The EA was de-amalgamated and is now a standalone EA.

The resulting EA contains conditions that are not all relevant and provides for activities which are not being undertaken, and do not currently enable the field development required within PL194.

1.3 Land description

This amendment specifically applies to activities within PL194 as shown in Figure 1. This Project area is located approximately 40 kilometres northwest of Dalby. The main activities proposed will be undertaken approximately 15 km east of Kogan, in the Southern Brigalow Belt Bioregion, and includes the Dalby State Forest (Lot 183FTY516).

Topography throughout the project area is typically flat to gently undulating, with some low hills, jump-ups, and excised river/creek banks. The project location is shown in Figure 1 below. PL194 has been awarded to Arrow on the basis of meeting requirements of a development plan approved by the Department of Resources (DoR). The Dalby State Forest is included in the PL194 tenure.

Land use across the tenement and the broader surrounds is predominantly based upon agriculture, including pastoral holdings used for grazing in the central and western areas. Depending on the location of infrastructure, post operational land use will include forestry, mining, grazing or cropping. Key industries in the wider region surrounding the project area include CSG exploration and agriculture.

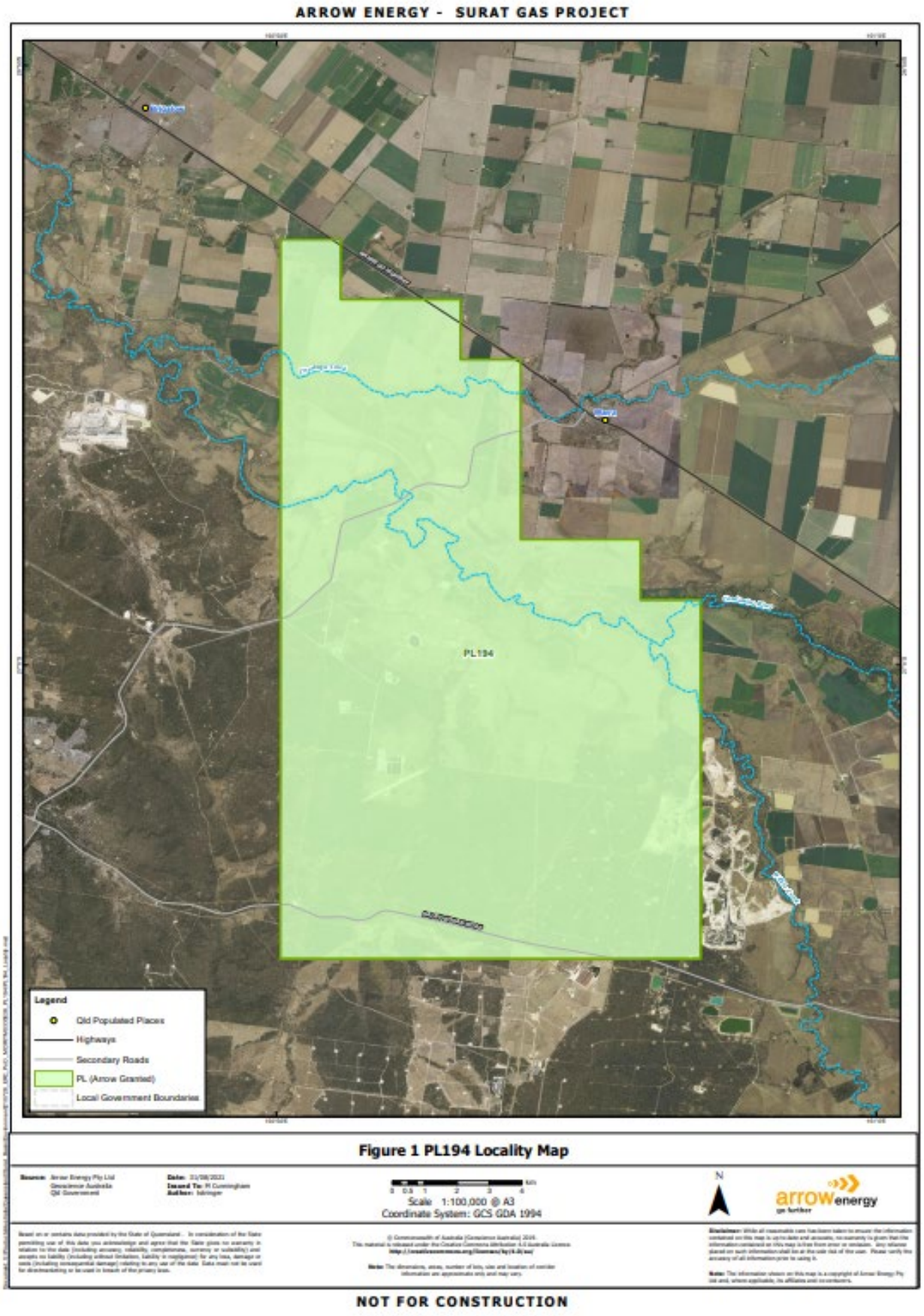

Figure 1: PL194 project location

2. Application Description

This application seeks to amend the existing conditions to enable the efficient development of PL194. The following sections describe petroleum activities and infrastructure development proposed to be undertaken.

There is no change to the management of produced water as a result of this amendment.

2.1 Description of Proposed Activities

The current EA authorises the following petroleum activities in Schedule A, Table 1 of the EA:

Table 1: Authorised Petroleum Activities

Petroleum Activities	Total Number of Authorised Petroleum Activities	Maximum Disturbance Authorised
Total coal seam gas wells, including: Core wells Exploration wells Development wells Production wells	**242** wells	**242** ha
Communication Towers	**3** units	**3** ha
Sewage treatment plants	1 unit	Less than 100 EP, **0.15** ha

There are a total of 103 existing wells in PL194. The next phase of planned activities includes approximately 39 wells with a combination of vertical and deviated wells. Each single well pad will be approximately 1 ha in size and the multi-well pads will be up to 1.5 ha in size.

The development also includes gas and water flowlines (gathering), which connect wells and compression facilities and are designed to enable correct operating pressures to be maintained.

Proposed activities include the construction and operation of the following:

- Well leases and equipment laydown areas;
- Drilling, completions and workovers;
- Gas and water gathering flowlines/pipelines;
- Access tracks and borrow pits;
- Temporary camps and sewage treatment plants and irrigation
- Surveys;
- Communication systems; and
- Other incidental petroleum activities.

These activities are essential to bringing the resource to surface and must be constructed to enable the resource to be delivered to the east coast gas market.

Rehabilitation following construction will be undertaken in accordance with Arrow's Land Rehabilitation Procedure (ORG-ARW-HSM-PRO-00073) which sets out Arrow's process for rehabilitation of disturbed land. This procedure was developed to comply with relevant regulatory requirements, current best practice and to minimise potential environmental harm.

The infrastructure layout is designed through an iterative approach using an area-wide planning process, which includes a combination of desktop and field based assessments in order to preferentially locate the proposed infrastructure to minimise environmental impacts. This iterative process needs to retain the flexibility necessary to address landholder preference, where this leads to appropriate environmental outcomes.

It is not possible to access the gas resource in this location without clearing some remnant vegetation. Therefore, this amendment is necessary and desirable to enable PL194 to be developed.

2.2 Assessment Approach

Section 5 provides a description of the existing environmental values that have potential to be impacted as a result of the proposed amendments. Potential impacts and corresponding environmental management practices are identified to appropriately minimise the impact of activities on these environmental values.

In accordance with Section 125 of the EP Act, the following is addressed as part of the assessment approach:

- Description of the environmental values likely to be affected by each relevant activity;
- Details of any emissions of releases likely to be generated by each relevant activity;
- Details of the management practices proposed to be implemented to prevent or minimise adverse impacts;
- Description of the risk and likely magnitude of impacts of the environmental values; and
- Details of how the land will be rehabilitated after each relevant activity ceases.

The assessment approach has been utilised to meet the requirements of the EP Act and demonstrate that Arrow have considered potential impacts of the proposed activities, with an aim to prioritise the avoidance of adverse impacts. Where no practicable alternate exists, these impacts can be managed, mitigated, and include being offset in accordance with the *Environmental Offsets Act* 2014 (EO Act).

The assessment has considered whether there are any significant on-ground conditions that may vary how the expected composition, structure and function of any regional ecosystem may be impacted by any proposed clearing. All reasonable steps have been taken to avoid, then where no reasonable alternative exits, minimise potential for adverse environmental impacts.

A summary of the ecological investigations used to determine relevant biodiversity values is provided in Section 6 – Biodiversity. The risk and magnitude of likely impacts are described along with management practices to be implemented.

Proposed conditions to be amended are contained in Section 4 and Attachment 3. These seek to authorise disturbance to ESAs, reflect current best practice, remove conditions no longer required on PL194 and address modifications to PEMs pursuant to Queensland's EO Act. Conditions to be amended represent outcomes of refinement of the field design process, or changes to the way fauna species habitat is identified or defined.

Relevant PEMs are addressed, with a summary table provided at Section 8.4. For the purposes of this amendment report, information on individual PEMs has been provided where the proposed impact requires changes to the existing Schedule D, Table 3.

As the disturbance limits are based on layout designs that are in advanced stages, a significant residual impact (SRI) assessment report, including all PEMs has been provided in accordance with Condition Biodiversity 14. The SRI report reflects further refinements of the field design which will be no greater than the disturbance areas approved.

2.3 Matters of National Environmental Significance - EPBC Act

Consideration has been given to the potential impacts of the EA amendments against the existing approval and current provisions of the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act).

The areas the subject of this EA amendment are part of the larger Surat Gas Project (SGP), which was referred to the Commonwealth (EPBC 2010/5344) and deemed to be a controlled action. Potential impacts of the project on matters of national environmental significance (MNES) were assessed by way of Environmental Impact Statement (EIS). Proposed disturbance areas and values relevant to this EA amendment application are within the overall disturbance for the Project as contemplated in the EIS.

Approval was subsequently granted by the then Commonwealth Department of the Environment (DoE) which included maximum disturbance limits for EPBC listed species and communities within the project and conditions relating to CSG water monitoring and management. The SGP project commenced under the EPBC Act on 22 October 2020.

There are some species that were not listed as MNES at the time Arrow received Commonwealth approval in 2013 (refer to Attachment 1) but were included within the SGP Stage 1 Offset Strategy in 2019. This plan has been approved by DoE.

The appropriate mechanism to recognise these species in the approval was discussed in meetings between The Department of Environment and Science (DES), Arrow and the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW), with all parties agreeing that they are to be included in the State EA PEMs tables (see Section 8) and the potential impacts to be offset as matters of state environmental significance (MSES), rather than as MNES.

This amendment seeks to include the required disturbance areas for these species in this EA now it has been de-amalgamated from the larger project EA.

3. Application requirements

Under Section 224 of the EP Act, the holder of an EA may at any time apply to the administering authority to amend the EA (an amendment application).

The statutory requirements for amending an EA are set out in sections 226 and 226A of the EP Act and are summarised in Table 2.

Table 2: Section 226 requirements and response

	Statutory requirement EP Act Section 226(1)	**Response**
(a)	Be made to the administering authority	This EA amendment application has been made to DES, which is the administering authority.
(b)	Be in the approved form	Arrow has applied for this EA using the most recent version of the approved application form. This report is provided as supporting information to the application.
(c)	Be accompanied by the fee prescribed under a regulation	Arrow has elected to pay the fee by credit card.
(d)	Describe the proposed amendments	See sections 1.1, 2.1, 2.2 and 4.
(e)	Describe the land that will be affected by the proposed amendment	See section 1.3.
(f)	Include any other document relating to the application prescribed by regulation	There are no other documents prescribed by regulation that have been included.
	EP Act Section 226A(1)	
(a)	Describe any development permits in effect under the Planning Act for the carrying out of the relevant activity for the authority	There are no development permits in effect under the Planning Act for the carrying out of the relevant activities for the authority.
(b)	State whether each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity	The application relates to a site-specific EA, and eligibility criteria do not apply to this application.
(c)	If the application states that each relevant activity will, if the amendment is made, comply with any eligibility criteria for the activity-include a declaration that the statement is correct	The application relates to a site-specific EA, and the application will not comply with the eligibility criteria. The application does not state that the amendment will comply with eligibility criteria.
(d)	State whether the application seeks to change a condition identified in the authority as a standard condition	No changes to standard conditions are proposed.
(e)	If the application relates to a new relevant resource tenure for the authority that is an exploration permit or	The application does not relate to a new relevant resource tenure

	GHG permit – state whether the applicant seeks an amended environmental authority that is subject to the standard conditions for the relevant activity or authority, to the extent it relates to the permit	and the application is not seeking an amendment which is subject the standard conditions.
(f)(i)	Describe environmental values likely to be affected by the proposed amendment	See section 5.
(ii)	Provide the details of emissions or releases likely to be generated by the proposed amendment	The proposed amendment does not change any of the emissions generated by the relevant activities authorised under the existing EA. See Section 5.
(iii)	Describe the risks and likely magnitude of impacts on the environmental values	See sections 6, 7, 8.
(iv)	Describe management practices proposed to be implemented to prevent or minimise adverse impacts	See sections 6, 7, 8.
(v)	If PRCP does not apply - describe how the land the subject of the application will be rehabilitated after each relevant activity ceases	A PRCP does not apply to this activity. See section 9.5
(g)	Describe the proposed measures for minimising and managing waste generated by amendments to the relevant activity	See Section 9.4.
(h)	Provide details of any site management plan or environmental protection order that relates to the land the subject of the application	There are no site management plans on the land subject to this application. There are no environmental protection orders for the land which is the subject of the application.

3.1 S227 requirements for site specific applications

In accordance with s227 of the EP Act, an application must state the matters mentioned in s126(1) and comply with s126(2), if the application:

a) relates to an EA for a coal seam gas activity; and

b) the proposed amendment would result in changes to the management of coal seam gas water; and

c) the coal seam gas activity is an ineligible ERA.

Table 3 lists the application requirements in accordance with s126(1) and (2) of the EP Act and where they are addressed in the application material.

Table 3: s126 Application Requirements

	Statutory requirement EP Act Section 126(1)	**Response**
(a)	the quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity	This EA amendment does not affect the quantity of water reasonably expected to be generated under the EA.
(b)	the flow rate at which the applicant reasonably expects the water will be generated	The flow rate remains unchanged from that currently authorised as a result of this amendment.
(c)	the quality of the water, including changes in the water quality the applicant reasonably expects will happen while each relevant CSG activity is carried out	The quality of water remains unchanged as a result of this amendment.
(d)	the proposed management of the water including, for example, the use, treatment, storage or disposal of the water	There is no change to water management proposed as a result of this amendment.
(e)	the measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of the management of the water, including, for example, criteria for each of the following—	The measurable criterion used for monitoring and assessing the effectiveness of the management of the water remains unchanged from that currently authorised.
(i)	the quantity and quality of the water used, treated, stored or disposed of	
(ii)	protection of the environmental values affected by each relevant CSG activity	
(iii)	the disposal of waste, including, for example, salt, generated from the management of the water	
(f)	the action proposed to be taken if any of the management criteria are not complied with, to ensure the criteria will be able to be complied with in the future	The proposed action for ensuring compliance with the management criteria remains unchanged from that currently authorised.
	Statutory requirement EP Act Section 126(2)	**Response**
	The proposed management of the water can not provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless—	An evaporation dam is not proposed as part of this amendment.
(a)	the application includes an evaluation of—	
(i)	best practice environmental management for managing the CSG water; and	
(iii)	alternative ways for managing the water; and	
(b)	the evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water.	

3.2 S227A Exercise of underground water rights

In accordance with s227AA of the EP Act, an application must state the matters mentioned in s126A(1) and comply with s126(2), if the application:

a) relates to a site-specific environmental authority for –

i) a resource project that includes a resource tenure that is a mineral development licence, mining lease or petroleum lease; or

ii) a resource activity for which the relevant tenure is a mineral development licence, mining lease or petroleum lease; and

b) the proposed amendment involves changes to the exercise of underground water rights.

The application does not involve changes to the exercise of underground water rights, therefore the matters mentioned to s126A(2) do not apply to this application.

3.3 Minor and major amendments

Table 4 sets out the threshold criteria for determining a 'minor amendment (threshold)' for an EA in accordance with Section 223 of the EP Act.

Table 4: Threshold criteria for an amendment to an EA to be considered a minor amendment

Threshold Criteria		Response
(a)	is not a change to a condition identified in the EA as a standard condition, other than a condition conversion or replacing a standard condition with a standard condition for the ERA	No changes to standard conditions are proposed.
(b)	does not significantly increase the level of environmental harm caused by the relevant activity	It is not anticipated that the amendment will lead to a significant increase in the risk of environmental harm beyond that already approved.
(c)	does not change any rehabilitation objectives in the EA in a way likely to result in significantly different impacts on environmental values than the impacts previously permitted under the EA	There will be no change to any rehabilitation objectives in the EA as a result of the proposed amendment.
(d)	does not significantly increase the scale or intensity of the relevant activity	The scale or intensity of the activity will be increased above that already approved in the EA.
(e)	does not relate to a new relevant resource tenure for the EA that is— (i) a new mining lease, or (ii) a new petroleum lease, or (iii) a new geothermal lease under the Geothermal Energy Act 2010, or (iv) a new greenhouse gas injection and storage lease under the Greenhouse Gas Storage Act 2009	The proposed amendment does not relate to a new relevant resource tenure for the EA.

Threshold Criteria		Response
(f)	Increases the existing surface area for the relevant activity by 10% or less	The proposed amendment will increase the overall surface area for the relevant activity above that already approved in the EA. Although the overall well count will still be far less than already provided for in the current EA.
(g)	For an EA for a petroleum activity: (i) Involves constructing a new pipeline that does not exceed 150km in length, and (ii) Involves extending an existing pipeline by no more than 10% of the existing length of the pipeline	The proposed amendment does not involve constructing a new pipeline exceeding 150km or extending an existing pipeline exceeding 10% of the existing length of the pipeline.
(h)	if the amendment relates to a new relevant resource tenure for the authority that is an exploration permit or greenhouse gas permit— the amendment application seeks an EA that is subject to the standard conditions for the relevant activity, to the extent it relates to the permit	The proposed amendment does not relate to a new relevant resource tenure.

As set out in Table 4, the amendments proposed do not satisfy all the threshold criteria for the application to be considered a minor amendment.

3.4 The Standard Criteria (EP Act)

The standard criteria (as defined by Schedule 4 of the EP Act) are required to be considered by the administering authority for both a major and minor amendment applications. Refer to Table 5 for an assessment of the proposed amendment against the standard criteria.

Table 5: Standard Criteria (EP Act)

Schedule 4 EP Act	Relevance to amendment application
a) the following principles of environmental policy as set out in the Intergovernmental Agreement on the Environment – (i) the precautionary principle; (ii) intergenerational equity; (iii) conservation of biological diversity and ecological integrity; and	The precautionary principle was considered for the application. The proposed activities will use accepted best practice technology for which there is sufficient scientific data to support the certainty of achieving the principles of sustainable development. The principle of intergenerational equity was considered for the application. It is considered that the proposed activities would not impact the use of environmental values by future generations. The principles of conservation of biological diversity and ecological integrity were considered for the application. The proposed application will not result in significant adverse impacts to biological diversity or ecological integrity when considered in its entirety.

Schedule 4 EP Act	Relevance to amendment application
b) Any Commonwealth or State government plans, standards, agreements or requirements about environmental protection or ecologically sustainable development	The proposed activities will be undertaken in accordance with the applicable requirements of the following: • *Environmental Protection Act 1994* (EP Act) • *Environmental Protection Regulation 2019* (EP Regulation) • *Petroleum and Gas (Production and Safety) Act 2004* • CSG Water Management Policy 2012 • *Nature Conservation Act 1992* (and associated 2018 guidance amendments) • *Environmental Protection and Biodiversity Conservation Act 1999* and Regulations • Australian Standards. Where relevant, these Acts are further referenced throughout this supporting information report
c) Any relevant environmental impact study, assessment or report	The activity subject to this amendment application was considered in the context of the EIS completed for the SGP.
d) The character, resilience and values of the receiving environment	Refer sections 5, 6, 7.
e) all submissions made by the application and submitters	The EA amendment should not be subject to public notification as there is not likely to be a substantial increase in the risk of environmental harm under the amended EA, nor a substantial change in the contaminants permitted to the be released to the environment.
f) Best Practice Environmental Management (BPEM) for activities under any relevant instrument, or proposed instrument, as follows- (i) an environmental authority; (ii) a transitional environmental program; (iii) an environmental protection order; (iv) a disposal permit; (v) a development approval;	Best Practice Environmental Management (BPEM) of the proposed activities will be achieved through compliance with the conditions of the EA) and implementation of management measures as described in Section 5 of this supporting information report.
g) Financial implications of the requirements under an instrument, or proposed instrument, mentioned in paragraph (g) as they would relate to the type of activity or industry carried	Arrow will continue to provide adequate funds, equipment and staff time to achieve compliance with the conditions of the EA. This will be reflected in approved Estimated Cost of Rehabilitation in accordance with the Financial Provisioning Scheme.

Schedule 4 EP Act	Relevance to amendment application
out, or proposed to be carried out under this instrument	
h) Public interest	The proposed amendment is in the public interest, as it will secure important natural gas supply which is vital to meet the needs of customers in the east coast market, along with other Australian states and territories. It plays an important role in powering the energy transition to meet State and Commonwealth renewable energy targets.
i) Site management plan (SMP)	There are no SMPs applicable or relevant to this application.
j) Relevant Integrated environmental management system (IEMS) or proposed IEMS	The Arrow Integrated HSE Management System (HSEMS) will be implemented for the proposed activities.
k) Other matters prescribed under a regulation	This application demonstrates compliance with relevant prescribed matters.

3.5 Great Barrier Reef Catchments

The project area is not located in a Great Barrier Reef catchment area. As a result, Section 41AA of the EP Regulation is not triggered. Section 41AA relates to the release of fine sediment and inorganic nitrogen in Great Barrier Reef catchment waters and in particular, section 41AA(3) states:

> *The administering authority must refuse to grant the application if the authority considers that—*
>
> *(a) the relevant activity will, or may, have a residual impact; and*
>
> *(b) having regard to the matters mentioned in the water quality offset policy, the residual impact will not be adequately counterbalanced by offset measures for the relevant activity.*

Proposed management measures for erosion and sediment control, stormwater and potential contaminants mean the risks of fine sediment and/or contaminants entering a watercourse are minimal, and the risk of any such sediment or contaminants being transported downstream to the GBR are negligible.

3.6 Notifiable activities

Notifiable activities are those activities identified as likely to cause environmental harm through contamination of land and are described in Schedule 3 of the EP Act. No notifiable activity is proposed to be carried out on the land associated with the proposed amendment.

3.7 Environmentally relevant activities

The amendment does not seek to change any of the currently authorised Environmentally relevant activities (ERAs).

4. Proposed amendments

The conditions sought to be amended in this application are summarised in Table 6 below, with detailed information and justification presented in Attachment 3. Several of these amendments are to update the conditions to reflect the authorised activities on PL194 now it has been deamalgamated from a larger Project EA.

Table 6: EA conditions sought in this amendment application

Proposed Amendment	Reasoning
Schedule A – General Conditions 11(a), 11(c), 18	This amendment seeks administrative updates to ensure conditions reflect: • relevant authorised activities. • current version of guidelines and regulations.
Schedule B – Water Conditions 1, 9(a), 12, 15 to 31 and associated tables	This amendment seeks administrative updates to ensure irrelevant activities no longer authorised in PL194 are removed and remaining conditions reference existing conditions and current mapping requirements.
Schedule BE – CSG Water Injection Trials Conditions 1 to 22 and associated tables	CSG water injection trials have not, and are not, proposed to be undertaken on PL194 at this time. This amendment seeks removal of conditions no longer relevant to authorised activities on PL194.
Schedule D – Land Condition Biodiversity 8B, Biodiversity 8C Schedule D, Table 2 Schedule D, Table 3 Removal of Conditions 17 to 22 and associated tables	This amendment seeks to replace tables 2 & 3 to reflect current environmental values and impacts to ESA and PEMs required for the development of PL194. This amendment seeks removal of conditions no longer required on PL194.
Schedule E – Acoustic Conditions 10 and 11 and associated Schedule E, Table 3	This amendment seeks removal of conditions no longer required for the development of PL194.
Schedule F – Air Schedule F, Table 1, and Table 2	This amendment seeks removal of conditions no longer required for the development of PL194.

5. Relevant Environmental Values

The proposed amendments do not change the risk and magnitude of impacts authorised by the current EA for the following values:

- Air
- Acoustics (noise and vibration)
- Water, including groundwater
- Wetlands
- Land
- Land use
- Waste
- Community
- Indigenous and Non-indigenous Heritage

The proposed amendments may potentially change the risk and magnitude of impacts to biodiversity and ESA values. An assessment of impacts to biodiversity and ESA values is provided in the following sections.

The proposed amendment will not result in any changes to how waste is managed while carrying out authorised petroleum activities, or rehabilitation objectives (i.e., these environmental values will be managed in accordance with existing management practices and relevant EA conditions).

For completeness, a summary of the values not expected to be changed have been included in the table below. For each value there are existing conditions in the EA that appropriately manage the risk of emissions or releases as a result of construction or operational activities.

Table 7 Environmental values not impacted by this amendment

Environmental value	Justification
Air Quality	The activities proposed do not differ to those that were assessed during the air impact assessment undertaken to inform the Surat Gas Project Environmental Impact Statement (EIS) (October 2013 and 19 December 2013 respectively) and Supplementary Report to the EIS (19 December 2013). The primary air quality emission relevant to this EA application is particulate matter (i.e. dust) generated by the construction activities. The main dust generating activities will be the movement of material for activities during the stripping and stockpiling topsoil; trenching activities; vehicle movements and restoration of topsoil. A construction environmental management plan will be developed to manage impacts for the project, including air quality impacts. Mitigation methods within this plan will include: - Application of water by water trucks on exposed areas including stockpiles; - Visual observation of dust emissions (particularly during dry and windy conditions) and increasing the water application frequency if required; - Vehicle loads that may generate nuisance dust will be covered; and

	- Vehicle speed restrictions will be imposed at the construction site to minimize wheel generated dust. As such, the risk to air quality from activities on PL194 are not expected to materially change. Particular conditions are included in General 21, 23 and Schedule F which appropriately manage the risk of impacts to air.
Noise and vibration	Project activities have been assessed and will continue to comply with existing conditions General 21, 23 and those included in Schedule E While it is unlikely, if blasting is required, a Blasting Management Plan will be developed (in accordance with AS 2187) by a suitably qualified specialist prior to any blasting activities. As such, the risk of noise from construction and operation are not expected to materially change.
Water, wetlands and groundwater including Groundwater Dependent Ecosystems (GDEs)	All construction and rehabilitation activities that occur within waterways are considered temporary works under the Fisheries Act 1994 and will be undertaken in accordance with the conditions of the EA, the Department of Agriculture and Fisheries 2018 requirements for operational work in a waterway. Construction using Horizontal Directional Drilling (HDD) will be considered for high-risk waterway crossings should they occur. Project activities have been assessed and will continue to comply with existing conditions included in Schedule B.
Land	The setting of the project area is typically flat to gently undulating, with some low hills, jump-ups, and excised river/creek banks. The activity that is the subject of this EA application is unlikely to impact on adjacent land use. Project activities have been assessed and will continue to comply with existing conditions included in Schedule D (particularly conditions Land 1 to 9).
Waste	There will be no significant waste streams generated by the construction or operation of the activity for which this application applies. Section 9.4 addresses these matters in detail. The Project will continue to comply with the existing conditions of the EA, including those in Schedule G.
Community, including visual amenity.	The Project activities are not expected to materially change impacts on the community. Arrow maintain dedicated land liaison officers who proactively engage with landholders and community members regarding project activities.
Indigenous and non-indigenous heritage	Arrow has negotiated Indigenous Land Use Agreements (ILUAs) with all relevant Native Title Parties for the Surat Gas Project. These ILUAs address provisions within the Native Title Act 1993 and ensure compliance with the Aboriginal Cultural Heritage Act 2003. Arrow is committed to ensuring that the cultural heritage places, objects and values identified throughout the project area are protected or managed in a culturally appropriate manner, and with the direct input of relevant parties. As such, cultural heritage preconstruction clearance surveys are undertaken with the relevant heritage parties as part of project planning activities.

6. Biodiversity

6.1 Existing Environment

Production from cropping and agriculture has resulted in large portions of cleared and disturbed land in the north-east of the tenement. The southern half of the tenement where most CSG development has occurred, is characterised by bushland including the Dalby State Forest. Mineral extraction encroaches on the south east boundary and the land use in the south west portion of the tenement includes intensive beef production.

Habitat quality in the PL194 area has been impacted by these land uses, including historic logging, particularly that associated with the Dalby State Forest, and recent fires, as described by Ecosmart (2017):

> "While, on balance, the State Forests have retained greater conservation value than vegetation on freehold land, the future of these areas may be affected by changes to fire regime. Within the last 10 years, three extremely hot fires have affected large expanses of State Forest within the SGP study area, and in the case of Kumbarilla State Forest on more than one occasion…These hot fires can cause significant damage to the canopy and vegetation composition (by removing fire-sensitive species). It is likely the vegetation will take many decades to fully recover after a significant wildfire. The frequency and intensity of wildfires are predicted to increase due to climate change (Williams et al. 2001), possibly leading to possible broad-scale vegetation changes."

The main habitats in and around Dalby State Forest include remnant and regrowth eucalypt woodlands on land zones 5 and 7 and taller forests (RE 11.3.18 and 11.3.25) associated with riparian zones, especially around Braemar Creek.

Biodiversity values have been assessed through the following studies, which included PL194:

- Surat Gas EIS ecological studies – broad-scale aquatic and terrestrial ecology studies undertaken between 2011 and 2013;
- Surat Gas Project Terrestrial Ecological Report (EcoSmart 2017) – Studies undertaken to address EIS commitments and approval conditions. There were undertaken over an area just over 200,000 ha and included:
    - Habitat mapping rules – assessment of potential habitat based on the results of pre-clearance surveys and through the application of peer-reviewed mapping rules to assess habitat impacts for potential threatened species;
    - Pre-clearance surveys – targeted local scale ground-truthing surveys undertaken in and around the proposed works on PL194. These surveys have occurred over the last 5 years and as recently as 2022. The occurrence of Regional Ecosystems has been ground-truthed using methodologies consistent with Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities (Neldner et al 2022).

Arrow has surveyed nearly 280 ha on PL194, split between Secondary, Site Validation, Flora and Fauna surveys, Koala surveys (240 trees) and Protected Plant Surveys (approx. 7 hours).

The ecological surveys have incorporated elements of both the BioCondition (Eyre, et al 2015) and CORVEG (Neldner, et al 2019) assessment methods in use in Queensland and enabled detailed descriptions of RE and vegetation communities, records of field traverses to verify RE, vegetation mapping (Site Validation), incidental observation of Wildlife and possible habitats, assessments of koala habitats (Spot Assessment Technique by Phillips and Callaghan, 2011) and analysis of the quality of the environment of koala habitats (Habitat Assessment by Jurskis, 2001) (Koala survey).

The SGP ecology report (attachment 5) states:

For the purpose of targeted survey sites, the terrestrial fauna surveys used a variety of recognised survey methods consistent with relevant federal and state survey guidelines. These included trapping (Elliot, pitfall, funnel and Harp), observation (spotlighting, bird survey, and active search), remote sensing (Anabat ultrasonic bat detection and camera trapping), and targeted methods (Koala [SAT] and Glossy Black Cockatoo ort searches, tripline, artificial shelter).

In addition to those detailed in the EcoSmart Report, Arrow ecologists surveyed the area in 2013, 2016, 2018, and 2022. The entire alignment has been assessed and further information is provided in the EcoSmart Report (attachment 5).

Areas mapped as 'flora survey trigger' areas were surveyed in accordance with the Flora Survey Guidelines – Protected Plants v2.01 (Wildlife and Threatened Species Operations, Department of Environment and Science (DES) 31 May 2019).

6.2 Environmental values

There are no prescribed legislative environmental values under the EP Act or subordinate legislation relating to biodiversity for PL194. Arrow Energy considers that the environmental values for PL194 are:

- The integrity of undisturbed land ecosystems within the project area
- The integrity of Regional Ecosystems and the habitat they provide; and
- The integrity of populations of significant species and ecological communities.

Additional detail on how biodiversity studies have informed the assessment of potential occurrence of threatened species/communities, or their habitat is presented in the following sections.

6.3 Details of emission or releases

There are no planned or expected emissions or releases to the identified biodiversity values as a result of this amendment. An unplanned release of chemicals has the potential to impact on terrestrial ecosystems and biodiversity values.

6.4 Potential impacts and management practices

Survey areas of proposed disturbance alignments include remnant and regrowth vegetation that has been ground-truthed to include the following:

Table 8: Ground-verified vegetation communities and cleared areas impacted by the Project.

Vegetation Community	Area (ha)
11.3.14	0.554
11.3.18	0.408
11.3.25	0.303
11.5.1	51.494
11.7.4	5.971
11.7.7	13.453
Regrowth (11.5.1)	49.609
Regrowth (11.7.4)	23.172
Cleared land (not remnant or regrowth)	54.595
Total	**199.559**

These REs have been assessed as potentially providing habitat for a number of NC Act listed fauna species including.

- *Furina dunmalli* (Dunmall's Snake)
- *Nyctophilus corbeni* (South-eastern Long-eared Bat)
- *Calyptorhynchus lathami* (Glossy Black-cockatoo)
- *Acanthophis antarcticus* (Common Death Adder)
- *Tachyglossus aculeatus* (Echidna)
- *Petauroides volans* (Greater Glider)
- *Petaurus australis* (Yellow-bellied Glider)
- *Stagonopleura guttata* (Diamond Firetail)
- *Phascolarctos cinereus* (Koala)
- *Hemiaspis damelii* (Grey Snake)
- *Adclarkia cameroni* (Brigalow Woodland Snail)
- *Dasyurus maculatus* (Spotted-tailed Quoll)

Disturbance to enable the proposed development was envisaged at the time of the approved Surat Gas Project Environmental Impact Statement (EIS) (October 2013 and 19 December 2013 respectively) and Supplementary Report to the EIS (19 December 2013).

Disturbance has been minimised through the strategic placement of pads and by co-locating infrastructure on existing disturbed areas where possible. This aims to achieve an optimal spacing between well centres of approximately 850m to 1250m, which is required to establish and maintain effective operation of wells.

The majority of the clearing required is for gathering infrastructure, with most of the pipeline alignment selected to avoid areas of 'Of Concern' remnant RE 11.3.25 (Biodiversity Status), other than a small section required to connect a well into the gathering network (0.303ha).

Taking a conservative approach, Arrow request Schedule D, Table 3 be updated to include the changes to the species where habitat may exist, and which may result in a significant residual impact. The potential for the project to have a significant residual impact on these species has been determined through preparation of a Significant Residual Impact (SRI) assessment and report. This is provided to DES prior to commencing the next stage of development, in accordance with Condition Biodiversity 14.

The SRI report provides an analysis of the estimated SRI to each PEM with further detail regarding targeted surveys undertaken. Where a significant residual impact to these species is proposed, further detail on proposed management is provided in Section 8 of this report.

This amendment application does not seek to provide additional disturbance to that already authorised but is to amend the EA to reflect currently identified environmental values not presently addressed in the EA. This is by amending the disturbance values to PEMs and ESAs to enable the efficient and effective development of PL194, while providing appropriate levels of protection to environmental values through avoidance, management and mitigation measures.

Arrow implements a management hierarchy for disturbance with the aim of avoiding and minimising impacts to PEMs and other environmental values.

This includes an initial desktop assessment by all Subject Matter Experts (SMEs) for each proposed disturbance. This is followed by targeted proactive ecological surveys to ground-truth values at a local scale (including mapping of regional ecosystems). Following these surveys, an Issued for Site Assessment (IFSA) meeting is held where the relevant SMEs are able to further refine project layout, based on all identified constraints including ecological values.

Subsequent detailed pre-clearance field inspection surveys of the specified disturbance footprint are then undertaken by suitably qualified ecologists. Pre-clearance surveys confirm the presence, absence and extent of environmental values (including EPBC Act species habitats and TECs). The survey results are then included in Arrow's GIS system to ensure verified values can be avoided and minimised.

Following pre-clearance surveys, the next review meeting, called the Released from Survey (RFS) meeting, is held with SMEs including project engineers, planners, ecologists, land liaison officer and an archaeologist. Through this meeting, each specialist provides input to route and location options for proposed infrastructure, using the opportunities and constraints data derived from desktop and field-based assessments. Landholders feedback is a key consideration in the process and is incorporated where practicable, and would include Queensland Parks and Wildlife Services (QPWS) as custodians of State forests.

The outcome of the RFS meeting is an agreed location for surface infrastructure, taking into consideration the outcomes of desktop and field-based assessments. The results of all assessments are recorded within Arrow's Access, Approvals and Compensation (AACS) database.

A final meeting to confirm the layout based on updated engineering deliverables (called the Final Layout Approved meeting) is held and SMEs further refine proposed infrastructure layouts, considering all relevant constraints so that Engineering Issued for Construction (IFC) drawings can be produced. At this point, the layout is locked and any further changes

must be subject to a formal Management of Change (MoC) process and will require further detailed assessments.

The assessment of potential impacts from the proposed disturbance has been done utilising a combination of constraints mapping (e.g., environmental, topographical, landholder) verified with surveyed ground-truthed data over laying the proposed infrastructure locations. The final layout will be determined subject to a signed Conduct and Compensation Agreement (CCA) with the relevant landholders. Pre-clearance surveys will be conducted in accordance with the EA, which will then be used to validate against the extent the of disturbance and any offset requirements as approved in the EA.

The following hierarchy is embedded in Arrow's design and approvals process:

Avoid:

- Significant disturbance to sensitive ecological values (e.g., protected flora, fauna and vegetation communities, and watercourses and wetlands).
- Significant disturbance to land outside the approved battery limits.
- Significant disturbance to land by maximising the use of previously disturbed land where possible.
- Example - Water and gas processing will be undertaken using existing facilities on other tenure, which avoids the need for construction of new facilities on PL194.

Minimise:

- The footprint (area) of the site (i.e., the total area of land disturbance within the approved battery limits).
- Clearing vegetation, especially native woody vegetation and grasslands (i.e., utilise previously disturbed areas).
- Example - In the initial planning phase, it was proposed to increase the size of each well pad to accommodate the drilling rig and supporting equipment. Through refinement, the intended layout of equipment has been reduced to fit within the currently authorised definition of essential petroleum activities.

Mitigate:

- Implement mitigation measures to further reduce direct and indirect impacts to ecological values.
- Example - A single proposed large laydown area of approximately 10ha has been removed and replaced with two smaller areas of 2.6ha and 0.6ha, totalling 3.2ha.

Remediate and rehabilitate:

- Actively remediate and rehabilitate impacted areas to promote and maintain long term recovery.
- Example - Once constructed, wells sites will be reduced down to the area required for operational purposes.

Offset:

- Identify and implement offsets in line with regulatory requirements where Matters of National (MNES) or State (MSES) Environmental Significance cannot be avoided and are significantly impacted.
- To enable the resource to be brought to surface some infrastructure needs to be placed in areas where clearing of remnant vegetation is required. Biodiversity offsets will be implemented where this results in a significant residual impact.

9 below identifies potential impacts and details of management practices to be implemented for the works on PL194.

Table 9: Management practices to be implemented for the works on PL194

Potential Impacts	Key Management Practices
Clearing of native vegetation, and habitat including for threatened wildlife species and of concern regional ecosystem types).	• During project planning, the assessment protocol will be used to preferentially minimise disturbance to biodiversity values. • Vegetation will not be cleared unless authorised under the AACS database prior to any vegetation clearance or disturbance occurring. • Prior to undertaking activities that result in significant disturbance to land, an ecological survey to confirm on ground biodiversity values will be undertaken by a suitably qualified person. • Targeted surveys for threatened species will be undertaken where potential habitat is proposed to be disturbed. • Infrastructure will be located preferentially in predisturbed areas of land. • RoW widths will be minimised; for gathering RoWs, the width is being designed to nominally be a 30 metres RoW. • Infrastructure will preferentially avoid, minimize or mitigate impacts on native vegetation or areas of ecological value. • To prevent unnecessary land and vegetation disturbance, vehicles and equipment will be retained within the approved work zone. • 'No-go' areas will be GPS located and clearly marked e.g. with signage, bunting, flagging tape.

Potential Impacts	Key Management Practices
	• A Species Impact Management Program will be implemented. • Clearing of mature or hollow bearing trees will be avoided where reasonably practicable, and otherwise undertaken in accordance with the Species Impact Management Program.
Introduction and/or spread of weed species.	• A biosecurity plan will be developed and implemented for the project. • Activities will be planned so that movement of vehicles, plant, machinery and equipment avoid moving between properties, corridors or areas with high priority weed infestations as required. • Site specific weed management requirements will be defined prior to access to any property or work site. • Weed management and control methods will depend upon the location, weed species identified, the degree of the infestation, relevant landholder agreement or conduct and compensation agreements (CCA) provisions, and local, state and national regulatory requirements. • Imported material able to transport weed seed will be assessed to ensure they are free of contamination, disease and invasive weeds. Landowner approval may also be required for imported soils and gravel.
Disturbance or displacement to fauna species from foraging or roosting habitat, or breeding places.	• Where identified as required, a qualified fauna spotter-catcher will conduct a search immediately prior to clearing of vegetation for the presence of fauna species. • Where fauna is detected, the spotter catcher will assess and implement the most appropriate method to avoid or minimise impacts on that fauna as a result of clearing. • A Species Impact Management Program will be implemented.
Degradation of native flora and fauna habitats, including through: • Excessive dust generation and deposition • Land disturbance causing indirect impacts via increased erosion • Accidental release or spill of hazardous materials.	• Staff and contractors will be made aware through general site induction and training of the potential to generate dust emissions and mitigation and management measures that should be implemented. • Vehicles, plant and machinery will comply with site-specific speed limits to minimise dust generation. • Disturbed areas and access roads will be watered using a water cart/truck on an as-required basis to minimise the potential for environmental nuisance due to dust. • Works on site will not commence until any relevant Contractor erosion and sediment control procedures have been approved by the Arrow Site Supervisor

Potential Impacts	Key Management Practices
	and installed as required on significantly disturbed land. • Sediment and erosion control to be managed in accordance with the Arrow Erosion and Sediment Control Procedure and the Contractor's erosion and sediment control procedures. • Erosion and sediment control structures must be inspected periodically as required and after rain events and maintenance carried out where required. • All fuel, oil and chemicals are to be stored, transported and handled in accordance appropriate standards including AS 3780:2008 – The storage and handling of corrosive substances, AS 1940:2004 – The storage and handling of flammable and combustible liquids, AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers. • Appropriate spill response equipment must be available on site and/or with vehicles, and regularly maintained.
Habitat fragmentation.	• Infrastructure will be located preferentially avoiding, then minimize isolating, fragmenting, edge effects or dissecting tracts of native vegetation. • Linear infrastructure will maximize co-location. • Natural vegetation buffers along creeks and rivers will not be disturbed unless authorised under an approval and only at the location indicated on site-specific environmental instructions. • RoW widths in native vegetation and waterway crossings will be minimised where possible. • Where activities may impose barriers to the movement of fauna for extended period of time, reasonable measures will be implemented to facilitate fauna movement around or through active work areas.
Fauna injury during construction and operation activities.	• Measures to prevent fauna entrapment and facilitate escape must be implemented during construction and operations where required (e.g. open excavations). • Excavations and trenches must be inspected for trapped fauna on a daily basis during construction. • Where identified as required, a qualified fauna spotter-catcher will conduct a search immediately prior to clearing of vegetation for the presence of fauna species. Where fauna are detected, the spotter catcher will assess and implement the most appropriate method to avoid or minimise impacts on that fauna as a result of clearing.

Potential Impacts	Key Management Practices
	• A Species Impact Management Program will be implemented.

6.5 Risk and likely magnitude of impacts on environmental values

The magnitude and severity of potential impacts have been determined based on assessments carried out by suitably qualified and experienced specialists. Indirect disturbances to terrestrial ecosystems relating to weeds and pests, displacement and degradation of habitat, as well as potential for mortality of fauna, will be effectively managed by implementing the environmental management practices outlined in section 6.

The Dalby State Forest has been and is subject to ongoing disturbance, including by logging activities, that will disrupt and ultimately remove existing vegetation. Layout of proposed infrastructure in the State Forest has been done in consultation with QWPS as custodians of the State Forest to ensure co-location of infrastructure such as fire breaks and fire roads or to provide new breaks and trails for QPWS. In addition, the location of proposed infrastructure is determined by topography.

Arrow have adopted a conservative approach to assessing the potential for vegetation to provide suitable habitat for protected wildlife. These areas will be offset in accordance with the EO Act with the aim of achieving no net loss of biodiversity as a result.

Where impacts are unavoidable, Arrow anticipates that those impacts will be localised, short-term and recoverable, or will be appropriately offset. The overall risk and magnitude of potential impacts has therefore been assessed as low.

7. Environmentally Sensitive Areas

7.1 Environmental values

Environmentally sensitive areas are defined in the *Environmental Protection Regulation 2008* and EA. The ESAs to be protected within the Petroleum Lease include:

- Of concern remnant vegetation areas (Category C ESA);
- State Forest (Dalby State Forest) (Category C ESA); and
- Essential Habitat (Category C ESA).

Environmentally Sensitive Areas (ESAs) have been determined with reference to the existing EA which defines Category A, B and C ESAs.

7.2 Details of Emissions or Releases

There are no planned or expected emissions or releases to the identified ESAs as a result of this amendment. An unplanned release of chemicals has the potential to impact on terrestrial ecosystems and ESAs.

7.3 Potential impacts and management practices

Where infrastructure is required to impact ESAs, priority has been given to areas that are pre-cleared and/or existing disturbed areas. While all reasonable efforts have been made to avoid impacts on ESAs, or the protection zones (PZs), through implementation of an environmental constraints assessment process, some disturbance will be required in these areas. This is primarily to enable the construction and operation of essential petroleum activities which are required to bring the resource to surface.

The methodology for determining the anticipated impacts on ESAs includes an initial assessment based on government mapping layers, which are then verified through more detailed site assessments undertaken by suitably qualified persons. In accordance with existing condition Biodiversity 3, where the ground-verified values differ from the government mapping, activities can proceed on the basis of the confirmed on-the-ground biodiversity values. This is reflected in the values provided in Table 10 below.

This amendment is in part triggered by the need to place petroleum activities within Category C ESA – that are 'essential habitat'.

For the purpose of assessing impacts to ESAs, Arrow have assessed essential habitat as per section 20AC of the *Vegetation Management Act 1999* (VMA), under the heading '*What is the essential habitat map'.*

Section 20AC(2) defines essential habitat for protected wildlife, as a category A area, a category B area or category C area shown in the regulated vegetation map:

> (1) that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or
>
> (2) in which the protected wildlife, at any stage of its life cycle, is located.

The regulated vegetation map is the map certified by the chief executive which shows the vegetation category areas for the State. When read in context of section 20AC, this links the definition of essential habitat with the essential habitat map which is certified by the chief executive as the essential habitat map for the State and shows areas the chief executive reasonably believes are areas of essential habitat for the protected wildlife.

Considering the above definition of essential habitat and following considerable efforts to minimise disturbance through careful placement of infrastructure, the current Schedule D, Table 2 does not provide adequate disturbance values to enable the development of PL194.

It is therefore requested that Schedule D, Table 2 be amended to recognise the extent of Category C ESA to be impacted. Noting these areas also overlap with habitat for protected wildlife and will be subject to a biodiversity offset, in accordance with the EO Act. The proposed changes to conditions are detailed in Attachment 3.

10 below provides the extent of ESAs anticipated to be impacted.

Table 10: Impacts to Environmentally Sensitive Areas

Regional Ecosystem (ground-verified)	Area (ha)	VMA	BD (ESA)	Cat B ESA (ERE)	Cat C ESA (OCRE)	Cat C ESA (Essential Habitat)	Cat C ESA (State Forest)
11.3.14	0.554	LC	NCAP			0.167	0.428
11.3.18	0.408	LC	NCAP			0.216 (including 0.023)	0.216
11.3.25	0.303	LC	OC		0.303		
11.5.1	51.494	LC	NCAP			6.352	31.256
11.7.4	5.971	LC	NCAP				2.724
11.7.7	13.453	LC	NCAP			1.369	13.123
Regrowth (11.5.1)	49.609	LC	NCAP			7.205 (including 2.289)	6.058
Regrowth (11.7.4)	23.172	LC	NCAP			2.672	
Cleared Land	54.595	NA	NA				3.159
Total	**199.559**	**Totals**		**0.000**	**0.303**	**17.981**	**56.964**

Schedule D, Table 1 in the current EA currently reflects the Streamline Model Conditions for Petroleum Activities and clearly provides for disturbance within the ESAs and PZs. It currently restricts activities in certain ESAs to 'only low impact petroleum activities' which does not extend to ground breaking activities required for development of PL194.

The current Schedule D, Table 2 also restricts the extent of impact to ESAs and PZs. This table originated from a broader project EA (EPPG00972513) which provided an upper limit of disturbance within ESAs and associated PZs that reflected the intended extent of disturbance across multiple Petroleum Leases (PLs), including PL194.

Through the process of de-amalgamating this EA (P-EA-100464322) for PL194 from the larger project EA, the values in Schedule D, table 2 were changed to record zero values. At that point in time, it was considered there was not sufficient detail to support specific numbers to be included. The intention at the time of the de-amalgamation was that no further disturbance would occur on PL194 before Arrow secured the amendment the subject of this current application. Arrow now propose to address Schedule D, Table 2 in this current EA amendment application.

This amendment seeks to amend Schedule D, Table 2 which is now contradictory to Schedule D, Table 1, by providing updated limits to represent the required field development in PL194.

There are engineering limitations for some essential infrastructure (namely wells and gathering flowlines), that prevent avoiding all impacts to ESAs. Wells are required to be placed at certain spacings to ensure effective resource recovery. Gathering flowlines are required to traverse topographic changes while maintaining consistent pressures to ensure

product can effectively be transported to processing facilities and also limited to where the landholder requires infrastructure to be located through CCAs. To enable the resource to be brought to surface some clearing of remnant vegetation is required.

The area of ESA impact proposed by this development have been limited where practicable and a summarised upper value of 75ha has been proposed for inclusion in Schedule D, Table 2. These areas are all overlapping areas of protected wildlife habitat and will be subject to a biodiversity offset in accordance with the EO Act. This approach will prevent the need for multiple small EA amendments over time and will provide for no net loss of biodiversity values.

Table 11 ESA Potential Impacts and Key Management Practices

Potential Impacts	Key Management Practices
Direct disturbance of an ESA of protection zone	• During project planning, the AAP Protocol will be used to preferentially minimise disturbance to biodiversity values. • Within ESAs, infrastructure will be preferentially located in areas of non-remnant vegetation, where practicable. • Prior to undertaking activities that result in significant disturbance to land, an ecological survey to confirm on ground biodiversity values will be undertaken by a suitably qualified person. • To prevent unnecessary land and vegetation disturbance to ESAs, vehicles and equipment will be retained within the approved work zones. • ESAs that are 'No-go' areas, will be GPS located and clearly marked e.g. with bunting, flagging tape.
Introduction and/or spread of weed species	• A biosecurity plan will be developed and implemented for the project. • Activities will be planned so that movement of vehicles, plant, machinery and equipment avoid moving between properties, corridors or areas with high priority weed infestations as required. • Site specific weed management requirements will be defined prior to access to any property or work site. • Weed management and control methods will depend upon the location, weed species identified, the degree of the infestation, relevant landholder agreement or conduct and compensation agreements (CCA) provisions, and local, state and national regulatory requirements. • Imported material able to transport weed seed will be assessed to ensure they are free of contamination, disease and invasive weeds.

Potential Impacts	Key Management Practices
	Landowner approval may also be required for imported soils and gravel.
Indirect degradation of ESAs, including: • Excessive dust • Land disturbance • Accidental release of spill of materials	• Staff and contractors will be made aware through general site induction and training of the potential to generate dust emissions and mitigation and management measures that should be implemented. • Vehicles, plant and machinery will comply with site-specific speed limits to minimise dust generation • Disturbed areas and access roads will be watered using a water cart/truck on an as-required basis to minimise the potential for environmental nuisance due to dust. • Works on site will not commence until any relevant Contractor erosion and sediment control procedures have been approved by the Arrow Site Supervisor and be installed as required on significantly disturbed land. • Sediment and erosion control to be managed in accordance with the Arrow Erosion and Sediment Control Procedure and the Contractor's erosion and sediment control procedures. • All fuel, oil and chemicals are to be stored, transported and handled in accordance appropriate standards including AS 3780:2008 – The storage and handling of corrosive substances, AS 1940:2004 – The storage and handling of flammable and combustible liquids, AS 3833:2007 – Storage and handling of mixed classes of dangerous goods in packaged and intermediate bulk containers. • Appropriate spill response equipment must be available on site and/or with vehicles, and regularly maintained.

7.4 Risk and likely magnitude of impacts on environmental values

The management practices offer effective controls to manage the potential impacts to ESAs associated with the proposed activities in the PL. Specifically, adherence to the EA conditions for Biodiversity and the management practices identified will minimise the extent of removal of ESAs and minimise indirect disturbances to ESAs. Given the construction activities will be progressive and followed by restoration and rehabilitation activities, disturbance will be localised, short term and recoverable. As a result of implementing the management practices outlined above, the risk of environmental harm to the overall ESAs is assessed as being medium.

Where impacts are unavoidable, Arrow anticipates that those impacts will be localised, short-term and recoverable, or will be appropriately offset to achieve a net environmental benefit. The overall risk and magnitude of potential impacts has therefore been assessed as low.

8. Environmental Offsets

An environmental authority amendment application for a resource activity is a prescribed activity under the *Environmental Offsets Regulation 2014* (EO Regulations) for which an environmental offset may be required if the activity will have a significant residual impact on a PEM.

PEMs are also identified in the EO Regulations, which under this application will be 'matters of state environmental significance' defined in Schedule 2.

The project's disturbance footprint has been used to identify areas that may have a significant residual impact (SRI) on PEMs as defined in the EO Act. The presence/absence of each matter was determined in accordance with the 'Method for mapping Matters of state environmental significance for the – State Planning Policy 2017 and *Environmental Offset Regulation 2014*' (DEHP, 2017).

In 2017, 2018 and 2019 EcoSmart Ecology (ESE) prepared a terrestrial ecology impact assessment report for the SGP included as Attachment 5. This work included inspecting relevant data sources to identify threatened species (flora and fauna specially protected under the EPBC Act and *Nature Conservation Act 1992* (NC Act), which are known within and surrounding the SGP. 'Rules' were created to map habitat for these Matters of National and State Environmental Significance (MNES and MSES) based on GIS data, allowing the prediction of high value habitat. These surveys and mapping rules were also used to assess the impacts and environmental values associated with PL194.

Habitats were classed as 'core' habitat or 'general' habitat. Core habitat areas reflect those REs which are likely to be regularly inhabited by, or of 'high importance' to, the species. Such areas include high amenity habitat which could include important resources such as roosting and nesting sites or food resources. General habitats are 'those REs that may be used less regularly by fauna' (3DE and ESE 2011) and have lower amenity habitat. These definitions roughly match the definitions of 'Core Habitat Possible' and 'General Habitat Possible' in DES (2020), which was not available in 2011. The mapping has been used to calculate predicted impacts (and subsequently offset requirements) based on the extent of Core Habitat Known and Core Habitat Possible.

Considerable field work has been completed within and surrounding the SGP area (which included the PL194 area) since this work was completed, therefore our local knowledge has increased substantially. In a few cases, this has identified ways in which the mapping rules could be modified and improved for greater accuracy. Furthermore, additional MNES and MSES species have been listed under legislation since the original work was completed. These new additional species had not been previously assessed (given their latest change in status) but have been included in this assessment as an abundance of caution. The assessment is based on likelihood of occurrence assessment and suitability of habitat within the survey corridor for the PL194 area, utilising the aforementioned ecology surveys, survey data and mapping rules.

The ecological assessments have provided ground-verified data which is used to cross-check government supplied mapping data on PEMs that are regulated vegetation, protected wildlife habitat, connectivity areas, wetlands and watercourses.

Additionally, the government's Landscape Fragmentation and Connectivity (LFC) Tool was used to assess potential impacts on connectivity areas of remnant vegetation.

The prior impacts on PL194 have been undertaken under the broad project EA (EPPG00972513), which encompassed activities on seven PLs, including PL194. The current SRI report has been provided to enable an assessment of the future proposed scope

of development on PL194 alone. This reflects the scale of activity proposed now the current EA has been de-amalgamated from the broader project. Any updates or amendments to the draft SRI report can be provided post approval of this amendment, and in accordance with existing condition Biodiversity 14. Arrow have provided this prior disturbance data in the most recent version of the Plan of Operations (23/04/2023).An assessment of the magnitude of the impacts specifically associated with this amendment is provided in Section 6 and 7.

As all practicable measures have been implemented to avoid and minimise the impacts, and the resource is not able to be extracted without the clearing of some remnant vegetation, it is appropriate that any significant residual impacts to PEMs be offset in accordance with the EO Act.

8.1 Conservation significant species

Conservation significant flora and fauna values have been derived from a range of sources, including Wildnet records, Queensland Government mapping, project-specific terrestrial flora and fauna surveys and comparison of ground-truthed RE data against habitat mapping rules for key species prepared by EcoSmart (2017, 2023).

The presence of the 'near threatened' Kogan waxflower (*Philotheca sp*oradica) has previously been confirmed on private land to the west of Dalby State Forest by targeted flora survey carried out by EcoSmart (2017) and Arrow ecologists. However, as this species is listed as 'near threatened' under the NC Act it does not constitute a 'prescribed environmental matter' for the purposes of the EO Act (i.e., high risk areas shown on the trigger map only constitute PEMs insofar as they contain endangered and vulnerable wildlife).

This Project has been described, assessed and approved in the EIS and EPBC Act approval (Ref. 2010/5344). Despite efforts to prioritise avoidance, there are fauna species, which Arrow had received approval to offset under the approved Commonwealth Offset Strategy and included within the Offset Area Management Plan (OAMP), but which were not listed as MNES at the time that Arrow received their initial approval in 2013 under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Now this EA has been de-amalgamated, this amendment seeks to provide appropriate disturbance values in the stand-alone EA. As such, these matters are proposed to be included in the PEMs table and offset as MSES.

The impact on individual species is related to their specific habitat preferences and ecology. All PEMs are included in Scheduled D, Table 3 on a precautionary basis (refer Attachment 3).

The impacts on habitat for conservation-significant fauna species relevant to the assessment for PL194 is discussed in further detail in the SRI assessment in Attachment 6.

A summary of the fauna species for which an SRI has not previously been identified on PL194 are provided below. Through this amendment process Arrow are seeking these species be included in the PEMS table, as per the SRI report (attachment 6).

***Glyphodon dunmalli* – (Dunmall Snake)**

Dunmall's Snake (*Glyphodon dunmalli*, previously *Furina dunmalli*) is confined to the Brigalow Belt bioregion of south-eastern Queensland and north-eastern New South Wales.

Most records are from the Dalby-Tara area of the Darling Downs (Hobson 2012). The species could occur through the entire SGP. The species is very rarely encountered, even in areas of known habitat, and has been described as 'extremely secretive, rarely encountered, possibly genuinely scarce' (Wilson 2022). Preferred habitat appears to be brigalow growing on cracking black clay and clay loams (Chapple et al. 2019), with the majority of records from between 200 to 500 m elevation (Hobson 2012).
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Nyctophilus corbeni* (South-eastern Long-eared Bat)**

The species is common in box/ironbark/cypress pine woodland and vegetation dominated by Buloke (*Allocasuarina luehmannii*) on sandy soils, though it can also occur in Brigalow (*Acacia harpophylla*) and Belah (*Casuarina cristata*) communities, dry sclerophyll forests with *Corymbia citriodora*, and semi-evergreen vine thickets (Turbill and Ellis 2006; Churchill 2008; Baker and Gynther 2023). The species prefers areas with a distinct overlapping canopy and a dense understorey (Churchill 2008; Law et al. 2016).
With broad, short wings, the South-eastern Long-eared Bat is highly manoeuvrable and welladapted 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). South-eastern Long-eared Bats typically forage up to about 4 km from their roost, although individuals have been captured up to 7 km from roost. Average forage distance is thought to be ~1-2 km (Law et al. 2016).
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Petauroides volans volans* (Greater Glider)**

Greater Gliders are described as a wide ranging species with a strictly 'eucalyptus' diet but will also occasionally take flowers and rarely Acacia phyllodes or mistletoe leaves. Dietary selection in the southern Brigalow Belt is poorly understood, with a single study finding foraging animals most often in *E. moluccana, E. fibrosa* and *Corymbia citriodora* (Eyre et. al., 2022). Greater Gliders require large, old growth trees with abundant large hollows for denning and its abundance is often linked to hollow density. In southern Queensland, the Greater Glider requires at least 2-4 live den trees for every 2 ha of suitable forest habitat (Eyre T. J., 2007). Males have larger home range sizes than females and sexes usually share a den when the breeding season commences (Mackay, 2008).
Greater Gliders are generally considered to be sensitive to fragmentation, with larger patches of suitable habitat having a higher probability of occupancy and persistence of Greater Glider populations (Possingham et. al., 1994). However, small patches should not be dismissed as important habitat, particularly if connected to other patches.
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Petaurus australis australis* (Yellow-bellied Glider)**

Due to the presence of suitable habitat, the species is likely to occur within the SGP but is yet to be detected. Habitat requirements for the species broadly encompass tall, mature Eucalyptus forest in large contiguous forest reserves of thousands of hectares in area (Goldingay and Possingham 1995; Eyre 2007).
The Yellow-bellied Glider is known to be particularly susceptible to the impacts of clearing (Youngentob et al, 2013), and is typically associated with intact forest remnants. Average

home range size of the Yellow-bellied Glider varies from 25 ha to 85 ha (Goldingay and Kavanagh 1990; Goldingay and Possingham 1995). Within these home ranges, the species often den in hollow-bearing trees and regularly change dens, as often as nightly in some instances (Craig 1985). While linear corridors and other disturbance may ultimately be navigable by individual gliders, it is considered there may be a significant impact on this species.
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Stagonopleura guttata* (Diamond Firetail)**

The species occurs across a range of habitat types, including eucalypt woodland, banksia shrubland, and cypress forest (Cooney and Watson 2005; McGuire and Kleindorfer 2007; Antos et al. 2008; Hodder 2019). Populations appear unable to persist in fragmented areas which lack remnant patches of vegetation larger than 200 ha (TSSC 2023b).
The Diamond Firetail is granivorous, with a diet consisting predominantly of grass seeds, with the remainder of the diet typically made up of forbs (Read 1994; Hodder 2019). Both native and introduced grasses and forbs are utilised dependent on availability (Read 1994; Hodder 2019). Breeding takes place from August to February. Nests are built up to 4-5 m above the ground in a range of plant species depending on location, including *Eucalyptus* spp., *Banksia* spp., *Allocasuarina* spp. and mistletoe, and are often adorned with flowers around the entrance (Cooney and Watson 2005; McGuire and Kleindorfer 2007).
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Phascolarctos cinereus* (Koala)**

Koalas required large, connected patches of eucalypt woodland to maintain a viable population though determining the maximum spatial extent to support Koalas either at the individual scale or the population level is complicated by the fact that Koalas can persist in highly fragmented landscapes and the area needed differs widely across their range (Youngentob et al, 2021).
Koalas feed on eucalyptus trees but show dietary preference based on geographical region and the types of tree species present. In the Brigalow Belt Koalas have at least 24 species of Eucalyptus upon which they preferentially forage (ANU 2021).
Koalas are not strongly territorial and home ranges will overlap. Home ranges vary in size from 1-2 hectares in optimum habitat up to 135 hectares in semi arid regions (Ellis et al. 2002; Baker and Gynther 2023). Movements are often as short as the distance between feed trees; however dispersing individuals will move over larger distances.
Koalas are surprisingly mobile and able to move large distances across artificial land. There are no limitations on suitable patch size. Established individuals have been known to make exploratory movements over larger distances before returning to home ranges (Dique et al. 2004). The breeding season occurs between October and May with females producing up to one offspring per year (Baker and Gynther 2023). Juveniles become independent from one year of age with males living for over 12 years and females living for over 15 years (Martin et al. 1999).
There is no agreement in the literature about how many preferred food trees are needed in the landscape to support a Koala population.
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

***Adclarkia cameroni* (Brigalow Woodland Snail)**

The species is found in Brigalow and alluvial eucalypt woodlands, which have dense cover and scattered debris, especially logs, dense leaf-litter, piles of fallen bark and flood debris. While egg-laying has not been recorded, it is assumed eggs are deposited in small depressions in the soil under logs and other debris where soil moisture is high.
This species has been recorded from highly disturbed and cleared habitats if there is suitable shelter on the ground (e.g., logs). Desiccation to adults and eggs is the greatest threat to the species (TSSC 2016a). The species has limited mobility and, while they can move between patches of habitat under favourable conditions, fragmentation is likely to lead to isolation (TSSC 2016a).
Given the limited dispersal capability of these species, any snails in these drainage lines would be assumed to constitute a population. If present, clearing for waterway crossings would have the potential to eliminate local populations of this species however, the area of impact is unlikely to have a significant impact on regional populations (Attexo 2023).
The clearing of habitat for this species is unavoidable and has been considered in the SRI report. It is expected a suitable offset will be available for this species which will provide for no net loss of habitat.

Two further species identified in a WildNet species search have also been described below.

***Hirundapus caudacutus* (White-throated Needletail)**

The White-throated Needletail is a migrant to Australia between spring and autumn, overwintering from its breeding grounds in eastern Siberia, China and Japan (Higgins 1999). It is predominantly an aerial species, flying from almost ground level to altitudes of over 1000 m above ground level (Watson 1955; Coventry 1989). White-throated Needletails are generalist insectivores, with consumption likely linked to availability of swarming prey rather than a preferential diet (Burwell and Pavey 1992). The species has been recorded feeding on a range of insect taxa including flying ants, beetles, cicadas, and grasshoppers (Cameron 1968; Burwell and Pavey 1992; Tarburton 1993; Rose 1997; Lepschi 1993). This species forages in the airspace over all types of terrestrial land systems including forests, cleared grazing land, tilled and cropped farmland and even urban cities (Tarburton 1993). The white-throated needletail occurs over most types of habitat, including cleared areas, but is most often recorded above wooded areas (SPRAT 2021). No significant impact to this species has been predicted.

***Lophochroa leadbeateri leadbeateri* (Major Mitchell's Cockatoo)**

Typical habitat for this species is sparsely timbered open grasslands, *Callitris* and *Casuarina* woodlands, mulga woodlands, trees in proximity to watercourses. Habitats within the SGP are, on balance, too closed and more mesic than areas inhabited by this species. This is noted as a transient species and is not expected to occur in this area (Ecosmart 2023).

8.2 Species management

As detailed earlier (Sections 2.1, 6.1, 6.4, 6.5), planning for disturbance activities includes assessment and ground-truthing of ecological values present within proposed impact areas. The quantification of direct impacts for each value is assessed against disturbance limits listed in the existing schedule D Table 3 (*Protecting biodiversity values, Table 3 Significant residual impacts to prescribed environmental matters*) (Refer Attachment 3).

Relevant sections of this report demonstrate that the avoid, minimise, mitigate hierarchy has, and will continue to be, implemented through the design of the proposed development.

The Surat Gas Project Species Impact Management Plan (SIMP) (Attachment 4) has been prepared by suitably qualified ecologists. It describes the management measures and monitoring program that will be implemented to avoid, track, and further minimise impacts to these and other EPBC listed species and communities through the life of the Project. The SIMP that was approved by DCCEEW is implemented across all of Arrow tenures including PL194 and continues to provide an appropriate level of protection for these values, and will be updated where required.

8.3 Connectivity

The PL194 area forms part of a State-significant biodiversity corridor that runs north-south between Dalby State Forest and Western Creek State Forest (east of Milmerran). The buffer applied to this corridor by the Brigalow Belt Biodiversity Planning Assessment is 5 km in width. Dalby State Forest and adjoining areas to the west occupy the full width of this corridor.

The State corridor mapping aligns with land reserved for forestry, including a number of State Forests that were included in the EcoSmart assessments for the SGP. Habitat assessments of these areas indicated that nearly all have been subject to previous disturbance as a result of logging. Native vegetation persists despite these disturbances, albeit with reduced habitat quality.

Connectivity has been assessed using the government's Landscape Fragmentation and Connectivity (LFC) tool. The output from the LFC have been used to calculate the impacts to connectivity and Logfiles of the analysis are included in Attachment 2.

The LFC tool determined no significant impact on connectivity areas, returning a total area of RVM Cat B clearing of 98.98 ha. Prior to the EA for PL194 being deamalgamated, there was 6.7 ha that was included in Schedule D, Table 3 (PEMs table) for connectivity impacts. This value was transferred to the EA for PL194 with the understanding the LFC tool would be re-run specifically for PL194 after refinement of the proposed disturbance footprint. The LFC tool for both significance test one and two returned a result of not significant, therefore the current 6.7 ha will no longer be required.

8.4 Schedule D, Table 3 – Prescribed Environmental Matters

The changes outlined in Table 11 relate to the proposed work in PL194. These disturbance limits are in addition to PEMs previously identified from the concept-level field development plan relevant to the original EA application.

A significant residual impact (Attachment 6) assessment is provided to the Department in accordance with Condition Biodiversity 14.

Table 12: Proposed changes to Schedule D, protecting biodiversity values, Table 3 – Significant residual impacts to prescribed environmental matters

Item	PEM	Potential for SRI	Comments
1	Regulated vegetation – Endangered regional ecosystems.	No	Not located within the disturbance footprint of the current project.
2	Regulated vegetation – Of concern regional ecosystems.	No	Not located within the disturbance footprint of the current project.
3	Regulated vegetation – Regional ecosystems (not within an urban area) that intersect a wetland on the vegetation management wetlands map.	No	Not located within the disturbance footprint of the current project.
4	Regulated vegetation – Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map.	Yes	Includes a total of 1.739 ha of ground-verified remnant vegetation across the following REs: • 0.501 ha of RE 11.3.14. • 0.256 ha of RE 11.3.18. • 0.408 ha of RE 11.5.1. • 0.574 ha of RE 11.7.7. This vegetation is associated with Braemar Creek and several other unnamed tributaries with stream orders of 1, 2, 3 and 4. An SRI assessment of this PEM is provided in accordance with Condition Biodiversity 14. All vegetation polygons are co-located with protected wildlife habitat.
5	Regulated vegetation – Essential habitat (not in an urban area) for critically endangered, endangered or vulnerable wildlife.	Yes	A total of 17.981 ha of Queensland Government mapped Essential Habitat will be impacted for the project: • 15.309 ha for the Koala* (*Phascolarctos cinereus*), listed as Endangered under both the NC Act and EPBC Act.

Item	PEM	Potential for SRI	Comments
			• 2.312 ha for the Spotted-tailed Quoll (southern subspecies) (*Dasyurus maculatus maculatus*), listed as Endangered under both the NC Act and EPBC Act (overlaps entirely with the Koala essential habitat listed above). • 2.672 ha for the Kogan waxflower (*Philotheca sporadica*), listed as Near Threatened under the NC Act and not listed under the EPBC Act. As a Near Threatened species, it is not relevant to this PEM. An SRI assessment of this PEM is provided in accordance with Condition Biodiversity 14. All vegetation polygons are co-located with protected wildlife habitat.
6	Connectivity Areas – Connectivity area that is a regional ecosystem (not in urban area)	No	Not located within the disturbance footprint of the current project.
7	Wetlands and watercourses – A wetland in a wetland protection area	No	Not located within the disturbance footprint of the current project.
8	Wetlands and watercourses – A wetland of high ecological significance shown on the map of Queensland wetland environmental values	No	Not located within the disturbance footprint of the current project.
9	Wetlands and watercourses – A wetland or watercourse in high ecological value waters	No	Not located within the disturbance footprint of the current project.
10	Designated precinct in a strategic environmental area	No	Not located within the disturbance footprint of the current project.

Item	PEM	Potential for SRI	Comments
11	Protected wildlife habitat – An area that is shown as a high risk area on the flora survey trigger map and that contains plants that are critically endangered, endangered or vulnerable.	No	Not located within the disturbance footprint of the current project. A total of 89.383 ha of the project footprint is within an area shown as a high risk area on the flora survey trigger map. However, the focal species is Kogan waxflower (Philotheca sporadica), listed as Near Threatened under the NC Act and therefore not a PEM under the EO Act. A protected plants flora survey, report and clearing permit or exemption application will be undertaken prior to clearing. However, as it has been determined that the high risk trigger area does not contain plants that are critically endangered, endangered or vulnerable, a SRI assessment of this PEM is not required. This matter will not be assessed any further in this SRI assessment report. All vegetation polygons are co-located with protected wildlife habitat.
12	Protected wildlife habitat – An area that is not shown as a high risk area on the flora survey trigger map, to the extent the area contains plants that are critically endangered, endangered or vulnerable.	No	Not located within the disturbance footprint of the current project.
13	Protected wildlife habitat – A koala habitat area as determined by the chief executive on the koala conservation plan map.	No	Not located within the disturbance footprint of the current project.
14	Protected wildlife habitat – Habitat for an animal that is critically endangered, endangered or vulnerable.	Yes	A total of 199.559 ha will be disturbed with 144.965 ha of ground-verified remnant and regrowth vegetation to be cleared representing core habitat for one or more of the 10 species listed below:

Item	PEM	Potential for SRI	Comments
			• 144.965 ha for the Koala, *Phascolarctos cinereus* (Endangered under both the NC Act and EPBC Act). • 71.776 ha for the Greater Glider, *Petauroides volans* (Endangered under both the NC Act and EPBC Act). • 71.221 ha for the Yellow-bellied Glider, *Petaurus australis* (Vulnerable under both the NC Act and EPBC Act). • 71.880 ha for the South-eastern Long-eared Bat[1], *Nyctophilus corbeni* (Vulnerable under both the NC Act and EPBC Act). • 72.184 for the Diamond Firetail, *Stagonopleura guttata* (Vulnerable under both the NC Act and EPBC Act). • 29.143 ha for the South-eastern Glossy Black-cockatoo, *Calyptorhynchus lathami* (Vulnerable under both the NC Act and EPBC Act). • 72.184 ha for the Common Death Adder, *Acanthophis antarcticus* (Vulnerable under the NC Act). • 71.326 ha for the Dunmall's Snake[1], *Glyphodon (Furina) dunmalli* (Vulnerable under both the NC Act and EPBC Act). • 1.265 ha for the Grey Snake, *Hemiaspis damelii* (Endangered under both the NC Act and EPBC Act). • 0.303 ha for the Brigalow Woodland Snail, *Adclarkia cameroni* (Vulnerable under the NC Act and Endangered EPBC Act). All remnant and regrowth vegetation is mapped as protected wildlife habitat for one or more threatened species, with all vegetation polygons co-located to varying

Item	PEM	Potential for SRI	Comments
			degrees with all other matters, and all the vegetation to be cleared is considered Koala habitat. An SRI assessment of this PEM is provided in accordance with Condition Biodiversity 14.
15	Protected wildlife habitat – Habitat for an animal that is special least concern (i.e. echidna or platypus).	Yes	A total of 53.720 ha of protected wildlife habitat for the Short-beaked Echidna (*Tachyglossus aculeatus*), listed as Special Least Concern under the NC Act, will be impacted for the project. All vegetation polygons are co-located with protected wildlife habitat for the Koala and other threatened species.
16	Protected areas	No	Not located within the disturbance footprint of the current project.
17	Highly protected zones of State marine parks	No	Not located within the disturbance footprint of the current project.
18	Fish habitat area	No	Not located within the disturbance footprint of the current project.
19	Waterway providing for fish passage – Fish passage (not in an urban area)	Yes	A total of 0.245 ha within in-stream components of watercourses will be impacted. These are associated with Braemar Creek and several other unnamed tributaries with Waterway Barrier Works (fish passage) impact categories of 1, 2, 3 and 4. An SRI assessment of this PEM is provided in accordance with Condition Biodiversity 14. Most are remnant or regrowth vegetation polygons and are therefore co-located with protected wildlife habitat.
20	Marine plants	No	Not located within the disturbance footprint of the current project.
21	Legally secured offset area	No	Not located within the disturbance footprint of the current project.

*The total mapped essential habitat for Koala is 15.309ha which is the total used to determine impacts on ESAs. Of this 7.205ha is located in regrowth vegetation which is not a prescribed regional ecosystem in the EO Act, therefore only the remaining 8.104ha would remain subject to a biodiversity offset and has been included in the PEMS table.

The extent to which these potential impacts have been determined to result in an actual SRI are further described in the SRI report in Attachment 6. The full changes requested to the existing Schedule D, Table 3 are detailed in Table 12 below and in Attachment 3. Where it has been determined there will be no SRI to a PEM, it has not been included in Table 12.

Table 12: Significant Residual Impacts (SRIs) to Prescribed Environmental Matters (PEMs) with updates required to the Environmental Authority (EA)

Prescribed environmental matter	Location of impact	Maximum extent of impact
REGULATED VEGETATION		
~~Endangered regional ecosystem~~		
~~RE 11.4.2~~	~~PL194~~	~~2 ha~~
~~Of concern regional ecosystem (not within an urban area)~~		
~~RE 11.3.2~~	~~PL194~~	~~4 ha~~
~~RE 11.3.4~~	~~PL194~~	~~3 ha~~
Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map		
~~RE 11.3.2 (BVG 17a)~~	~~PL194~~	~~0.14 ha~~
~~11.3.4 (BVG 16c)~~	~~PL194~~	~~0.72 ha~~
11.3.18 (BVG 17a)	PL194	~~0.43 ha~~ 0.3ha
~~11.3.25 (BVG 16a; 22c)~~	~~PL194~~	~~2.14 ha~~
~~11.4.12 (BVG 17a)~~	~~PL194~~	~~0.14 ha~~
11.5.1 (BVG 17a; 18b)	PL194	~~0.72 ha~~ 0.5 ha
~~11.7.4 (BVG 12a)~~	~~PL194~~	~~0.07 ha~~
11.7.7 (BVG 12a)	PL194	~~0.14 ha~~ 0.6
11.3.14 (BVG 18a)	PL194	0.6
~~CONNECTIVITY AREAS~~		
~~Connectivity area that is a regional ecosystem (not in urban area)~~		
~~PL194~~	~~PL194~~	~~6.7 ha~~
Essential habitat (not in an urban area) for endangered wildlife		
Phascolarctos cinereus ***(Koala)***	PL194	8.7
PROTECTED WILDLIFE HABITAT		
Habitat for an animal that is vulnerable wildlife		
Acanthophis antarcticus **(Common Death Adder)**	PL194	~~53 ha~~ 72.2 ha
Petaurus australis **(Yellow-bellied Glider)**	PL194	71.3 ha
Nyctophilus corbeni **(South-eastern Long-eared Bat)**	PL194	71.9 ha
Glyphodon (Furina) dunmalli **(Dunmall's Snake)**	PL194	71.4 ha
Stagonopleura guttata **(Diamond Firetail)**	PL194	72.2 ha
Calyptorhynchus lathami **(Glossy Black Cockatoo)**	PL194	~~16~~ 29.2 ha
Adclarkia cameroni **(Brigalow Woodland Snail)**	PL194	0.4 ha
~~*Jalmenus eubulus* **(Pale Imperial Hairstreak)**~~	~~PL194~~	~~3 ha~~

Prescribed environmental matter	Location of impact	Maximum extent of impact
~~*Tachyglossus aculeatus* **(Echidna)**~~	~~PL194~~	~~10 ha~~
Habitat for an animal that is endangered wildlife		
Hemiaspis damelii **(Grey Snake)**	PL194	~~36 ha~~ 1.3 ha
Phascolarctos cinereus **(Koala)**	PL194	145.7
Petauroides Volans **(Greater Glider)**	PL194	71.8
~~Habitat for an animal that is Special Least Concern~~		
~~*Tachyglossus aculeatus* **(Echidna)**~~	~~PL194~~	~~11.21 ha~~
~~**FISH HABITAT AREAS**~~		
~~Fish passage (not in an urban area)~~	~~PL194~~	~~1 0.25~~

9. Supporting Arrow documents

As set out in the Surat Gas Project EIS, the environmental management of Arrow's coal seam gas development is being achieved through the maintenance of its environmental management system, the integration of the environmental framework with that system and the development and implementation of environmental management plans for construction and operational activities.

9.1 Health, safety and environmental management system

Arrow maintains an integrated health, safety and environmental management system (HSEMS) based on the principles of international standard ISO 14001, Environmental Management Systems - Requirements with Guidance for Use (ISO,1996), and Australian and New Zealand standard AS/NZS 4801:2001, Occupational Health and Safety Management Systems - Specification with Guidance for Use (Standards Australia, 2001).

The HSEMS incorporates an environmental policy that sets out Arrow's approach to the management of health, safety and the environment. Arrow's environmental policy is implemented by:

- Seeking continuous improvement in managing significant environmental impacts by clearly defining objectives and targets and evaluating them through transparent review and implementation processes.
- Establishing programs to reduce environmental impacts, conserve and recycle resources, reduce waste and pollution, and improve processes to help protect the natural environment, as well as monitoring and measuring performance.
- Ensuring all activities comply with all applicable environmental laws and regulations.
- Promoting a culture in which employees and service providers are aware of environmental impacts affecting their work and promptly report any environmental impacts or incidents and that encourages improvements.

- Monitoring policy implementation at all relevant Arrow-controlled workplaces and periodically reviewing and updating.

Arrow has a good understanding of the construction, operations and maintenance activities required to produce and transport gas and to treat water. This knowledge, coupled with exploration and pilot well results, informs gas field development planning, that occurs progressively over the life of the project. A consequence of this iterative and progressive process is uncertainty about the ultimate location of production wells and facilities and pipelines, i.e., where and when development will occur.

9.2 Environmental framework

Arrow's environmental framework reduces the risk and uncertainty about potential impacts of coal seam gas development by identifying environmental constraints and proposing environmental management controls that are derived from the sensitivity of the environmental values, with more sensitive values resulting in the adoption of more stringent environmental controls.

Constraints that can be defined spatially (e.g., endangered vegetation communities) are maintained in the project geographic information system and presented in maps. These include separation distances to ensure public health and safety, particularly from air emissions, noise and hazardous facilities. The level of environmental constraint determines the types of activities permitted and the applicable environmental management measures.

Environmental management measures are incorporated in Arrow's HSEMS and provide the policy, management and audit framework for construction and operations environmental management plans. The measures include a standard operating procedure that describes the process and frequency of updates to constraints mapping, which are integral to the site and route selection standard operating procedure already being used by Arrow to plan development.

The environmental framework is an essential consideration in the planning process for coal seam gas field development. This planning process covers a range of activities which take approximately five years. The way in which the environmental framework is integrated with the planning process is set out below:

- Step 1: Analysis of geological and geophysical data to inform exploration program, including location of exploration wells. Exploration drilling program.
- Step 2: Analysis of exploration data. Installation of pilot wells to prove coal seam gas yields and coal seam gas water production.
- Step 3: Conceptual and preliminary design of gas field. Land access negotiations with landowners initiated. Consultation with landowners and key stakeholders on gas field development. Ecological and cultural heritage preconstruction clearance surveys and geotechnical investigations.
- Step 4: Detailed design of gas field and production facilities. Ongoing land access negotiations.
- Step 5: Detailed design of gas field and production facilities, revision or development of work plans, preparation of site-specific environmental management plans. Land access arrangements finalised.

9.3 Biodiversity and operational management

The HSEMS and environmental framework is supported by numerous guiding documents, including documents relevant to the management and monitoring of activities that may impact species and vegetation communities. These include:

- Operations Environmental Management Plan (ORG-ARW-AOP-PLA-00016) – this document identifies the relevant procedures and other control mechanisms that are used to minimise potential environmental impacts of production operations activities and ensures the requirements of relevant legislation are met.
- Biodiversity Standard (ORG-ARW-HSM-STA-00034) – the intent of this document is to ensure the protection of biodiversity (flora, fauna and natural habitats) in the areas in which Arrow operates in recognition of the value of healthy and functioning terrestrial and aquatic natural systems. The Standard places a responsibility on all Arrow line managers and contractors to monitor potential biodiversity impacts and controls.
- HSE Incident Management Standard (ORG-ARW-HSM-STA-00007) and the Incident Management Procedure (ORG-ARW-HSM-PRO-00089) – these documents specify the process for reporting, recording, classifying, notifying and investigating unplanned events and incidents that have resulted in damage to the environment.

Beyond the above-mentioned overarching documents, two Arrow procedures are particularly relevant:

- Ecological Impact Assessment Procedure (ORG-ARW-HSM-PRO-00070) – this document provides the step-by-step process implemented for all Arrow development activities that involve significant disturbance to land, including the requirement to record the GPS coordinates and maps of all vegetated areas that required clearing. Clearing extents will also be an input on a monthly basis into an Arrow database to track EPBC Act species and community disturbance against approved limits.
- Fauna Management Procedure (ORG-ARW-HSM-PRO-00067) – this document informs all Arrow staff and contractors of their obligations to protect and manage native fauna whilst operating on Arrow controlled works sites. It includes the requirements to:
  - Record and report all interactions with fauna to the Arrow Ecologist (notification within 24 hours using the Fauna Incident Notification (FIN) form is required for listed threatened (including EPBC Act listed species), near threatened and special least concern fauna).
  - Record and report all interactions with fauna to the regulator, under their own permit, as required (but not before reporting to the Arrow Ecologist).
  - Regularly monitor mitigation measures that have been constructed and/or implemented (e.g. fauna exclusion fences) and report their effectiveness to the Site Supervisor.

- Provide clear communications on any ongoing action requirements (e.g. monitoring and maintenance) during site handover processes, and these must be implemented, monitored and their effectiveness reported.

9.4 Water reuse and waste management

The proposed amendment will not result in any changes to how waste is managed while carrying out authorised petroleum activities. Environmental values will continue to be appropriately managed in accordance with existing management practices and relevant EA conditions.

Therefore, no separate assessment has been made of the quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity as this EA amendment does not affect the quantity of water reasonably expected to be generated under the EA.

All CSG water produced from the PL194 development area will be managed by existing infrastructure and is unaffected by the conditions and activities that are subject of this EA amendment.

Arrow will continue to evaluate potential management options for water against the Queensland Government's CSG Water Management Policy (DES, 2012) and implement Priority 1 options (beneficial reuse) wherever feasible. Where Priority 1 options are not feasible, Priority 2 options (disposal) are implemented.

Arrow has a current Water Services Agreement in place with a third party for processing, treatment, and use of produced water for the purposes of beneficial reuse. This sharing of existing infrastructure prevents Arrow needing to establish specific water management infrastructure and therefore reduces the amount of disturbance required for PL194.

This is enabled by the existing conditions of the EA and may also be addressed under the End of Waste Code – Associated Water (including coal seam gas water) (ENEW07547018), in accordance with the *Waste Reduction and Recycling Act 2011*.

With respect to waste management, Arrow's HSE Standards Compendium (ORG-ARW-HSM-STA-00001) sets out Arrow's intent and the requirements that are the responsibilities of all Line Managers and that need to be met by employees and contractors. Requirements address:

- Have processes in place that address legislative and regulatory requirements
- Risk assessments and risk controls in place ensuring risks are reduced to as low as is reasonably practicable
- Ensuring competency in all personnel carrying out waste management activities
- A management plan that identifies, documents and manages waste in manner that address the waste minimisation hierarchy
- Limiting waste disposal to appropriate government approved disposal sites.

For all Arrow operations, standard measures for minimising and managing waste include:

- Reuse (e.g., for the temporary camps (if required), pumps and tanks)
- Recycle (e.g., for steel, piping and fencing)

- Dispose (e.g., of general waste).

Arrow will continue to ensure that the proposed measures for minimising and managing waste generated by relevant activities will be in accordance with the relevant EA conditions.

9.5 Rehabilitation

Arrow will continue to rehabilitate the land subject of the application in accordance with the relevant current EA conditions and Arrow's Land Rehabilitation Procedure (ORG-ARW-HSM-PRO-00073).

Arrow's Land Rehabilitation Procedure sets out the steps to be undertaken when rehabilitating areas of disturbance resulting from Arrow's activities in order to maintain stability for its operational life (referred to as stabilisation). It also outlines rehabilitation requirements following infrastructure decommissioning, completion of exploration, appraisal and production phases or other short-term activities (referred to as final rehabilitation).

The Land Rehabilitation Procedure contains standard rehabilitation requirements and guides rehabilitation through:

- Stabilisation
- Decommissioning
- Rehabilitation.

The procedure is supported by:

- Required Administering Authority documentation
- Responsibilities for key rehabilitation-related activities
- Monitoring, compliance and assurance requirements.

The Land Rehabilitation Procedure forms part of Arrow's Land Management under the HSEMS. Supporting documents to this procedure include the Land Rehabilitation Plan, Rehabilitation Monitoring Assessment Form, Site-Specific Rehabilitation Plans and work method and instructions related to on-site disposal of residual drilling material.

The amends sought as part of this application do not alter the rehabilitation outcomes to be achieved through the EA, as currently authorised.

10. Conclusion

This report supports an application to DES to amend the EA with the proposed amendments detailed in Section 4.

In this report environmental values have been anticipated for each of the amendments and Environmental risks and likely magnitude of impacts have been assessed with appropriate management practises outlined.

This EA amendment application is necessary and desirable to enable the development of PL194. This tenure has been awarded to Arrow on the basis of commitments to the State Government. These commitments include the development of the acreage whilst achieving the purpose and principles of sustainable development.

EA Amendment Application

It should be noted that the project work and activities impacted by the proposed amendment are wholly located within the extent of PL194 boundaries and are currently addressed by the approved EA which has been de-amalgamated from EA P-EA-100464322.

The design and construction of infrastructure will continue over the life of the project and as each component is designed, site-specific impacts will need to be assessed. This process will continue to apply DES's avoid, minimise, mitigate, offset hierarchy, as reflected in the conditions of the EA and in accordance with Arrow's relevant programs, procedures, and guidelines.

11. References

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Attachment 1. – EPBC approval 2010/5344

Approval

Surat Gas Expansion Project (EPBC 2010/5344)

This decision is made under sections 130(1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

person to whom the approval is granted	Arrow Energy Pty Ltd
proponent's ABN	ABN: 73 078 521 936
proposed action	To expand coal seam gas operations in the Surat Basin, Queensland, as described in the referral received under the EPBC Act on 2 February 2010; and as described in the Surat Gas Project Environmental Impact Statement (March 2012) and Supplementary Report to the Environmental Impact Statement (June 2013).
decision	To approve the proposed action for each of the following controlling provisions: • Listed threatened species and communities (sections 18 and 18A) • Listed migratory species (sections 20 and 20A) • A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E)
Conditions of approval	This approval is subject to the conditions specified below.
expiry date of approval	This approval has effect until **31 December 2080**.

Decision-maker	Greg Hunt
name and position	The Hon Greg Hunt MP Minister for the Environment
signature	
date of decision	19:12:2013

Conditions of approval

1. The **Minister** may determine that a plan, strategy or program approved by the Queensland Government satisfies a plan required under these conditions.

Disturbance Limits

2. For the purpose of the action, the **approval holder** must not take any action outside the **project area**.
3. The action is limited to a maximum of 6,500 coal seam gas production wells and associated infrastructure.
4. The **approval holder** must not undertake hydraulic fracturing.
5. To protect **EPBC listed species** and **EPBC communities** within the **project area** the maximum disturbance limits in Table 1 apply to the project. The **approval holder** must not exceed these disturbance limits.

Table 1: Whole of project maximum disturbance limits

Terrestrial species	**Maximum disturbance (hectares) to core habitat**
Curly-bark Wattle, *Acacia curranii*	1210
Hando's Wattle, *Acacia handonis*	1210
Belson's Panic, *Homopholis belsonii*	140
Lobed Blue Grass, *Bothriochloa biloba*	305
Kogan Waxflower, *Philotheca sporadica*	480
Prostanthera sp Dunmore	380
Small-leaved Denhamia, *Denhamia parvifolia*	50
Calytrix gurulmundensis	1210
Ooline, *Cadellia pentastylis*	No disturbance
Finger Panic Grass, *Digitaria porrecta*	174
Austral Toadflax, *Thesium australe*	160
Acacia lauta	990
Cobar Greenhood Orchid, *Pterostylis cobarensis*	2 170
Xerothamnella herbacea	110
Hawkweed, *Picris evae*	120
Austral Cornflower, *Rhaponticum australe*	160
Eucalyptus virens	170
King Blue-grass, *Dichanthium queenslandicum*	160
Queensland White-gum, *Eucalyptus argophloia*	10
Macrozamia machinii	No disturbance
South-eastern Long-eared Bat, *Nyctophilus corbeni*	4 080
Dunmall's Snake, *Furina dunmalli*	4 400
Five-clawed Worm-skink, *Anomalopus mackayi*	560
Squatter Pigeon (Southern), *Geophaps scripta scripta*	3261

Regent Honeyeater, *Anthochaera phrygia*	20
Collared Delma, *Delma torquata*	90
Yakka Skink, *Egernia rugosa*	310
Australian Painted Snipe, *Rostratula australis*	5
EPBC Communities	**Maximum disturbance (hectares)**
Brigalow (*Acacia harpophylla* dominant and co-dominant)	106
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	8
Weeping Myall Woodlands	1
Natural Grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	No disturbance
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	No disturbance
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	No disturbance

6. To protect **EPBC listed species and communities** within the **project area** the maximum disturbance limits in Table 2 apply to **Stage 1**. The **approval holder** must not exceed these disturbance limits.

Table 2: Maximum disturbance limits for Stage 1

Terrestrial species	**Maximum disturbance (hectares) to core habitat**
South-eastern Long-eared Bat, *Nyctophilus corbeni*	167
Dunmall's Snake, *Furina dunmalli*	66
Five-clawed Worm-skink, *Anomalopus mackayi*	2
Squatter Pigeon (Southern), *Geophaps scripta scripta*	203
Regent Honeyeater, *Anthochaera phrygia*	1
Collared Delma, *Delma torquata*	11
Yakka Skink, *Egernia rugosa*	19
EPBC Communities	**Maximum disturbance (hectares)**
Brigalow (*Acacia harpophylla* dominant and co-dominant)	39
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	8

EPBC Species Impact Management and Offset Plan

EPBC Species Impact Management and Offset Plan – Stage 1

7. An EPBC Species Impact Management and Offset Plan for **Stage 1** must be submitted for approval of the **Minister** at least 3 months prior to **commencement**, and must include:

    (a) measures to report the methodology and results of **pre-clearance surveys,** and quantification of actual impacts, in the annual reporting required by condition 28. **Pre-clearance surveys** must be undertaken in accordance with the **Department's survey guidelines** in effect at the time of the survey or other survey methodology approved by the **Department** in writing;

(b) a map of the location of each **EPBC listed threatened species** and its habitat or **EPBC community** in relation to infrastructure and proposed disturbance for **Stage 1**;

(c) potential threats and **impacts** to **EPBC listed species** and **EPBC communities** from **Stage 1**;

(d) a description of the measures that will be taken to avoid, mitigate and manage **impacts** to the **EPBC listed species** and its habitat, including to the **Murray Cod** and **Fitzroy River Turtle,** or an **EPBC community**;

(e) measures to report to the **Department** on the occurrence and circumstances of **EPBC listed species** deaths as a result of the action and actions taken to reduce the likelihood of any such circumstance reoccurring;

(f) a monitoring program to determine the success of mitigation and management measures and inform the next Stage of the EPBC Species Impact Management and Offset Plan to ensure adaptive management for the duration of the project approval;

(g) a discussion of relevant **conservation advice**, **recovery plans** and **threat abatement plans** and how the EPBC Species Impact Management and Offset Plan - **Stage 1** is consistent with these documents;

(h) details of the following minimum offset areas for **Stage 1** including, for each area, the location, tenure, site description and map of environmental values:

i. 112 hectares for Brigalow (*Acacia harpophylla* dominant and co-dominant);

ii. 30 hectares Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions;

iii. 80 hectares for Yakka Skink, *Egernia rugosa*;.

iv. 42 hectares for Collared Delma, *Delma torquata*;

v. 230 hectares for Dunmall's Snake, *Furina dunmalli*;

vi. 545 hectares for Squatter Pigeon (Southern), *Geophaps scripta scripta*;

vii. 6.5 hectares for Five-clawed Worm-skink, *Anomalopus mackayi*;

viii. 4 hectares for Regent Honeyeater, *Anthochaera phrygia*; and

ix. 765 hectares for South-eastern Long-eared Bat, *Nyctophilus corbeni*.

(i) a process for any significant **impact** to an **EPBC listed species** or **EPBC community** for **Stage 1**, where the species or community is not identified in Table 2, to be offset in accordance with the **EPBC Act Offsets Policy**;

(j) an offset area management plan for each offset area, which sets out management measures that will be implemented to improve the offset site for the respective **EPBC species** and/or **EPBC community**; and

(k) a timeline for when actions identified in the EPBC Species Impact Management and Offset Plan will be implemented and for legally securing offsets including, for each area, the proposed legal mechanism for securing the offset. Offsets for **Stage 1** must be legally secured prior to **commencement** of **Stage 2**.

8. The EPBC Species Impact Management and Offset Plan for **Stage 1** must be peer reviewed by a **suitably qualified ecologist** approved by the **Minister** in writing. The peer review must be submitted to the **Minister** together with the EPBC Species Impact Management and Offset Plan for **Stage 1** and a statement from the **suitably qualified ecologist** stating that they carried out the peer review and endorse the findings of the peer review.

9. The **approval holder** must not **commence** the action until the EPBC Species Impact Management and Offset Plan for **Stage 1** has been approved by the **Minister** in writing.

EPBC Species Impact Management and Offset Plan – Stages 2 to 4

10. The **approval holder** must update the EPBC Species Impact Management and Offset Plan for the next **development stage** (i.e. **Stage 2, Stage 3** and **Stage 4**) and submit for approval of the **Minister** at least 3 months prior to **commencement** of each **development stage**. Each updated plan must include:

    (a) the information required for the EPBC Species Impact Management and Offset Plan in conditions 7 (a) to (g) and conditions 7 (j) and 7 (k) for the respective **development stage**;

    (b) where **impacts** are unavoidable, an offset strategy to compensate for residual **impacts** to each **EPBC species** or **EPBC community** for that **development stage** in accordance with the **EPBC Act Offsets Policy**. The offset strategy must:

        i. demonstrate how the offset builds on offsets secured as part of the EPBC Species Impact Management and Offset Plan – **Stage 1** and any other **development stage** and, where possible, will contribute to a larger strategic offset for whole of project **impacts**;

        ii. identify land (including a map, site description and shapefile) that has or will be acquired and how it has been or will be legally secured;

        iii. include a detailed discussion of the quality, condition, site context and environmental values of the impact and offset site relevant to the **EPBC species** or **EPBC community** being offset;

        iv. include a description of potential risks to successful implementation of the offset, including a description of contingency measures that would be implemented to mitigate against these risks; and

        v. discuss connectivity of the offset area with other habitats and biodiversity corridors.

    (c) a reconciliation of **impacts** against whole of project disturbance limits. To incentivise avoidance, the **approval holder** is only required to offset realised **impacts**. Where the full **impact** from **Stage 1, Stage 2** or **Stage 3** that has been offset is not realised, the balance of the offset can be transferred to a future offset liability for a future **development stage** for this project.

11. The updated EPBC Species Impact Management and Offset Plan for each **development stage** must be peer reviewed by a **suitably qualified ecologist** approved by the **Minister** in writing. The peer review must be submitted to the **Minister** together with the EPBC Species Impact Management and Offset Plan for each **development stage** and a statement from the **suitably qualified ecologist** stating that they carried out the peer review and endorse the findings of the peer review.

12. The **approval holder** must not **commence Stage 2, Stage 3** or **Stage 4** until the EPBC Species Impact Management and Offset Plan for that **development stage** has been approved by the **Minister** in **writing**. The approved EPBC Species Impact Management and Offset Plan for each **development stage** must be implemented.

Note 1: The Minister may determine that a plan, strategy or program approved by the Queensland Government satisfies the requirements for the EPBC Species Impact Management and Offset Plan under these conditions.

Note 2: Offsets for some species may be accommodated within ecological communities or overlap State approval requirements or other species habitat requirements, as long as they meet the requirements of these conditions of approval in respect of each individual species being offset.

Coal Seam Gas Water Monitoring and Management Plan

Stage 1 CSG Water Monitoring and Management Plan

13. Prior to **commencement**, the proponent must submit a Stage 1 Coal Seam Gas Water Monitoring and Management Plan (Stage 1 CSG WMMP) for the approval of the **Minister,** who may seek the advice of an **expert panel**. The Stage 1 CSG WMMP must include:

    (a) an analysis of the results of the most recent **OGIA model** (built or endorsed by **OGIA**), relevant to all of the project's tenement areas;

    (b) a fit for purpose numerical simulation to assess potential impacts on water resources arising from the action in the project area, subsequent surface water-groundwater interactions in the Condamine Alluvium and impacts to dependent ecosystems;

    (c) an assessment of potential **impacts** from the action on non-spring based groundwater dependent ecosystems through potential changes to surface-groundwater connectivity and interactions with the sub-surface expression of groundwater;

    (d) an assessment of predicted project wide groundwater drawdown levels and pressures from the action, together with confidence levels;

    (e) parameters and a sampling regime to establish baseline data for surface and groundwater resources that may be impacted by the action, including: surface water quality and quantity in the **project area**, and upstream and downstream of potential impact areas; groundwater quality, levels and pressures for areas that may be **impacted** by the project; and for determining connectivity between surface water and groundwater that may be **impacted** by the project;

    (f) a best practice baseline monitoring network that will enable the identification of spatial and temporal changes to surface water and groundwater. This must include a proposal for aquifer connectivity studies and monitoring of relevant aquifers to determine hydraulic connectivity (including potential groundwater dependence of Long Swamp and Lake Broadwater) and must also enable monitoring of all aquatic ecosystems that may be **impacted** by the action;

    (g) a program to monitor subsidence **impacts** from the action, including trigger thresholds and reporting of monitoring results in annual reporting required by condition 28. If trigger thresholds are exceeded, the **approval holder** must develop and implement an action plan to address impacts within 90 calendar days of a trigger threshold being exceeded;

    (h) provisions to make monitoring results publicly available on the **approval holder's** website to facilitate a greater understanding of cumulative **impacts**;

    (i) a discussion on how the **approval holder** is contributing to the **Joint Industry Plan,** including its periodic review. The **approval holder** must contribute to the **Joint Industry Plan** and comply with any part of the **Joint Industry Plan**, or future iterations of the **Joint Industry Plan**, that applies to the **approval holder**;

    (j) a groundwater early warning monitoring system, including:

        i. groundwater drawdown limits for all consolidated aquifers potentially impacted by the action, excluding the Walloon Coal Measures;

        ii. for the Condamine Alluvium, appropriate triggers and groundwater limits and a rationale for their selection;

        iii. early warning indicators and trigger thresholds, including for Lake Broadwater, Long Swamp and other groundwater dependent ecosystems that may potentially be impacted by the action, including

those that may occur outside the **project area** and may be impacted by the action; and

iv. investigation, management and mitigation actions, including substitution and/or groundwater repressurisation, for both early warning indicators and trigger thresholds to address flux impacts on the Condamine Alluvium.

(k) early warning indicators and trigger thresholds, including corrective actions for both early warning indicators and trigger thresholds, for aquatic ecology and aquatic ecosystems;

(l) a CSG water management strategy for produced salt/brine, which discusses how co-produced water and brine will be managed for the action, including in the context of other coal seam gas activities in the Surat Basin;

(m) an analysis of how the **approval holder** will utilise beneficial use and/or groundwater repressurisation techniques to manage produced CSG water from the action, and how any potential adverse **impacts** associated with groundwater repressurisation will be managed;

(n) a discharge strategy, consistent with the recommendations and requirements of the Department of the Environment and Heritage Protection in its **Assessment Report** (pages 94 to 95 and pages 254 to 255) and that includes scenarios where discharge may be required, the quality of discharge water (including water treated by reverse osmosis), the number and location of monitoring sites (including upstream and downstream sites), frequency of monitoring and how the data from monitoring will be analysed and reported, including recommendations on any changes or remedial actions that would be required;

(o) a flood risk assessment for processing facilities and any raw co-produced water and brine dams, which addresses flood risks to the environment from the action in the case of a 1:1000 ARI event. The risk assessment should estimate the consequences if major project infrastructure was subject to such an event, including release of brine and chemicals into the environment;

(p) a cumulative **impact** assessment based on the outputs of the **OGIA model** which integrates groundwater model outputs with known and potential groundwater dependent ecosystems and presents the outputs in map form. Contribute to investigations coordinated through the OGIA to assess hydrological and ecological characteristics of **impacted** groundwater dependent ecosystems;

(q) details of performance measures; annual reporting to the **Department**; and publication of reports on the internet; and

(r) an explanation of how the Stage 1 CSG WMMP will contribute to work undertaken by other CSG proponents in the Surat Basin to understand cumulative **impacts**, including at the local and regional scale, and maximise environmental benefit.

14. The Stage 1 CSG WMMP must be peer reviewed by a **suitably qualified water resources expert/s** approved by the **Minister** in writing. The peer review must be submitted to the **Minister** together with the Stage 1 CSG WMMP and a statement from the **suitably qualified water resources expert/s** stating that they carried out the peer review and endorse the findings of the Stage 1 CSG WMMP.

15. The **approval holder** must not exceed the groundwater drawdown or groundwater limits for each aquifer specified in the Stage 1 CSG WMMP.

16. Unless otherwise agreed in writing by the **Minister**, the **approval holder** must not **commence** the action until the Stage 1 CSG WMMP is approved in writing by the **Minister**. The approved Stage 1 CSG WMMP must be implemented.

Note 3: to ensure efficiency the approval holder may prepare and align the Stage 1 WMMP with the requirements of the Queensland Government, as long as the relevant matters under the conditions of this approval are clearly and adequately addressed.

Stage 2 CSG Water Monitoring and Management Plan

17. Prior to **Stage 2** the **approval holder** must submit a Stage 2 Coal Seam Gas Water Monitoring and Management Plan (Stage 2 CSG WMMP) to the **Minister** for approval, who may seek the advice of an **expert panel.** The Stage 2 CSG WMMP must:

    (a) include all matters in the Stage 1 CSG WMMP, and discuss how the Stage 1 CSG WMMP is informing adaptive management for the Stage 2 CSG WMMP;

    (b) include any updated modelling for the project, including in respect of the **OGIA model** or any updates to the **OGIA model** by **OGIA**;

    (c) include an explanation of how the **approval holder** will contribute to the **Condamine Interconnectivity Research Project**. The Stage 2 CSG WMMP must present the findings of the Condamine Interconnectivity Research project and any modelling done by the **OGIA** to validate predicted drawdown and a review of trigger thresholds and corrective actions for the action;

    (d) report on the potential for flow reversal from the Condamine Alluvium to underlying aquifers, based on data obtained during the Stage 1 CSG WMMP;

    (e) review and update the monitoring network in Stage 1 WMMP to reflect changes in understanding of **impacts** to water resources, including from baseline monitoring and relevant research;

    (f) identify any predicted changes in stream connectivity due to groundwater drawdown from the action and assess potential impacts to groundwater dependent ecosystems due to any predicted changes in stream connectivity, including to water quality, quantity and ecology;

    (g) address any uncertainty in the groundwater-dependency of ecosystems and springs with supporting evidence from field-based investigations for any groundwater-dependent ecosystems and springs confirmed in the **OGIA model**;

    (h) provide details of an ongoing monitoring plan that:

        i. sets out the frequency of monitoring and rationale for the frequency;

        ii. includes continued collection of baseline data for each monitoring site over the life of the project;

        iii. outlines the approach to be taken to analyse the results including the methods to determine trends to indicate potential **impacts**; and

        iv. builds on the groundwater early warning system required at condition 13 (j) and sets out early warning indicators and trigger thresholds and limits for groundwater and surface water.

    (i) include a risk based exceedance response plan that details the actions the **approval holder** will take and the timeframes in which those actions will be undertaken if: early warning indicators and trigger threshold values contained in the Stage 2 CSG WMMP are exceeded, or there are any emergency discharges.

18. The Stage 2 CSG WMMP must be peer reviewed by a **suitably qualified water resources expert/s** approved by the **Minister** in writing. The peer review must be submitted to the **Minister** together with the Stage 2 CSG WMMP and a statement from the **suitably qualified water resources expert/s** stating that they carried out the peer review and endorse the findings of the Stage 2 CSG WMMP.

19. The **approval holder** must not exceed the groundwater drawdown or groundwater limits specified in the Stage 2 CSG WMMP.

20. The **Minister** may direct in writing that the **approval holder** cease water/gas extraction and/or water discharge or use if an early warning indicator, trigger threshold or limit is exceeded, and if the **Minister** is not satisfied that the action proposed or taken by the proponent will remedy the situation. The **Minister** may direct the proponent to implement alternative action at the expense of the proponent.

Note 4: The proponent will be provided with a reasonable opportunity to comment on any such direction before it is required to be implemented.

21. Unless otherwise agreed by the **Minister** in writing, the Stage 2 CSG WMMP must be approved in writing by the **Minister** prior to first extraction of gas. The approved Stage 2 CSG WMMP must be implemented. The Stage 1 CSG WMMP will apply until the commencement of the approved Stage 2 CSG WMMP.

Note 5: to ensure efficiency the approval holder may prepare and align the Stage 2 WMMP with the requirements of the Queensland Government, as long as the relevant matters under the conditions of this approval are clearly and adequately addressed.

Revision of the Stage 2 CSG WMMP

22. To ensure an adaptive management approach, the proponent must submit periodic revisions of the Stage 2 CSG WMMP for approval by the **Minister** in writing, who may seek the advice of an **expert panel**. Revisions must be submitted at least 3 months prior to planned **commencement** of each new **development stage** for the project. The revised CSG WMMP must take into account outcomes of the ongoing monitoring program in the Stage 2 CSG WMMP, groundwater model updates and any bioregional assessments.

23. If the **OGIA model** ceases to exist, then the **approval holder** must submit an alternate model to be used for the purpose of these conditions that replaces the **OGIA model** as referred to in these conditions. The alternate model must be approved by the **Minister** in writing before the next relevant stage of the CSG WMMP is submitted to the **Minister** for approval.

24. The **approval holder** must not **commence Stage 3** or **Stage 4** until a revised Stage 2 CSG WMMP is approved in writing by the **Minister** for that **development stage.** The approved revised Stage 2 CSG WMMP must be implemented.

25. The **Minister** may, by written request to the **approval holder**, require the Stage 1 or Stage 2 CSG WMMP to be revised, including to address expert advice. Any request must be acted on by the **approval holder** within the timeframe specified in the request.

Note 6: The Minister may throughout the life of the project life seek advice from experts, or an expert panel. As a consequence specific matters identified through such advice may need to be addressed in the CSG WMMP Plan. Where such advice is sought the approval holder would be provided with opportunity to submit information and respond to the specific matters identified, in order to ensure the CSG WMMP Plan is based on the best available information. Review requirements will facilitate adaptive management, align with Queensland Government approval requirements, and account for potential cumulative impacts as new scientific information becomes available over the life of the project.

General

26. Within 20 business days after the **commencement** of the action, the **approval holder** must advise the **Department** in writing of the actual date of **commencement.**

27. The **approval holder** must maintain accurate records substantiating all activities associated with or relevant to the conditions of approval, including measures taken to implement the management plans, reports or strategies required by this approval, and make them available upon request to the **Department**. The annual report (condition 28) must state all confirmed cases of non-compliance along with details of any remedial actions. Such records may be subject to audit by the **Department** or an independent auditor in accordance with section 458 of the **EPBC Act,** or used to verify compliance with the conditions of approval. Summaries of audits will be posted on the **Department's** website. The results of audits may also be publicised through the general media.

28. Within three months of every 12 month anniversary of the **commencement** of the action, the **approval holder** must publish a report on its website for the life of the approval outlining how they have been compliant with the conditions of this approval over the previous 12 months, including implementation of any management plans as specified in the conditions. The **approval holder** must also report against disturbance limits. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the **Department** at the same time as the compliance report is published.

29. The **approval holder** must notify the **Department** in writing of potential non-compliance with any condition of this approval as soon as practical and within no later than ten business days of becoming aware of the potential non-compliance. The notice provided to the **Department** under this condition must specify:

    a) the condition which the **approval holder** has potentially breached;

    b) the nature of the potential non-compliance;

    c) when and how the **approval holder** became aware of the non-compliance;

    d) how the non-compliance will affect the approved action;

    e) how the non-compliance will affect the anticipated **impacts** of the approved action, in particular how the non-compliance will affect the **impacts** on the matters of national environmental significance;

    f) the measures the approval holder will take to address the **impacts** of the non-compliance on the matters of national environmental significance and rectify the non-compliance; and

    g) the time by when the approval holder will rectify the non-compliance.

30. Upon the direction of the **Minister**, the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor must be approved by the **Minister** prior to the commencement of the audit. Audit criteria must be agreed to by the **Minister** and the audit report must address the criteria to the satisfaction of the **Minister.**

31. If the **approval holder** wishes to carry out any activity other than in accordance with the management plans as specified in the conditions, the **approval holder** must submit to the **Department** for the **Minister's** written approval a revised version of that management plan. The approval holder must not **commence** the varied activity until the **Minister** has approved the varied management plan. The **Minister** will not approve a varied management plan unless the revised management plan would result in an equivalent or improved environmental outcome over time. If the **Minister** approves the revised management plan, that management plan must be implemented in place of the management plan originally approved.

32. If the **Minister** believes that it is necessary or convenient for the better protection of listed threatened species, listed migratory species or water resources to do so, the **Minister**

may request that the **approval holder** make specified revisions to the management plans specified in the conditions and submit the revised management plan for the **Minister's** written approval. The **approval holder** must comply with any such request within the timeframe specified by the **Minister**. The revised approved management plan must be implemented. Unless the **Minister** has approved the revised management plan, then the person taking the action must continue to implement the management plan originally approved, as specified in the conditions.

33. If, at any time after five years from the date of this approval, the **approval holder** has not **commenced** the action, then the **approval holder** must not **commence** the action without the written agreement of the **Minister.**

34. Unless otherwise agreed to in writing by the **Minister**, the **approval holder** must publish all management plans referred to in these conditions of approval on their website. Each management plan must be published on the website within 1 month of being approved and remain available on that website for the life of the approval.

Definitions

Approval holder: means the person to whom the approval is granted.

Assessment Report: means the Queensland Department of Environment and Heritage Protection's report under the *Environmental Protection and Biodiversity Conservation Act 1994* for the action.

Commenced/commencement: means any physical disturbance, including clearance of native vegetation, new road work and the establishment of well sites to develop the gas field project area. Commencement does not include:

a) minor physical disturbance necessary to undertake pre-clearance surveys or establish monitoring programs or geotechnical investigations; or

b) activities that are critical to commencement that are associated with mobilisation of plant and equipment, materials, machinery and personnel prior to the start of development only if such activities will have no adverse impact on matters of national environmental significance, and only if the proponent has notified the Department in writing before an activity is undertaken.

Core habitat: means core habitat known and core habitat possible as defined in the rules for habitat mapping for each individual species in the *Supplementary Report to the Surat Gas Project EIS (March 2012), Attachment 1 – Matters of National Environmental Significance.*

Conservation advice: means an approved conservation advice under the EPBC Act for an EPBC Act listed species or community.

Core habitat known: means 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 the Queensland Department of Environment and Heritage Protection (or successor agency) or high resolution habitat mapping developed for a specific purpose. Core habitat known also means a 1 km buffer around all spatially accurate (< 400 metres accuracy) species records.

Condamine Interconnectivity Research Project: means the Condamine Interconnectivity Research Project being undertaken by the Queensland Office of Groundwater Impact Assessment as part of the implementation of the Surat Underground Water Impact Report (UWIR), which was prepared by the Queensland Water Commission (QWC) in 2012.

Core habitat possible: means an area where 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.

Department: means the Australian Government Department administering the *Environment Protection and Biodiversity Conservation Act 1999*.

Department's survey guidelines: means:
Matters of National Environmental Significance, Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999 - http://www.environment.gov.au/epbc/publications/nes-guidelines.html.

Survey Guidelines for Australia's Threatened Frogs, Threatened Birds, Threatened Fish, Threatened Mammals, Threatened Reptiles and Threatened Bats: http://www.environment.gov.au/epbc/guidelines-policies.html.

Development stage: means Stage 1, Stage 2, Stage 3 or Stage 4 of project development, as defined in these definitions.

EPBC/ EPBC Act: means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).

EPBC Act Offsets Policy: means the *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (October 2012) including the Offsets Assessment Guide.

EPBC community: means an endangered ecological community listed under the EPBC Act.

EPBC listed threatened species: means a threatened flora or fauna species listed under the EPBC Act.

Expert panel: means an expert panel appointed by the Minister.

Fitzroy River Turtle: means the Fitzroy River Turtle, *Rheodytes leukops*, listed as vulnerable under the EPBC Act.

General habitat: means 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

Impact: has the definition assigned to it in section 527E of the EPBC Act.

Joint Industry Plan: means the *Joint Industry Plan for an Early Warning System for the Monitoring and Protection of EPBC Springs* established with other coal seam gas proponents operating within the Surat Cumulative Management Area.

Minister: means the Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* and includes a delegate of the Minister.

Murray Cod: means the Murray Cod, *Maccullochella peelii*, listed as vulnerable under the EPBC Act.

OGIA: means the Office of Groundwater Impact Assessment or its successor body,

OGIA model: means the groundwater model developed by the Office of Groundwater Impact Assessment, or its successor body, for the Surat Cumulative Management Area.

Pre-clearance surveys: means surveys that are undertaken for EPBC species and EPBC communities for all areas of the project area that may be disturbed by project activities.

Project area: means the area identified as the project area in Attachment A.

Recovery plan: means an approved recovery plan under the EPBC Act for an EPBC listed species or EPBC community.

Stage 1: means year 1 to 3 (inclusive) of the action, starting at the date of commencement.

Stage 2: means year 4 to 11 (inclusive) of the action.

Stage 3: means year 12 to 20 (inclusive) of the action

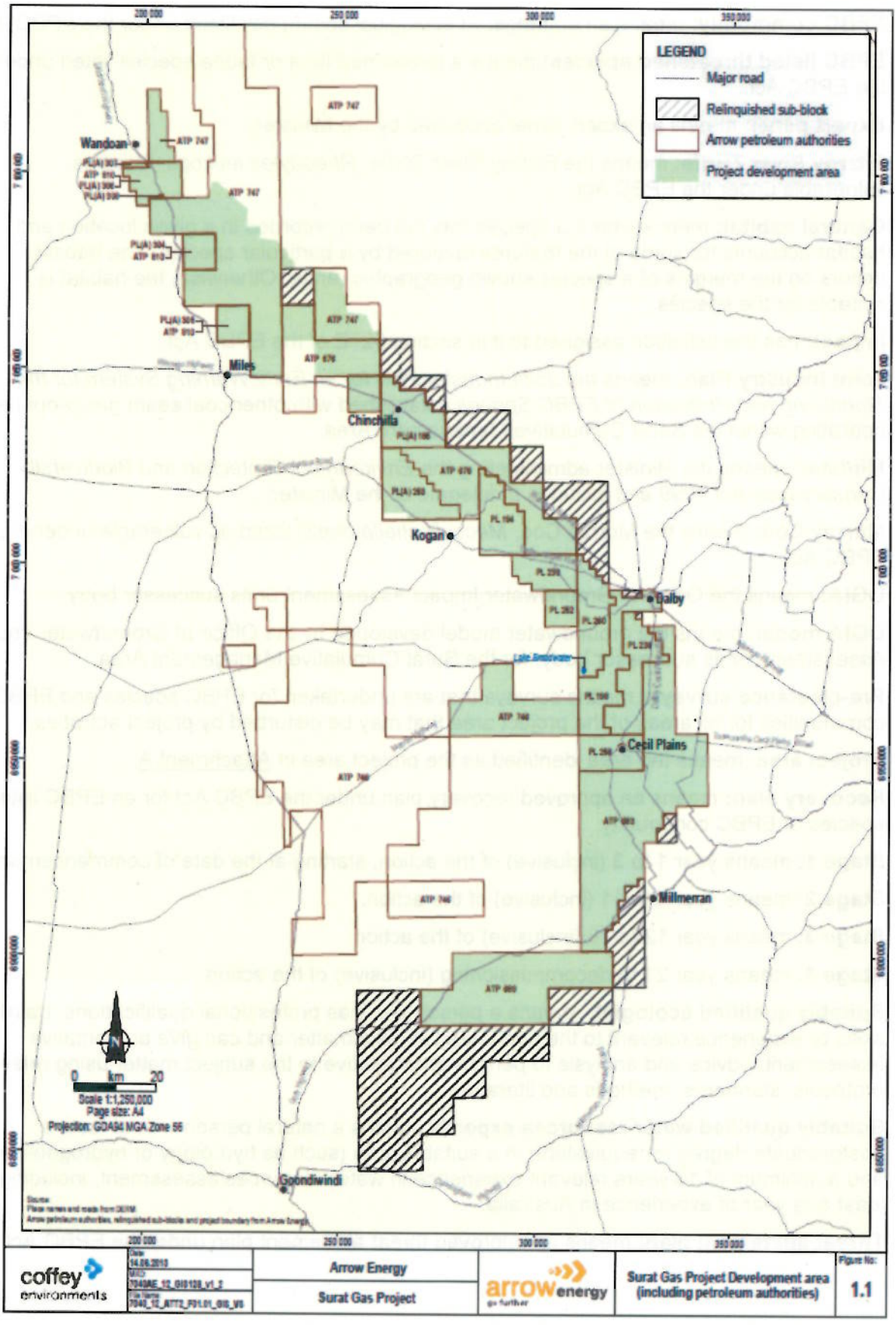
Stage 4: means year 21 to decommissioning (inclusive) of the action.

Suitably qualified ecologist: means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis to performance relative to the subject matter using relevant protocols, standards, methods and literature.

Suitably qualified water resources expert/s: means a natural person with at least a postgraduate degree (or equivalent) in a suitable area (such as hydrology or hydrogeology) and a minimum of 10 years relevant experience in water resources assessment, including at least one year of experience in Australia.

Threat abatement plan: means an approved threat abatement plan under the EPBC Act.

ATTACHMENT A



Attachment 2. – LFC Tool Logfiles

Department of Environment and Heritage Protection (DEHP)
Landscape Fragmentation and Connectivity (LFC) Tool version 1.4 LOGFILE
Process started at 09-08-2023 01:29:18 PM
Python version: 2.7.18 (v2.7.18:8d21aa21f2, Apr 20 2020, 13:19:08) [MSC v.1500 32 bit (Intel)]
Arcpy version: 10.8.1
Username: tstringer

INPUT PARAMETERS
Output Workspace: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\OutputGov
Threshold lookup table:
R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\LFC_data.gdb\tbl_Regional_frag_local_threshold
Remnant cover layer:
R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\LFC_data.gdb\Surat_Regulated_Veg_Man_230809
Remnant cover layer edited: False
Regional buffer extent: 20 kilometres
Local buffer extent: 5 kilometres
Impact layer: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Disturbance\New File Geodatabase.gdb\Disturbance3
layer projection: GCS_GDA_1994
Raster cell resolution for analysis: 10 metres
Edge Width: 50 metres
(The distance from non-remnant landscapes through to the core ecosystem - the edge of remnant ecosystems)
Default projection: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\scripts\QLD Albers Equal Area Conic.prj

13:29:19 Checking out the spatial analyst tool - required for LFC

13:29:19 _____BEGINNING LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____

13:29:19 This tool will categorise the landscape into:
{0: 'non-rem', 1: 'patch', 2: 'edge', 3: 'perforated', 4: 'core (< 100 hectares)', 5: 'core (100-500 hectares)', 6: 'core (> 500 hectares)', 7: 'water'}

13:29:27 R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\OutputGov\lyr_file does not exist, creating it now.
13:29:27 Copying across impact site feature(s) and calculating area in hectares (AreaHA)
13:29:33 Making a local copy of the impact site
13:29:38 Preparing remnant cover layer for analysis
13:29:40 Created regional scale buffer of 20 kilometres
13:29:43 Created local scale buffer of 5 kilometres
13:29:52 Clipped the remnant cover to the regional buffer extent
13:29:54 Unioned the pre impact remnant layer with the impact site
13:29:57 Attributed the impact area as not RVM Cat B
13:29:57 Area of RVM Cat B clearing is 98.98 hectares
13:29:57 SQL selection used is "RVM_CAT" = 'B' and "Cover" = 'Not RVM Cat B' on shapefile R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\OutputGov\main_output\clip_remcover_post.shp

13:29:59 Categorised the cover attributes in clip_remcover_pre.shp ready for raster conversion

13:30:33 Converted clip_remcover_pre.shp to raster

13:30:35 Categorised the cover attributes in clip_remcover_post.shp ready for raster conversion
13:31:08 Converted clip_remcover_post.shp to raster

13:31:08 Run Landscape fragmentation analysis on the pre impact regional landscape

REGULATED VEGETATION TYPES BEING EXTRACTED FROM LAND COVER
IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS
COMBINING FRAGMENTATION CLASSES
CLASSIFYING CORE FOREST PATCHES BY AREA
COMPOSING FINAL FRAGMENTATION MAP
COMPOSING FINAL FRAGMENTATION MAP
(FRAGMENTATION CALCULATION TIME WAS 10.1 MINUTES)

13:41:13 Run Landscape fragmentation analysis on the post impact regional landscape

REGULATED VEGETATION TYPES BEING EXTRACTED FROM LAND COVER
IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS
COMBINING FRAGMENTATION CLASSES
CLASSIFYING CORE FOREST PATCHES BY AREA
COMPOSING FINAL FRAGMENTATION MAP
COMPOSING FINAL FRAGMENTATION MAP
(FRAGMENTATION CALCULATION TIME WAS 9.4 MINUTES)

Extracting a local subset of lfc_regional_pre_impact
Extracting a local subset of lfc_regional_post_impact

Collating pre and post impact statistics and trigger assessment
13:51:20 Summarising area statistics for: lfc_localmsk_pre_impact
13:51:20 Summarising area statistics for: lfc_localmsk_post_impact
13:51:21 Summarising area statistics for: lfc_regional_pre_impact
13:51:22 Summarising patch count for lfc_localmsk_pre_impact
13:51:39 Summarising patch count for lfc_localmsk_post_impact

Analysing impact on Connectivity Areas

SIGNIFICANCE TEST ONE

The regional total area is 195030.77
The regional extent of core remnant is 48428.28
The regional extent of core remnant is 24.83 percent
This level of regional fragmentation sets a local impact threshold of: 5.0 percent

The table below lists the local impact thresholds for categories of regional core remnant extent:

REGIONAL CORE CATEGORY	LOCAL IMPACT THRESHOLD
< 10	2.0
10 - 30	5.0
30 - 50	10.0
50 - 70	20.0
70 - 90	30.0
>90	50.0

Area of core at the local scale (pre impact): 11265.8
Area of core at the local scale (post impact): 10875.07
Percent change of core at the local scale (post impact): 3.47 percent

SIGNIFICANCE TEST TWO

The number of core remnant areas occurring on the site: 2
The number of core remnant areas remaining on the site post impact: 2
(Only core polygons greater than or equal to 1 hectare are included)

RESULT

13:52:13 This analysis has determined any impact on connectivity areas is NOT significant
(A significant reduction in core remnant at the local scale is False OR a change from core to non-core remnant at the site scale is False)

The significance table has been written to: ..\main_output\lfc_significance_assessment.csv
The local scale summary table has been written to: ..\main_output\lfc_local_scale_summary.csv
The site scale summary table has been written to: ..\main_output\lfc_site_scale_summary.csv
GIS layer files copied into folder \lyr_file within the project folder.
View layers in ArcMAP
using..\R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Govdata\OutputGov\lyr_file\lyr_file\Connectivity Area Impact Assessment.lyr

Please scrutinise the output tables and spatial layers to confirm the desktop modelling of connectivity area impact

This analysis used an unedited copy of the Regulated Vegetation layer.

13:59:01 _____COMPLETED LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____

Department of Environment and Heritage Protection (DEHP)
Landscape Fragmentation and Connectivity (LFC) Tool version 1.4 LOGFILE
Process started at 09-08-2023 09:07:21 PM
Python version: 2.7.18 (v2.7.18:8d21aa21f2, Apr 20 2020, 13:19:08) [MSC v.1500 32 bit (Intel)]
Arcpy version: 10.8.1
Username: tstringer

INPUT PARAMETERS
Output Workspace: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\OutputArrow2
Threshold lookup table:
R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\LFC_data.gdb\tbl_Regional_frag_local_threshold
Remnant cover layer:
R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\LFC_data.gdb\ArrowGovVeg_230809
Remnant cover layer edited: True
Regional buffer extent: 20 kilometres
Local buffer extent: 5 kilometres
Impact layer: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Disturbance\New File Geodatabase.gdb\Disturbance3
layer projection: GCS_GDA_1994
Raster cell resolution for analysis: 10 metres
Edge Width: 50 metres
(The distance from non-remnant landscapes through to the core ecosystem - the edge of remnant ecosystems)
Default projection: R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\scripts\QLD Albers Equal Area Conic.prj

21:07:22 Checking out the spatial analyst tool - required for LFC

21:07:22 _____BEGINNING LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____

21:07:22 This tool will categorise the landscape into:
{0: 'non-rem', 1: 'patch', 2: 'edge', 3: 'perforated', 4: 'core (< 100 hectares)', 5: 'core (100-500 hectares)', 6: 'core (> 500 hectares)', 7: 'water'}

21:07:31 R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\OutputArrow2\lyr_file does not exist, creating it now.
21:07:31 Copying across impact site feature(s) and calculating area in hectares (AreaHA)
21:07:37 Making a local copy of the impact site
21:07:44 Preparing remnant cover layer for analysis
21:07:46 Created regional scale buffer of 20 kilometres
21:07:49 Created local scale buffer of 5 kilometres
21:08:08 Clipped the remnant cover to the regional buffer extent
21:08:12 Unioned the pre impact remnant layer with the impact site
21:08:19 Attributed the impact area as not RVM Cat B
21:08:19 Area of RVM Cat B clearing is 72.16 hectares
21:08:19 SQL selection used is "RVM_CAT" = 'B' and "Cover" = 'Not RVM Cat B' on shapefile R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\OutputArrow2\main_output\clip_remcover_post.shp

21:08:23 Categorised the cover attributes in clip_remcover_pre.shp ready for raster conversion
21:09:01 Converted clip_remcover_pre.shp to raster

21:09:06 Categorised the cover attributes in clip_remcover_post.shp ready for raster conversion
21:09:48 Converted clip_remcover_post.shp to raster

21:09:48 Run Landscape fragmentation analysis on the pre impact regional landscape

REGULATED VEGETATION TYPES BEING EXTRACTED FROM LAND COVER
IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS
COMBINING FRAGMENTATION CLASSES
CLASSIFYING CORE FOREST PATCHES BY AREA
COMPOSING FINAL FRAGMENTATION MAP
COMPOSING FINAL FRAGMENTATION MAP
(FRAGMENTATION CALCULATION TIME WAS 10.4 MINUTES)

21:20:16 Run Landscape fragmentation analysis on the post impact regional landscape

REGULATED VEGETATION TYPES BEING EXTRACTED FROM LAND COVER
IDENTIFICATION OF CORE, PATCH, EDGE AND PERFORATIONS
COMBINING FRAGMENTATION CLASSES
CLASSIFYING CORE FOREST PATCHES BY AREA
COMPOSING FINAL FRAGMENTATION MAP
COMPOSING FINAL FRAGMENTATION MAP
(FRAGMENTATION CALCULATION TIME WAS 9.6 MINUTES)

Extracting a local subset of lfc_regional_pre_impact
Extracting a local subset of lfc_regional_post_impact

Collating pre and post impact statistics and trigger assessment
21:30:35 Summarising area statistics for: lfc_localmsk_pre_impact
21:30:35 Summarising area statistics for: lfc_localmsk_post_impact
21:30:36 Summarising area statistics for: lfc_regional_pre_impact
21:30:38 Summarising patch count for lfc_localmsk_pre_impact
21:30:55 Summarising patch count for lfc_localmsk_post_impact

Analysing impact on Connectivity Areas

SIGNIFICANCE TEST ONE

The regional total area is 195030.76
The regional extent of core remnant is 44157.38
The regional extent of core remnant is 22.64 percent
This level of regional fragmentation sets a local impact threshold of: 5.0 percent

The table below lists the local impact thresholds for categories of regional core remnant extent:

REGIONAL CORE CATEGORY	LOCAL IMPACT THRESHOLD
< 10	2.0
10 - 30	5.0
30 - 50	10.0
50 - 70	20.0
70 - 90	30.0
>90	50.0

Area of core at the local scale (pre impact): 8665.6

Area of core at the local scale (post impact): 8439.3
Percent change of core at the local scale (post impact): 2.61 percent

SIGNIFICANCE TEST TWO

The number of core remnant areas occurring on the site: 8
The number of core remnant areas remaining on the site post impact: 8
(Only core polygons greater than or equal to 1 hectare are included)

RESULT

21:31:29 This analysis has determined any impact on connectivity areas is NOT significant
(A significant reduction in core remnant at the local scale is False OR a change from core to non-core remnant at the site scale is False)

The significance table has been written to: ..\main_output\lfc_significance_assessment.csv
The local scale summary table has been written to: ..\main_output\lfc_local_scale_summary.csv
The site scale summary table has been written to: ..\main_output\lfc_site_scale_summary.csv
GIS layer files copied into folder \lyr_file within the project folder.
View layers in ArcMAP
using..\R:\GIS\Geomatics_Team\SCRIPTS_TOOLS\MSES\LFC_Surat_Bowen\Arrow\OutputArrow2\lyr_file\lyr_file\Connectivity Area Impact Assessment.lyr

Please scrutinise the output tables and spatial layers to confirm the desktop modelling of connectivity area impact

This analysis used an edited version of the Regulated Vegetation layer.

21:37:44 _____COMPLETED LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____

Attachment 3. – Proposed conditions to be amended

Attachment

Environmental Authority (EA) P-EA-100464322

Proposed changes

1. PL194 EA

Section	Changes Proposed	Reasoning
Schedule A – General Condition General 11 (a) & 11(c)	**Existing:** (a) for waters and aquatic environments, the Queensland Government's Monitoring and Sampling Manual 2009 – *Environmental Protection (Water) Policy 2009* (c) for noise, the *Environmental Protection Regulation 2008* **Proposed:** (a) for waters and aquatic environments, the Queensland Government's Monitoring and Sampling Manual **Version 2, June 2018** – *Environmental Protection (Water) Policy 2009* **(c)** for noise, the *Environmental Protection Regulation **2019***	This administrative amendment updates the reference to a later version of the monitoring and sampling manual and updates the reference to the current edition of the Environment Protection Regulation.
Schedule A – General Condition General 18	**Existing:** General 18 The following infrastructure must be signed with a unique reference name or number in such a way that it is clearly observable: (a) regulated dams and low consequence dams (b) exploration, appraisal, and development wells (c) water treatment facilities (d) brine encapsulation facilities (e) landfill cells (f) sewage treatment facilities	This amendment removes conditions no longer required under this EA, as the infrastructure types are no longer authorised.

Section	Changes Proposed	Reasoning
	(g) specifically authorised discharge points to air and waters (h) any chemical storage facility associated with the environmentally relevant activity of chemical storage (i) field compressor stations (j) central compressor stations (k) gas processing facilities; and (l) pipeline compressor stations. **Proposed: Remove -** • Condition General **18 (d)** brine encapsulation facilities • Condition General **18 (e)** landfill cells • Condition General **18 (g)** specifically authorised discharge points to air and waters	
Schedule B – Water Condition Water 1	**Existing:** Contaminants that will or may cause environmental harm must not be directly or indirectly released to any waters, except as authorised by condition (B15). **Proposed:** Contaminants that will or may cause environmental harm must not be directly or indirectly released to any waters, except as authorised by **this environmental authority**.	This amendment removes the reference to a condition no longer required in the EA. This does not change the intention of the condition.
Schedule B – Water Condition Water 9 (a)	**Existing:** A register must be kept of all linear infrastructure construction and maintenance activities in a wetland of other environmental value and watercourses, which must include: (a) location of the activity (e.g. GPS coordinates (GDA94) and watercourse name) **Proposed:** (a) location of the activity (e.g., GPS coordinates (GDA94, **GDA2020** and watercourse name)	This administrative amendment updates the mapping to be used in the register of linear infrastructure and does not change the intent of the condition.

Section	Changes Proposed	Reasoning
Schedule B – Water Condition Water 12	**Existing:** A seepage monitoring program must be developed by a suitably qualified person which is commensurate with the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants **by 1 August 2019**. **Proposed**: Water 12 A seepage monitoring program must be developed by a suitably qualified person which is commensurate with the site-specific risks of contaminant seepage from containment facilities, and which requires and plans for detection of any seepage of contaminants to groundwater as a result of storing contaminants **in regulated structures**.	This administrative amendment removes reference to a passed date which is no longer relevant.
Schedule B – Water Condition B15 to B31	**Remove (Conditions B15 to B31).**	These conditions relate to the discharge of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule B, Table 2 – Treated CSG Water Release Point, Source and Receiving Waters	**Remove (table).**	This table relate to the discharge of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule B, Table 3 – Treated CSG Water Release Limits for Monitoring Point (M1) – Daily Monitoring	**Remove (table).**	This table relate to the discharge of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule B, Table 4 – Treated CSG Water Release Limits for Monitoring Point (M1) – Quarterly Monitoring	**Remove (table).**	This table relate to the discharge of treated CSG water and monitoring requirements.

Section	Changes Proposed	Reasoning
		This activity is no longer required to be authorised under this EA.
Schedule B, Table 5 – Contaminant Release During Flow Events	**Remove (table).**	This table relate to the discharge of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule B, Table 6 – Receiving Water Upstream Background Sites and Downstream Monitoring Points	**Remove (table).**	This table relate to the discharge of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule BE – Coals Seam Gas Water Injection Trial Conditions BE 1 to BE 22	**Remove (Conditions BE1 to BE22).**	These conditions relate to the injection of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule BE, Table 1 – Details of Authorised Fluid Injection	**Remove (table).**	This table relate to the injection of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.
Schedule BE, Table 2 – Specific Contaminant Limits for Injection Fluid	**Remove (table).**	This table relate to the injection of treated CSG water and monitoring requirements. This activity is no longer required to be authorised under this EA.

<table>
<tr><th>Section</th><th>Changes Proposed</th><th>Reasoning</th></tr>
<tr><td>Schedule BE, Table 3 – Monitoring Parameters and Frequencies for Injection Fluid</td><td>Remove (table).</td><td>This table relate to the injection of treated CSG water and monitoring requirements.

This activity is no longer required to be authorised under this EA.</td></tr>
<tr><td>Schedule D – Land Condition Biodiversity 8B

Schedule D, Table 2 – Maximum significant disturbance in environmentally sensitive areas and their protection zones.</td><td>Existing:
The petroleum activities authorised under condition (Biodiversity 8A) must not exceed the maximum footprint for the activities specified in Schedule D, Table 2 – Maximum significant disturbance in environmentally sensitive areas and their protection zones.

<table>
<tr><th>Activity</th><th>Maximum Footprint</th></tr>
<tr><td>Ground disturbance within a Category B Environmentally Sensitive Area</td><td>0 ha</td></tr>
<tr><td>Ground disturbance within a protection zone of a Category B Environmentally Sensitive Area</td><td>0 ha</td></tr>
<tr><td>Ground disturbance within a Category C Environmentally Sensitive Area</td><td>0 ha</td></tr>
<tr><td>Ground disturbance within a protection zone of a Category C Environmentally Sensitive Area</td><td>0 ha</td></tr>
</table>

Change to:

<table>
<tr><th>Activity</th><th>Maximum Footprint</th></tr>
<tr><td>Ground disturbance within a Category C Environmentally Sensitive Area</td><td>75 ha</td></tr>
</table>
</td><td>All disturbance areas in this table current record zero disturbance values. This contradicts with Schedule D, Table 1, which clearly provides for varying levels of activities in these environmentally sensitive areas and their protection zones.

Schedule D, Table 1 directly reflects the Streamline Model Conditions for Petroleum Activities (SMC). The SMC have been agreed between industry and regulatory authorities as providing adequate protection for ESAs.

Arrow are proposing to amend the table to include authorisations in Category C ESA. Arrow has presented a rolled-up impact in Category C ESA with the break down of that make up in Attachment A. This proposed condition can then be read in conjunction with the proposed inclusion of Biodiversity 8C to provide the despite clause which authorises impacts in the ESA where they are in conflict with authorised activities in Schedule D, Table 1.</td></tr>
</table>

Section	Changes Proposed	Reasoning
Biodiversity 8C	**Insert new proposed condition** Despite condition (Biodiversity 8A) and (Biodiversity 8B), essential petroleum activities are permitted in Category B and Category C ESAs where there is significant residual impact authorised in **Schedule D, Table 2 – Significant residual impacts to prescribed environmental matters** and where shapefiles (consistent with the DES Spatial Schema) of the impact can be provided to the administering authority upon request.	Proposed change is to provide a linkage to the authorised limit/ pool to be drawn down on through Table 2, and a despite clause to Schedule D, Table 1 – Authorised petroleum activities in environmentally sensitive areas and their protection zones (Table 1), to allow essential petroleum activities to occur in relevant ESA without the need to go through numerous EA amendments to authorise. These authorisations would also be linked to PEMs, offsets, and SRI assessments. The inclusion and linkage to the DES Spatial Schema is to include a loop back for DES compliance to check against the limits. i.e., by Arrow Energy providing spatial data consistent with Annual returns, ERC, and Plan of Operations. DES can then do periodic checks as to where disturbance has occurred in ESAs and have the limitations been set in Table 2 of the EA and PEMs complied

Section	Changes Proposed	Reasoning
		with. It then removes the need to provide GPS coordinates (which historically often only corner points), and an assessment where there are despite/exemptions provided for certain infrastructure as the EA provides for limitations in the ESA and PEMs table.
Protecting biodiversity values, Table 3 – Significant residual impacts to prescribed environmental matters	**Changes:** As per the following sections table *Protecting biodiversity values, Table 3 – Significant residual impacts to prescribed environmental matters* **REGULATED VEGETATION** **Remove:** • Endangered regional ecosystems RE 11.4.2 • Of Concern regional ecosystem (not within and urban area) RE 11.3.2, RE 11.3.4 • Regional ecosystems (not within and urban area) that intersect a wetland on the on the vegetation management wetlands map RE 11.3.4, RE 11.3.2, RE11.3.25, RE11.4.12, RE 11.7.4. **Add:** • Regional ecosystems (not within and urban area) that intersect a wetland on the on the vegetation management wetlands map RE 11.3.14 (0.6ha).	These values represent updated predicted impacts based on the current infrastructure alignment, habitat mapping rules and ground-truthed survey information. Ecological assessment have included inspecting relevant data sources to identify threatened species (flora and fauna specially protected under the EPBC Act and NC Act 1992, which are known within and surrounding the SGP. 'Rules' were created to map

Section	Changes Proposed	Reasoning
	Change: • Regional ecosystems (not within and urban area) that intersect a wetland on the on the vegetation management wetlands map RE 11.3.18 (reduce from 0.43ha to 0.3ha), RE 11.5.1 (reduce from 0.72ha to 0.5ha), RE 11.7.7 (increase from 0.14ha to 0.6ha). **CONNECTIVITY AREAS** **Remove:** • Connectivity area that is a regional ecosystem (not in urban area) 6.7ha. **PROTECTED WILDLIFE HABITAT** **Remove:** • Habitat for an animal that is vulnerable wildlife: ▪ *Jalmenus eubulus* **Add:** • Habitat for an animal that is vulnerable or endangered wildlife: ▪ *Petaurus australis (71.3ha)* ▪ *Nyctophilus corbeni (71.9ha)* ▪ *Stagonopleura guttata (72.2ha)* ▪ *Glyphodon (Furina) dunmalli (71.4ha)* ▪ *Adclardia cameroni (0.4ha)* ▪ *Phascolarctos cinereus (145.7ha)* ▪ *Petauroides volans (71.8ha)* **Change:** ▪ *Acanthophis antarcticus (increase from 53ha to 72.2 ha)* ▪ *Calyptorhynchus lathami (increase from 16ha to 29.2ha)* ▪ *Hemiaspis damelii (reduce from 36ha to 1.3ha)* **FISH HABITAT AREAS** **Change:** • Fish passage (not in an urban area) – remove. **Change:** Total numbers of Maximum extent of impact to the ones in table below *Protecting biodiversity values, Table 3 – Significant residual impacts to prescribed environmental matters* below:	habitat for these Matters of National and State Environmental Significance (MNES and MSES) based on GIS data, allowing the prediction of high value habitat. These surveys and mapping rules were also used to assess the impacts and environmental values associated with PL194. Habitats were classed as 'core' habitat or 'general' habitat. Core habitat areas reflect those REs which are likely to be regularly inhabited by, or of 'high importance' to, the species. Such areas include high amenity habitat which could include important resources such as roosting and nesting sites or food resources. General habitats are 'those REs that may be used less regularly by fauna' (3DE and ESE 2011) and have lower amenity habitat. These definitions roughly match the definitions of 'Core Habitat Possible' and 'General Habitat Possible' in DES (2020), which was not available in 2011. The mapping has been used to calculate predicted impacts (and subsequently offset requirements) based on the extent of Core Habitat Known and Core Habitat Possible. Considerable field work has been completed within and surrounding the SGP area (which included the PL194 area) since this work was

<table>
<tr><th>Section</th><th>Changes Proposed</th><th>Reasoning</th></tr>
<tr><td></td><td>
Add: Schedule D to the table title (see below).

Schedule D, Protecting biodiversity values, Table 3 – Significant residual impacts to prescribed environmental matters
<table>
<tr><th>Prescribed environmental matter</th><th>Location of impact</th><th>Maximum extent of impact</th></tr>
<tr><td colspan="3">REGULATED VEGETATION</td></tr>
<tr><td colspan="3">~~Endangered~~ ~~regional ecosystem~~</td></tr>
<tr><td>~~RE 11.4.2~~</td><td>~~PL194~~</td><td>~~2 ha~~</td></tr>
<tr><td colspan="3">~~Of concern~~ ~~regional ecosystem~~ ~~(not within an urban area)~~</td></tr>
<tr><td>~~RE 11.3.2~~</td><td>~~PL194~~</td><td>~~4 ha~~</td></tr>
<tr><td>~~RE 11.3.4~~</td><td>~~PL194~~</td><td>~~3 ha~~</td></tr>
<tr><td colspan="3">Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map</td></tr>
<tr><td>~~RE 11.3.2 (BVG 17a)~~</td><td>~~PL194~~</td><td>~~0.14 ha~~</td></tr>
<tr><td>~~11.3.4 (BVG 16c)~~</td><td>~~PL194~~</td><td>~~0.72 ha~~</td></tr>
<tr><td>11.3.18 (BVG 17a)</td><td>PL194</td><td>~~0.43 ha~~ 0.3ha</td></tr>
<tr><td>~~11.3.25 (BVG 16a; 22c)~~</td><td>~~PL194~~</td><td>~~2.14 ha~~</td></tr>
<tr><td>~~11.4.12 (BVG 17a)~~</td><td>~~PL194~~</td><td>~~0.14 ha~~</td></tr>
<tr><td>11.5.1 (BVG 17a; 18b)</td><td>PL194</td><td>~~0.72 ha~~ 0.5 ha</td></tr>
<tr><td>~~11.7.4 (BVG 12a)~~</td><td>~~PL194~~</td><td>~~0.07 ha~~</td></tr>
<tr><td>11.7.7 (BVG 12a)</td><td>PL194</td><td>~~0.14 ha~~ 0.6</td></tr>
<tr><td>11.3.14 (BVG 18a)</td><td>PL194</td><td>0.6</td></tr>
<tr><td colspan="3">~~CONNECTIVITY AREAS~~</td></tr>
<tr><td colspan="3">~~Connectivity area that is a~~ ~~regional ecosystem~~ ~~(not in urban area)~~</td></tr>
<tr><td>~~PL194~~</td><td>~~PL194~~</td><td>~~6.7 ha~~</td></tr>
<tr><td colspan="3">Essential habitat (not in an urban area) for endangered wildlife</td></tr>
<tr><td>Phascolarctos cinereus (Koala)</td><td>PL194</td><td>8.7</td></tr>
</table>
</td><td>completed our local knowledge has increased substantially. In a few cases, this has identified ways in which the mapping rules could be modified and improved for greater accuracy. Furthermore, additional MNES and MSES species have been listed under legislation since the original work was completed.

These new additional species had not been previously assessed (given their latest change in status) but have been included in this assessment as an abundance of caution based on likelihood of occurrence assessment and suitability of habitat within the survey corridor for the PL194 area utilising the aforementioned ecology surveys, survey data and mapping rules.

The changes in this table also represent reduced disturbance through refinements to infrastructure layout.</td></tr>
</table>

<table>
<tr><th>Section</th><th>Changes Proposed</th><th>Reasoning</th></tr>
<tr><td></td><td>
<table>
<tr><th colspan="3">PROTECTED WILDLIFE HABITAT</th></tr>
<tr><td colspan="3">Habitat for an animal that is vulnerable wildlife</td></tr>
<tr><td>Acanthophis antarcticus (Common Death Adder)</td><td>PL194</td><td><s>53 ha</s> 72.2 ha</td></tr>
<tr><td>Petaurus australis (Yellow-bellied Glider)</td><td>PL194</td><td>71.3 ha</td></tr>
<tr><td>Nyctophilus corbeni (South-eastern Long-eared Bat)</td><td>PL194</td><td>71.9 ha</td></tr>
<tr><td>Glyphodon (Furina) dunmalli (Dunmall’s Snake)</td><td>PL194</td><td>71.4 ha</td></tr>
<tr><td>Stagonopleura guttata (Diamond Firetail)</td><td>PL194</td><td>72.2 ha</td></tr>
<tr><td>Calyptorhynchus lathami (Glossy Black Cockatoo)</td><td>PL194</td><td><s>16</s> 29.2 ha</td></tr>
<tr><td>Adclarkia cameroni (Brigalow Woodland Snail)</td><td>PL194</td><td>0.4 ha</td></tr>
<tr><td><s>Jalmenus eubulus (Pale Imperial Hairstreak)</s></td><td><s>PL194</s></td><td><s>3 ha</s></td></tr>
<tr><td><s>Tachyglossus aculeatus (Echidna)</s></td><td><s>PL194</s></td><td><s>10 ha</s></td></tr>
<tr><td colspan="3">Habitat for an animal that is endangered wildlife</td></tr>
<tr><td>Hemiaspis damelii (Grey Snake)</td><td>PL194</td><td><s>36 ha</s> 1.3 ha</td></tr>
<tr><td>Phascolarctos cinereus (Koala)</td><td>PL194</td><td>145.7</td></tr>
<tr><td>Petauroides Volans (Greater Glider)</td><td>PL194</td><td>71.8</td></tr>
<tr><td><s>Habitat for an animal that is Special Least Concern</s></td><td></td><td></td></tr>
<tr><td><s>Tachyglossus aculeatus (Echidna)</s></td><td><s>PL194</s></td><td><s>11.21 ha</s></td></tr>
<tr><td colspan="3"><s>FISH HABITAT AREAS</s></td></tr>
<tr><td><s>Fish passage (not in an urban area)</s></td><td><s>PL194</s></td><td><s>1 0.25</s></td></tr>
</table>
</td><td></td></tr>
<tr><td>Schedule D – Land
Condition D17 to D22</td><td>Remove (Conditions D17 to D22).

These conditions relate to:
• Daandine Brine Dam 2
• release of treated CSG water to Wilke Creek
• disturbance areas for water release outlets, Tipton Treated Water Pipeline
• Longswamp 31 monitoring bore</td><td>These activities are no longer required to be authorised under this EA. Therefore, the conditions are no longer required.</td></tr>
</table>

Section	Changes Proposed	Reasoning
Schedule D, table 4 – Coordinates Enclosing the Disturbance Area for Daandine Brine Dam 2	**Remove (table).**	This activity is no longer required to be authorised in this EA.
Schedule D, Table 5 – Coordinates Enclosing the Disturbance Area for the Water Release Outlet and Pipeline	**Remove (table).**	This activity is no longer required to be authorised in this EA.
Schedule D, Table 6 – Coordinates Enclosing the Disturbance Area for Tipton Treated Water Pipeline	**Remove (table).**	This activity is no longer required to be authorised in this EA.
Schedule D, Table 7 – Authorised footprint for disturbance to environmentally sensitive areas	**Remove (table).**	This activity is no longer required to be authorised in this EA.
Schedule E – Acoustic Condition E10 and E11	**Remove (Conditions E10 and E11).**	These conditions relate to the Tipton expansion project which is no longer required to be authorised under this EA.
Schedule E, Table 3 – Tipton Expansion Project units	**Remove (table).**	This table relates to the Tipton expansion project which is no longer required to be authorised under this EA.
Schedule F, Table 1 – Authorised Point Sources	**Remove (table).**	This table relate to activities no longer required to be authorised under this EA.
Schedule F, Table 2 – Annual Air Quality Monitoring	**Remove (table).**	This table relate to activities no longer required to be authorised under this EA.

Tables for PL194 EA.

Attachment A:

Schedule D, Table 2 – Authorised footprint for disturbance to environmentally sensitive areas and PPZ

Regional Ecosystem (ground-verified)	Area (ha)	VMA	BD (ESA)	Cat B ESA (ERE)	Cat C ESA (OCRE)	Cat C ESA (Essential Habitat)	Cat C ESA (State Forest)
11.3.14	0.554	LC	NCAP			0.167	0.428
11.3.18	0.408	LC	NCAP			0.216	0.216
11.3.25	0.303	LC	OC		0.303		
11.5.1	50.701	LC	NCAP			6.352	31.256
11.7.4	5.958	LC	NCAP			0.625	2.724
11.7.7	13.453	LC	NCAP			1.398	13.123
Regrowth (11.5.1)	49.608	LC	NCAP			7.213	6.058
Regrowth (11.7.4)	23.172	LC	NCAP			1.341	
Total	**199.559**	**Totals**		**0.000**	**0.303**	**17.313**	**56.964**

Attachment 4. – Species impact management plan

Surat Gas Project

Species Impact Management Plan

arrow energy
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Contents

Figures

Tables

Appendices

Cover Page

EPBC Number: EPBC 2010/5344

Project Name: Surat Gas Expansion Project

Proponent and ABN: Arrow Energy Pty Ltd (ABN: 73 078 521 936)

Approved Action: To expand coal seam gas operations in the Surat Basin, Queensland, as described in the Referral provided under the EPBC on 2 February 2010; and as described in the Surat Gas Project Environmental Impact Statement (March 2012) and Supplementary Report to the Environmental Impact Statement (June 2013).

Location of the Action: The Project covers an area of approximately 6,100 km^2 and is located approximately 160 km west of Brisbane in Queensland's Surat Basin. The project development area extends from the township of Wandoan in the north towards Goondiwindi in the south.

Date of preparation of this Plan: 20 November 2018

Signed Declaration of Accuracy:

In making this declaration, I am aware that section 491 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or *Environment Protection and Biodiversity Conservation Regulation* (2000) (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have knowledge of that authorisation being revoked at the time of making this declaration.

Signed:

Full name: Nathan Blundell

Organisation:

Arrow Energy Pty Ltd

Date: 20/11/2018

Executive Summary

Background and Purpose

- On 19 December 2013 Arrow Energy Pty Ltd (Arrow) received approval from the Australian Government to proceed with the Surat Gas Project (SGP) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC 2010/5344).

- On 29 March 2017 'Variation to Conditions Attached to Approval' was granted, whereby the more detailed Offset Management Plan is now required within 12 months of project commencement. On 29 May 2018 a second 'Variation to Conditions Attached to Approval' was granted, whereby maximum Stage 1 disturbance areas were refined and Stage 1 minimum offset areas were removed. On 31 October 2018 a third variation was granted to separate the SGP Species Impact Management Plan and the Stage 1 Offset Strategy.

- The purpose of this document is to satisfy Conditions 7 of the approval, whereby Arrow is submitting the EPBC Species Impact Management Plan (SIMP) for approval by the Minister prior to project commencement.

Key Elements

- This SIMP has been prepared by suitably qualified ecologists, with evidence of the authors' qualifications and experience provided in Appendix A.

- Arrow has undertaken comprehensive seasonal ecological surveys to gain a detailed understanding of EPBC listed threatened species and EPBC communities within the Project development area, and have modified our field development layout to avoid and minimise impacts to these national values.

- This SIMP details how Arrow will meet Condition 7A and 7B of the SGP approval conditions including describing the management measures and monitoring program that will be implemented to avoid, track and further minimise impacts to EPBC Act species and communities through the life of the SGP.

- As per Condition 7B, Arrow will not commence Project Phase 1 until this EPBC SIMP has been approved by the Minister in writing. Once approved Arrow will implement this SIMP.

Recommendation

That the Minister or delegate approves this Surat Gas Project EPBC Species Impact Management Plan.

Abbreviations and Acronyms

The following table provides a list of abbreviations and acronyms used throughout this report.

Abbreviations and Acronyms

Term	Definition
CSG	Coal Seam Gas
DotEE	Department of the Environment and Energy (Australia)
EA	Environmental Authority
DES	Department of Environment and Science (Queensland)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GIS	Geographic Information System
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
RE	Regional Ecosystem
ROW	Right of Way
SIMP	Species Impact Management Plan
SREIS	Supplementary Report to the Environmental Impact Statement
TEC	Threatened Ecological Community

1. Introduction

Arrow Energy is a Queensland based subsidiary of Arrow Energy Holdings Pty Ltd (Arrow), a 50:50 joint venture between Royal Dutch Shell (Shell) and PetroChina Company Ltd (PetroChina). Arrow is currently developing coal seam gas (CSG) resources in Queensland, including resources in the Surat Basin.

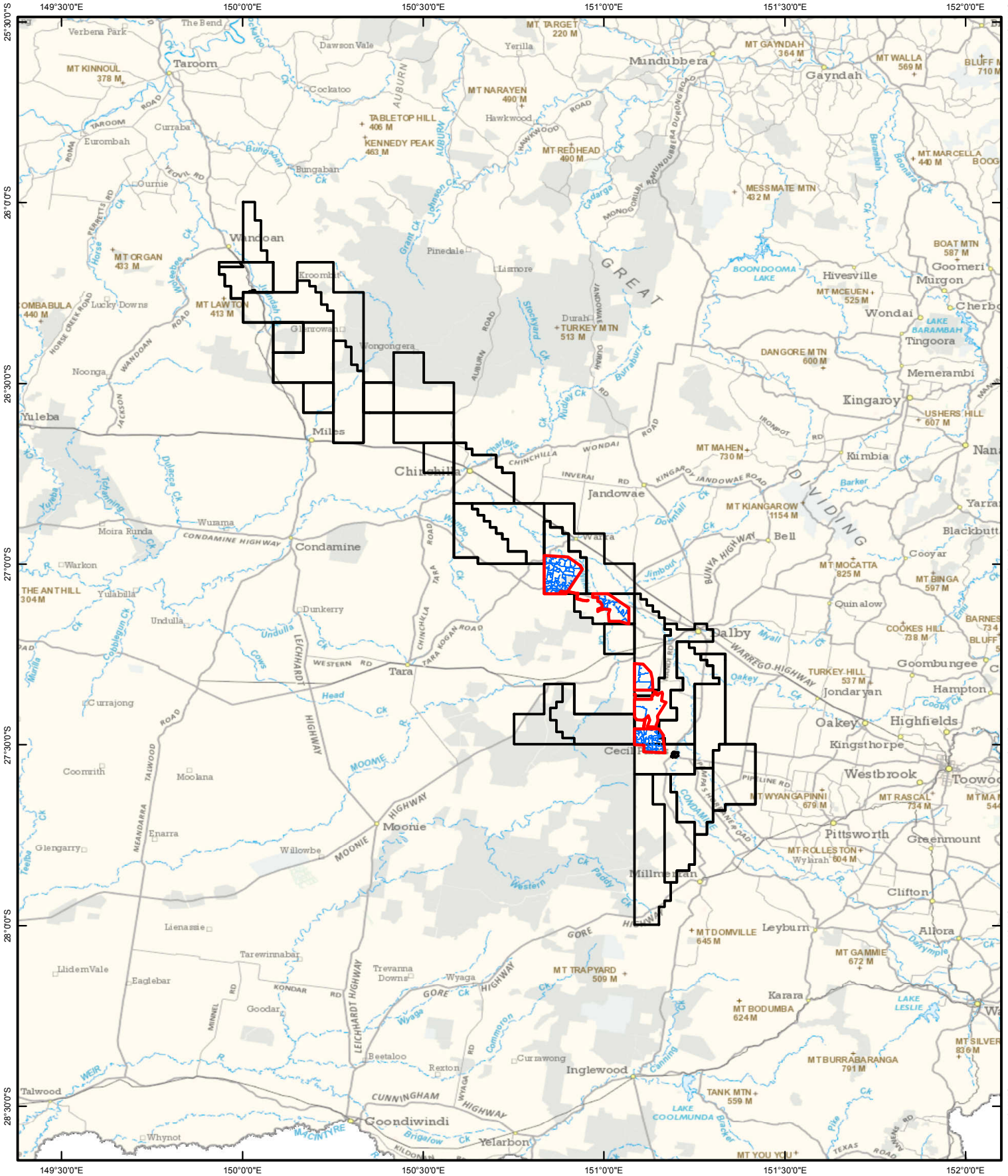
The Surat Gas Project (SGP) Environmental Impact Statement (EIS) for up to 6,500 coal seam gas production wells and associated infrastructure was granted approval from the Queensland Government in October 2013 and the Australian Government in December 2013. The Project covers an area of approximately 6,100 km^2, extending from the township of Wandoan in the north towards Millmerran in the south (see Figure 1.1).

The EPBC Act approval for the SGP (EPBC 2010/5344) specifies that "*prior to the commencement of Stage 1, the approval holder must prepare and submit an EPBC Species Impact Management Plan for the Minister's written approval*" and that the plan must include a number of matters (Condition 7A (a) – (d) of the EPBC Act approval; refer Table 1.1 of this SIMP). The purpose of this SIMP is to satisfy these conditions.

The EPBC Act approval also identifies those EPBC Act listed species and communities (listed at the date of approval for the SGP) where a significant impact is likely, and specifies disturbance limits for each (Condition 5, Table 1 of the EPBC approval; shown in Table 1.2 of this SIMP; noting that MNES with 'no disturbance' limit is excluded from Table 1.2). This SIMP addresses all of these EPBC species and communities.

For completeness, this SIMP also addresses three listed EPBC Act species which have been identified as having the potential to be impacted by the SGP (i.e. *Phascolarctos cinereus* (Koala), *Petauroides volans* (Greater Glider) and *Grantiella picta* (Painted Honeyeater)). These three species were listed under the EPBC Act subsequent to the SGP's EBPC Act approval. Although these species are discussed in this SIMP, they do not form part of the EPBC Act approval but are included by Arrow in the SGP Offset Strategy.

Table 1.1 identifies the sections within this SIMP that addresses each of the Condition 7 requirements.



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Issued To: M Ryan
Author: tstringer

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Source:
Arrow Energy Limited, Geosciences Australia
Dept. Envir. and Resource Mgmt.

N

Coordinate System: GCS GDA 1994

0 12.5 25 50
km

Figure 1.1
Surat Gas Project
Location in the Regional Context

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Date: 8/01/2018

Document: V:\Products\Australia\Queensland\Surat_Basin\General\Surat_Integration\180108_SIMPO_Stage1_Figures_MR\mxd\FIG1_SIMOP_St1_SGP_Location.mxd

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Table 1.1 Cross-reference table for information requirements and SIMP section

Condition Number	Condition requirement	Section of this SIMP
7A	Prior to the commencement of Stage 1, the approval holder must prepare and submit an EPBC Species Impact Management Plan for the Minister's written approval. The EPBC Species Impact Management Plan must include:	
7(a)	Measures that will be taken to avoid, mitigate and manage impacts to EPBC listed threatened species and their habitat during clearance of vegetation, including the involvement of a suitably qualified ecologist at all times during clearance of vegetation	Section 3
7(b)	Measures that will be taken to avoid, mitigate and manage impacts to EPBC listed threatened species and their habitat and to EPBC communities during construction, operation and decommissioning of the action	Section 4
7(c)	A monitoring program to determine the success of impacts avoidance and mitigation measures and that will inform adaptive implementation of the action for the duration of this approval	Section 5
7(d)	A description of how measures proposed in the EPBC Species Impact Management Plan are consistent with the measures in relevant conservation advice, recovery plans and threat abatement plans	Section 6
7B	The approval holder must not commence Stage 1 until an EPBC Species Impact Management Plan has been approved by the Minister in writing. The approved EPBC Species Impact Management Plan must be implemented by the approval holder	Section 7

Table 1.2 Whole of project maximum disturbance limits (source: Table 1 of EPBC Act approval)

Matter of National Environmental Significance	Maximum disturbance (hectares) to core habitat
Terrestrial Species	
Curly-bark Wattle (*Acacia curranii*)	1,210
Hando's Wattle (*Acacia handonis*)	1,210
Belson's Panic (*Homopholis belsonii*)	140
Lobed Blue Grass (*Bothriochloa biloba*)	305
Kogan Waxflower (*Philotheca sporadica*)	480
Prostanthera sp *Dunmore*	380
Small-leaved Denhamia (*Denhamia parvifolia*)	50
Calytrix gurulmundensis	1,210

Matter of National Environmental Significance	Maximum disturbance (hectares) to core habitat
Finger Panic Grass (*Digitaria australe*)	174
Austral Toadflax (*Thesium australe*)	160
Acacia lauta	990
Cobar Greenhood Orchid (*Pterostylis cobarensis*)	2,170
Xerothamnella herbacea	110
Hawkweed (*Picris evae*)	120
Austral Cornflower (*Rhaponticum australe*)	160
Eucalyptus virens	170
King Bluegrass (*Dichanthium queenslandicum*)	160
Queensland White-gum (*Eucalyptus argophloia*)	10
South-eastern Long-eared Bat (*Nyctophilus corbeni*)	4,080
Dunmall's Snale (*Furina dunmalli*)	4,400
Five-clawed Worm-skink (*Anomalopus mackayi*)	560
Squatter Pigeon (*Geophaps scripta scripta*)	3,261
Regent Honeyeater (Anthochaera phrygia)	20
Collared Delma (Delma torquate)	90
Yakka Skink (Ergernia rugosa)	310
Australian Painted Snipe (*Rostratula australis*)	5
EPBC Communities	
Brigalow (*Acacia harpophylla* dominant and co-dominant)	106
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregion	8
Weeping Myall Woodlands	1

2. Management of EPBC Species and Communities

2.1 Management hierarchy

Coal Seam Gas developments apply an iterative process in terms of locating wells and gathering lines. This is required because there are several competing constraints when it comes to locating the infrastructure on the surface. These constraints include ecological values, landholder preferences, geological features, existing infrastructure and access tracks. Planning and management of surface activities and ground disturbance is undertaken utilising a set of hierarchical management principles used to avoid, minimise and mitigate impacts to ecological values. These principles are:

- Avoid: Arrow's first preference is to avoid EPBC Act listed threatened ecological communities and the habitat of EPBC listed threatened species
- Minimise: where other competing constraints or the scale / location of EPBC communities or species habitat dictate that avoidance is not possible (e.g. where there are long linear strips of Brigalow that need to be crossed or large areas of suitable habitat for wide ranging species such as the Squatter Pigeon), Arrow will preferentially locate infrastructure in a manner that minimises the impact to these values (e.g. cross the Brigalow at the narrowest or most degraded part or where practicable on the edge of suitable habitat for listed species so as not to bisect good quality habitat)
- Mitigate: implement mitigation measures to further minimise the direct and indirect impacts on ecological values
- Remediate and rehabilitate: actively remediate and rehabilitate impacted areas to promote and maintain long term recovery
- Offset: Arrow will offset unavoidable significant residual impacts to MNES as per the SGP Offset Strategy.

2.2 Application of the management hierarchy

Sections 3 and 4 of this document provide considerable detail of Arrow's commitments to avoid, minimise and mitigate impacts to MNES. The following steps will be undertaken to implement the above mentioned management hierarchy:

- Pre-clearance surveys
- Framing trade-offs
- On-site management and reporting
- Annual reporting.

Pre-clearance surveys

Arrow has already completed ecological surveys within the areas of proposed activities. However, additional pre-clearance surveys will be undertaken when the SGP activities proceed through the detailed design and planning phase and secondary approvals are required (e.g. an Environmental Authority, Clearing Permit or a landholder agreement).

At this point in time, a field inspection of the specified disturbance footprint will be undertaken by a suitably qualified ecologist. The pre-clearance survey will confirm the presence, absence and extent of environmental values (including EPBC Act species habitats and TECs) and these will be mapped in the field via GIS. The results of this step will be recorded within Geocortex (Arrow's GIS based mapping system) and the Arrow Sharepoint site (Arrow's data compilation software used by the Access and Approvals Team).

Framing trade-offs

Following the pre-clearance surveys, a framing trade-offs meeting will be held with the project engineers, planners, ecologists, land liaison officer and an archaeologist. The purpose of this meeting is for each specialist to discuss the proposed location of the infrastructure and the opportunities and constraints based on the findings of their field assessment. It is at this meeting where the ecologist will be reiterating Arrow's management hierarchy for MNES and aiming to avoid and minimise impacts to MNES. The outcome of the framing trade-offs meeting is an agreed location for the surface infrastructure after taking into consideration each competing constraint. The results of this step will be recorded within the Arrow Sharepoint database.

On-site management and reporting

Where the framing trade-offs meeting has identified that impacts to MNES are unavoidable, the following will be undertaken so that the actual area cleared will be surveyed to quantify the impacts (in addition to the detailed measures outlined in Table 3.1):

- Record GPS coordinates of the boundary of the MNES in relation to the proposed clearing boundaries and ensure the limits of the area to be cleared are clearly marked on the ground (e.g. high visibility flagging tape, hazard netting or similar).
- Complete a Habitat Quality Assessment as per the Queensland Government Department of Environment and Heritage Protection's *Guide to determining terrestrial habitat quality – A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy* (2017).
- Ensure a fauna spotter-catcher is present during clearing. The spotter-catcher will be a suitably qualified ecologist. The number of fauna spotter-catchers on site at the time of clearing will depend on the number of machines being used at any given time.
- Record the coordinates and total area of MNES habitats and communities cleared.
- Ensure the success of on-site mitigation measures by review and assurance against this EPBC Species Impact Management Plan and the accompanying SGP EPBC Phase 1 Offset Strategy.

Annual reporting

- The field data collected above will be provided to the Environment Team at the completion of site disturbance activities and tracked monthly against approved Stage 1 maximum disturbance limits.

- This data, together with other reporting requirements specified in this plan and the accompanying SGP EPBC Offset Strategy will be collated for annual compliance reporting as per Condition 28 of the SGP EPBC approval.

2.3 Supporting Arrow documents

Arrow has been installing and operating coal seam gas infrastructure since 2005. We have numerous guiding documents relevant to the monitoring of activities that may impact species and vegetation communities; namely:

- Operations Environmental Management Plan (ORG-ARW-AOP-PLA-00016) – this document identifies the relevant procedures and other control mechanisms that are used to minimise potential environmental impacts of production operations activities and ensures the requirements of relevant legislation are met.

- Biodiversity Standard (ORG-ARW-HSM-STA-00034) – the intent of this document is to ensure the protection of biodiversity (flora, fauna and natural habitats) in the areas in which Arrow operates in recognition of the value of healthy and functioning terrestrial and aquatic natural systems. The Standard places a responsibility on all Arrow line managers and contractors to monitor potential biodiversity impacts and controls.

- HSE Incident Management Standard (ORG-ARW-HSM-STA-00007) and the Incident Management Procedure (ORG-ARW-HSM-PRO-00089) – these documents specify the process for reporting, recording, classifying, notifying and investigating unplanned events and incidents that have resulted in damage to the environment.

Beyond the above mentioned overarching documents, two Arrow procedures are particularly relevant:

- Ecological Impact Assessment Procedure (ORG-ARW-HSM-PRO-00070) – this document provides the step by step process implemented for all Arrow development activities that involve significant disturbance to land, including the requirement to record the GPS coordinates and maps of all vegetated areas that have required clearing. Clearing extents will also be input into an Arrow database to track EPBC Act species and community disturbance against approved limits on a monthly basis.

- Fauna Management Procedure (ORG-ARW-HSM-PRO-00067) – this document informs all Arrow staff and contractors of their obligations to protect and manage native fauna whilst operating on Arrow controlled works sites. It includes the requirements to:

  - Record and report all interactions with fauna to the Arrow Ecologist (notification within 24 hours using the Fauna Incident Notification (FIN) form is required for listed

threatened (including EPBC Act listed species), near threatened and special least concern fauna).

- Record and report all interactions with fauna to the regulator, under their own permit, as required (but not before reporting to the Arrow Ecologist).
- Regularly monitor mitigation measures that have been constructed and/or implemented (e.g. fauna exclusion fences) and report their effectiveness to the Site Supervisor.
- Provide clear communications on any ongoing action requirements (e.g. monitoring and maintenance) during site handover processes, and these must be implemented, monitored and their effectiveness reported.

3. Mitigation measures

Condition 7A(a): measures that will be taken to avoid, mitigate and manage impacts to the EPBC listed threatened species and their habitat during clearance of vegetation, including the involvement of a suitably qualified ecologist at all times during clearance of vegetation.

Table 3.1 provides a description of the measures that will be implemented by Arrow to avoid, mitigate and manage impacts to the MNES.

Table 3.1 Description of mitigation measures / commitments

Mitigation	Commitment	Intended outcome	Responsible manager/s
Pre-construction clearance surveys / minimise clearing	• Minimise the disturbance footprint and vegetation clearing • Use existing roads and tracks, where practicable • Avoid unnecessary impervious surface coverings and reduce land footprint and vegetation clearing when designing facilities • Reduce the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers • Conduct preconstruction clearance surveys to identify any additional areas that may need to be avoided • Conduct preconstruction clearance surveys and include as a minimum: – Vegetation mapping at a scale suitable for site- specific planning – Identification of habitats and listed species – Identification of site-specific sensitive areas that require avoidance or buffer areas	• To identify opportunities where the residual impacts to MNES matters can be further reduced	• SGP Pre-execution (i.e. Planning) Manager (Arrow)
Construction activities as per plan (no-go areas)	• Ensure construction activities do not extend beyond the work site boundaries • Mark site boundaries clearly for site-specific sensitive areas that require avoidance • 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 • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Retain habitat trees, where practicable • Construct production wells, gathering lines and access tracks within cleared areas, where practicable, with the aim of avoiding sensitive areas • 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	• To ensure that no unplanned impacts occur on MNES as a result of construction activities	• SGP Construction Manager (Arrow)

Mitigation	Commitment	Intended outcome	Responsible manager/s
Clear Communication	• 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 • Prohibit disturbance or harassment of wildlife and the unauthorised collection of flora and forest products	• To ensure that no unplanned impacts occur on MNES as a result of construction activities	• SGP Construction Managers (Arrow and Third Party Contractor)
Fauna spotter catcher	• Assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter-catcher (FSC) and roll them so that the hollows are facing upwards, allowing fauna to escape • Identify key koala trees (*Eucalyptus tereticornis* and *Eucalyptus populnea*), and visually inspect prior to clearing to ensure that they are free of koalas. If koalas are located, the tree should be retained until the animals have moved on, typically overnight • Use appropriately trained personnel or a FSC to capture injured wildlife, where possible. If further action is required, consult with a qualified vet to determine appropriate action • The FSC will be present during clearing. The FSC will be suitably qualified as per the definition provided in EPBC 2010/5344. The number of FSCs on site at the time of clearing will depend on the number of machines being used at any given time • Checks for identified EPBC Act fauna species breeding places will be undertaken immediately prior to commencing vegetation clearing • Potential breeding places will be clearly marked in the field with spray paint, coloured flagging tape (unless not permitted by land owners, e.g. some cattle properties), or by other suitable methods	• To ensure that no unplanned impacts occur on the Koala, Dunmall's Snake, Greater Glider, South-eastern Long-eared Bat, Regent Honeyeater, Painted Honeyeater or Squatter Pigeon	• SGP Construction Managers (Arrow and Third Party Contractor)
Appropriate rehabilitation	• 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 • Translocate or propagate significant species where it is deemed necessary for use during rehabilitation or in offsets in accordance with relevant legislation • 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	• To ensure that no unplanned impacts occur on MNES as a result of construction activities	• SGP Construction Managers (Arrow and Third Party Contractor)

Mitigation	Commitment	Intended outcome	Responsible manager/s
Reduce light spill	• Reduce light spill resulting from project activities to reduce disturbance to nocturnal fauna	• To ensure that no unplanned impacts occur on the Koala, Dunmall's Snake, Greater Glider or South-eastern Long-eared Bat	• SGP Construction Managers (Arrow and Third Party Contractor)
Reduce project traffic speed	• Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife • Confine project traffic to designated roads and access tracks, where practicable	• To ensure that no unplanned impacts occur on the Koala, Dunmall's Snake, Collared Delma or Yakka Skink	• SGP Construction Managers (Arrow and Third Party Contractor)
Weed control	• Inspect work sites and access routes for notifiable weeds and pest plants and animals prior to accessing the site • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Advise all relevant personnel of the location and extent of weed infestations in the vicinity of the work areas and the risks involved in moving from one site or property to another • Identify declared weeds [as per the Land Access Code 2016] during the preconstruction clearance survey	• To avoid degradation of the Brigalow, Coolibah-Black Box or Weeping Myall TEC • To avoid reduction in the condition of listed threatened species habitat	• SGP Construction Managers (Arrow and Third Party Contractor)
Documentation	• Develop management procedures, 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 • Develop and implement a compensation framework to 'add value' rather than just compensating for impacts • 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	• To ensure that the planned (and actual) impacts to MNES are accurately documented and offset	• Environment Manager (Arrow)

In addition to the mitigation measures listed in Table 3.1, Arrow's response to, and reporting of, injury or mortality of EPBC Act fauna is described in Sections 3.1 and 3.2.

3.1 Arrow response to fauna mortality and injury

In the case of animal mortality/injury, the suitably qualified ecologist/spotter/catcher would inspect the animal to determine the extent of injury and the following would occur:

- If injured, temporary first-aid shall be applied (e.g. stopping blood-flow or binding a wound or broken limb). For superficial scratch wounds, antibiotic ointment, spray or powder shall be applied prior to release.
- Sickness usually takes the form of cold stress during winter (this is alleviated during trapping by providing insulated material within any traps). An animal which appears to be suffering from cold-stress will be placed in a warm holding container in a quiet area until it recovers. Holding containers are always carried as part of the survey equipment and comprise tins or appropriate wooden or plastic boxes/ carriers.
- If successful recovery does not appear to be occurring, or the injury requires further treatment, the animal will be transported in a holding container to the nearest veterinarian or to a local wildlife carer.
- Fauna will not be contained for longer than four hours. If prolonged containment is necessary due to difficultly accessing storage facilities (i.e. veterinary surgery, wildlife carers premises), food and water shall be provided.
- The final aim of the response is to release the recovered animal back into the area where it was originally captured. Once assessed by a veterinary surgeon, injured or sick fauna shall be transported to an authorised wildlife carer if it is to be rehabilitated. If the fauna is to be released into the wild, the animal will be released in the location where it was originally captured.
- If it is necessary to euthanize an animal, humane procedures will be used. These procedures will be reliable, avoid distress and produce rapid loss of consciousness without pain until death occurs. It is important to recognise that whilst some physical methods of euthanasia (e.g. stunning followed by exsanguinations) are not aesthetically pleasant, they may be humane as they ensure immediate insensitivity to pain. The choice of technique will be made based on the sensibilities of the animal to be euthanized rather than the sensitivities of the observer or personnel involved.
- Spotter/catchers used by Arrow receive instruction of humane methods of euthanasia prior to entering the field. Should a situation arise where the spotter/catcher is not suitable or comfortable then works will stop and not proceed until assistance from another suitably qualified spotter/catcher can attend the site and deal with the situation. During this time no further works are permitted to occur.

- Animals that are euthanized or found dead will be disposed of humanely and at or near the site where they were found.

3.2 Reporting on fauna mortality and injury

Regular reporting for the SGP will be included in the annual report provided to the Department.

With regards to exceptional events, such as mortality to an EPBC listed species as a result of the SGP activities, the following information is collected:

- During vegetation clearing, information on all fauna impacted by the clearing works (i.e. instances that have involved the spotter/catcher) are recorded.
- Photographs of the fauna and habitat features will be communicated through various methods (e.g. posters, presentations, etc.) to assist site staff with the identification of fauna and their required habitats.
- Data/information must be provided to the Arrow permit holder or authorised representative and include the following:
  - Fauna sighted, relocated, injured and/or euthanized
  - Fauna breeding places identified and actions taken
  - Notable actions
  - GPS co-ordinates for any species that was captured, relocated or euthanized. The co-ordinate should be of the capture point and the release point, where relevant.

With regards to exceptional events, such as mortality to an EPBC listed species as a result of SGP activities, the following reporting to the Department will occur:

- Reporting of such an exceptional event will be carried out in writing to the Secretary of DotEE within a short period (e.g. 7 days) of Arrow becoming aware of the incident (contact details used will be as per the Department's webpage: http://www.environment.gov.au/biodiversity/threatened/listed-species-and-ecological-communities-notification).
- All such incidents will be reported on an Arrow incident report form and registered in an electronic database.
- The information provided to the Secretary will include the listed threatened species, the date on which the incident took place, the activity being undertaken at the time of the incident, and the immediate actions taken as a result of the death.

- Incidents will be assessed and tracked to ensure that the appropriate investigation, corrective actions and measures are taken to prevent the incident from reoccurring.
- Incidents will be reviewed by Arrow on a monthly and annual basis to determine incident trends, which will enable targeting of areas that require further adaptive management to assist in preventing future incidents. While the review of incidents will occur monthly, the reporting of such trends will be annual.

The annual reporting required by Condition 28 will also include information pertaining to mortalities of any listed threatened species.

4. Mitigation measures during construction, operation and decommissioning

Condition 7A(b): Measures that will be taken to avoid and mitigate impacts to EPBC listed threatened species and their habitat and to EPBC communities during construction, operation and decommissioning of the action.

Table 3.1 in the preceding section described the mitigation measures relevant to the construction phase and particularly in relation to clearing activities. This section does not repeat those measures but rather describes measures additional to those provided in Table 3.1.

Table 4.1 lists the mitigation measures that will be undertaken to avoid or reduce impacts to EPBC species and communities during construction, operation and decommissioning (these are consistent with relevant SGP EIS mitigation commitments).

Further to the commitments provided within the SGP EIS and reproduced below, a number of other mitigation measures included within the Arrow Energy Species Management Program for Tampering with Animal Breeding Places (which was developed for the State Department of Environment and Science (DES) in March 2018) are of relevance and have been included in the list below.

In addition to the mitigation measures listed in Table 4.1, Arrow's response to, and reporting of, injury or mortality of EPBC Act fauna during construction, operation and decommissioning is described in Sections 3.1 and 3.2.

Table 4.1 Description of additional mitigation measures / commitments

Mitigation	Commitment	Intended outcome	Responsible manager/s
Construction - clearing	• See Table 3.1		
Construction - Open trench management	• Trenches will be inspected and monitored as per the APIA Code of Environmental Practice (B159) and will be checked within two hours of sunrise and trapped fauna released. Additional monitoring will be undertaken following rainfall events • The time a trench is left open will be minimised. Fauna exit points will be incorporated when construction is within 1 km of native vegetation, using appropriate material. Fauna refuges, such as sawdust-filled bags, will be provided regularly through areas of high fauna activity • As soon as practical following pipe laying, the trench will be backfilled with excavated material, compacted and topsoil replaced and erosion controls implemented	• To ensure that no unplanned impacts occur on Dunmall's Snake, Koala, Collared Delma or Yakka Skink	• SGP Construction Managers (Arrow and Third Party Contractor)
Construction - Reduce light spill	• Lighting will be designed in a manner that limits disruption on landscape character, views and visual amenity and lighting will be directed into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat	• To ensure that no unplanned impacts occur on the Koala, South-eastern Long-eared Bat and Greater Glider	• SGP Construction Managers (Arrow and Third Party Contractor)
Construction - Reduce project traffic speed	• Speed limits on Project controlled roads will be developed with due consideration to reduce the potential for vehicle collisions with wildlife	• To ensure that no unplanned impacts occur on Dunmall's Snake, Squatter Pigeon, Koala or Yakka Skink	• SGP Construction Managers (Arrow and Third Party Contractor)
Construction - Bushfire	• Fire management plans will be developed for production facilities • Radiation exclusion zones around flares will be designed according to API standard • Enclosed spaces where flammable gas may accumulate will be minimised • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards • Gathering lines will be buried at a minimum depth of 600 mm. Where gathering lines are present above the ground (at wellheads and at vents or drains), a clear area will be maintained. The size of the cleared area will be determined on a site-by-site basis with consideration of the site-specific risk of bushfire	• To avoid degradation of TECs • To avoid reduction in the condition of listed threatened species habitat	• SGP Construction Managers (Arrow and Third Party Contractor)

Mitigation	Commitment	Intended outcome	Responsible manager/s
	• Fire-safety equipment will be commissioned in the early phase of the construction period • All buildings and production facilities will be fitted with smoke or fire alarms • Fire and gas detection systems will be installed to shutdown compressors • Protocols will be developed for the control of operational activities during extreme fire danger periods, e.g., flaring or shutdowns • Regular patrols and inspections of pipeline easements will be conducted, including status of signposting subsidence and of fire breaks • Vegetation surrounding production facilities and wellheads will be maintained in a manner that limits the amount of combustible material in the area. The size of the cleared area will be determined on a site-by-site basis with consideration of the site-specific risk of bushfire • Access tracks to well sites will be kept clear of dry grass and combustible material wherever practicable and where there is a higher risk of bushfire (to minimise the risk of dry grass being ignited by hot components of vehicles accessing the sites) • Daily operations will be managed with consideration of the fire danger current at that time		
Construction / Operation / Decommissioning - Weed control	• A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species (B152). This plan will include requirements for machinery washdown procedures to be followed during all clearing activities • Weed monitoring and targeted weed control measures will be undertaken within sensitive EVNT habitats (particularly threatened communities such as Brigalow and native grasslands) (B158). Weed control methods within EVNT habitats will be selected on the basis of minimising the risk of adverse impacts on EVNT species or communities • In accordance with the Pest Management Plan regular inspections for pest flora and evidence of pest fauna will be undertaken within Project disturbed areas • Washdown facilities will be designed to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas • When sourcing maintenance materials, materials such as bedding sand, topsoil, straw bales and sand bags will be brought to site only after it is ascertained that the materials are not contaminated with weeds and plant or animal pathogens. A weed hygiene declaration form will be requested from the supplier where there is possible risk of	• To avoid degradation of TECs • To avoid reduction in the condition of listed threatened species habitat • Successful implementation of Arrow's Vehicle and Machinery Hygiene Procedure (ORG-ARW-HSM-PRO-00138) and Weed Management Procedure (ORG-ARW-HSM-PRO-00139)	• SGP Managers (Arrow and Third Party Contractor)

Mitigation	Commitment	Intended outcome	Responsible manager/s
	contamination in products • All relevant personnel will be made aware of the location and extent of weed infestations in the vicinity of the work area and the risks involved in moving from one site or property to another • A declared weed and pest management plan will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion. The pest management plan will include, as a minimum, training, management of pest spread, management of pest infestations and monitoring effectiveness of control measures		
Construction / Operation / Decommissioning – Pest control	• Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES	• Successful implementation of Arrow's Pest Management Procedure (ORG-ARW-HSM-PRO-00096)	• SGP Managers (Arrow and Third Party Contractor)
Operation - Grazing	• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites	• To avoid degradation of TECs • To avoid reduction in the condition of listed threatened species habitat	• SGP Operations Managers (Arrow)
Operation / decommissioning - Appropriate rehabilitation	• The cleared areas and stockpiles will be progressively rehabilitated through revegetation and/or mulching • Areas will be cleared progressively and rehabilitation implemented as soon as practicable following construction and decommissioning activities • Rehabilitation timeframes will be compliant with applicable Environmental Authority conditions and consider any landholder requirements/expectations • Rehabilitation plans will be developed addressing ground preparation requirements, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates • Rehabilitation of available areas will be undertaken that is consistent with pre-clearance habitats, to increase the rate of recovery	• To ensure that no unplanned impacts occur on MNES as a result of construction activities • To return the area to pre-disturbed condition (or better) as agreed with the landholder and as required by DES in order to grant progressive rehabilitation certification and EA surrender	• SGP Managers (Arrow and Third Party Contractor)

Mitigation	Commitment	Intended outcome	Responsible manager/s
	• Woody debris, logs and rocks will be retained for use in rehabilitation. Where practical, these will be piled along the edge of the cleared corridor. Where possible these features will be spread over all or part of the corridor to provide refugia for crossing fauna. Systematic removal of surface debris will be avoided and cleared timber will never be burnt • Data collection, particularly of EVNT species identified during pre-clearance surveys, during trench checking or in other Project related activities, will be ongoing until rehabilitation is complete • Site planning, preparation and management requirements will be implemented in accordance with a decommissioning and rehabilitation plan • After decommissioning, rehabilitation areas will be inspected for regrowth similar to the surrounding environment • Regular monitoring of rehabilitation success will be carried out • During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality • Excavations, particularly pipeline trenches and drilling sumps, will be backfilled and rehabilitated. Backfilling will be conducted in a manner that will promote successful rehabilitation, including capping of exposed subsoil with topsoil and replacement of the land surface to preconstruction levels to reduce trench subsidence and concentration of flow. Soils will be mounded where required to allow for settling. However, in laser-levelled paddocks, this may not be practicable, and backfilling will be carried out in consultation with the landowner • A rehabilitation management plan for decommissioning will be developed and implemented which includes monitoring and maintenance of rehabilitated areas until rehabilitation sign off criteria are met • Monitoring of the rehabilitated areas will be undertaken to identify whether the general objectives of the rehabilitation strategy are being met, and whether a sustainable and stable landform has been achieved. Monitoring will be conducted by suitably skilled and qualified persons at representative locations. Annual reviews of monitoring data will be conducted during operations, and post closure, to assess trends and performance • A final rehabilitation report and a decommissioning plan, including a contaminated land assessment where required, landowner commitments and agreements, and rehabilitation		

Mitigation	Commitment	Intended outcome	Responsible manager/s
	status, will be prepared and submitted to the appropriate authorities for approval where required • The area disturbed within the pipeline corridor during the laying of the pipelines will be progressively rehabilitated as soon as practicable after completion of the pipeline installation. Fences, roads and tracks and other existing infrastructure impacted during construction of the pipeline will be repaired and/or replaced as required • At decommissioning, a suitable vegetation cover will be re-established to enable natural vegetation progression and minimal weed invasion • Final ground conditions will be rehabilitated to a state that is conducive to support further natural regeneration at project closure		
Construction / Operation / Decommissioning - Documentation	• A Water Management Plan, Erosion and Sediment Control Plan, and Waste Management Plan will be designed to avoid or minimise the potential impacts of Project • Corrective actions will be undertaken in accordance with the outcomes of incident investigations, audits, monitoring results or advice given by the relevant regulatory authority • Arrow will develop emergency response plans in consultation with emergency services organisations that includes a list of required equipment, training and other resources, and foreseeable emergency and crisis situations. The plans will include safe evacuation procedures, communication protocols (internal and to emergency services, including the Petroleum and Gas Inspectorate), accounting for personnel and visitors, roles and responsibilities, and requirements for training • Any residual impacts to EPBC Act species and communities will be offset. A detailed SGP Phase 1 Offset Strategy and additional offset strategies for the subsequent phases will be developed and implemented to add value rather than just compensating for impact	• To ensure that the planned (and actual) impacts to MNES are accurately documented and offset	• Environment Manager (Arrow)
Construction / Operation / Decommissioning - Hazardous materials management	• Appropriate international, Australian and industry standards and codes of practice will be applied for the handling and storage of hazardous materials, such as chemicals, fuels and lubricants • Appropriate spill response equipment including containment and recovery equipment will be available onsite • Staff will be trained on appropriate handling, storage and containment practices for chemical, fuels and other potential chemicals as relevant	• To avoid degradation of TECs • To avoid reduction in the condition of listed threatened species habitat	• SGP Managers (Arrow and Third Party Contractor)

5. Monitoring program

Condition 7A(c): A monitoring program to determine the success of impacts avoidance and mitigation measures and that will inform adaptive implementation of the action for the duration of this approval.

Monitoring will be undertaken to determine the success of the mitigation and management measures identified within this SIMP and to identify whether the general objectives of the rehabilitation strategy are being met, and whether a sustainable and stable landform has been achieved. The monitoring program will focus on those sensitive ecological values at risk of a high level of residual impact and will be based on review and assurance of the environmental management plan active for the site. The plan will include reference to the relevant environmental impact management processes and procedures, assurance methods and incident response procedures.

Monitoring will be conducted by suitably skilled and qualified persons at representative locations. Annual reviews of monitoring data will be conducted during operations, and post closure, to assess trends and performance. Corrective actions will be undertaken based on the outcomes of incident investigations, audits, monitoring results and advice given by the relevant regulatory authority.

Table 5.1 sets out the monitoring program which will be undertaken which relate specifically to EPBC Act species and communities. The table describes the location, methods and proposed timing as well as identifying responsible parties, reporting formats, trigger values for corrective actions to be initiated and describes adaptive management responses and / or how they will be determined.

Note that Geocortex and the Arrow Sharepoint database, referred to in Table 5.1 is a web-based collaborative platform that integrates with Microsoft Office and allows multiple users to enter and view project data.

Table 5.2 identifies the indicators of success and corrective actions that correlate to each of the mitigation measures identified in Tables 3.1 and 4.1.

Table 5.1 Monitoring program components for EPBC Act species and communities

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
Review of compliance with approval conditions and SIMP mitigation measure commitments	The coordinates and total area of cleared EPBC Act species and community habitat will be recorded and tracked monthly against approved maximum disturbance limits and used for annual compliance reporting. All confirmed cases of non-compliance (and remedial actions) will be reported on the Arrow website. Monitoring and inspection of avoidance, mitigation and management measures will be implemented to ensure the impacts and residual risks continue to be low throughout the lifetime of the Project.	SGP activity areas	Clearing tracked & monitored monthly. Reporting to Dept annual except if non-compliance occurs – self report as per conditions.	Arrow	Annual Compliance Report	Non - compliances	As determined by Annual Compliance Reports
Pre- clearance surveys	Surveys to identify any additional areas that need to be avoided and quantify areas of EPBC Act species, species habitat or TEC which are unavoidable and will be cleared. As a minimum, these will include: • vegetation mapping at a scale suitable for site-specific planning. • identification of habitats for EVNT species.	Proposed vegetation clearing sites	Prior to all vegetation clearing Reported annually	Supervised by a suitably qualified person	Annual Pre - clearance Survey Report provided on the Arrow website	Clearances proposed which would result in the project exceeding the maximum disturbance limit for any EPBC Act species or	A more detailed assessment will be undertaken to identify if the EPBC Act species, habitat or community can be avoided or impacts minimised. Information on the findings and potential impacts will be prepared and notification provided

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
	• identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers. Quantification will be based on field recording of GPS coordinates of the boundary of the habitat within proposed clearing boundaries. These surveys will also be used to ensure that the limits of the area to be cleared are clearly marked on the ground (i.e. high visibility flagging tape, hazard netting or similar) in accordance with the construction limits shown on construction drawings.					communities including any residual significant impact to any of these that are not included in Table 1 of the EPBC approval.	to DotEE and Department of Environment and Science (DES). Approval for additional unavoidable residual significant impacts to any EPBC Act species or community (including any of these which were not in Table 1 of the EPBC approval) will be sought. Arrow also commits to providing offsets for any such additional residual significant impacts.
	Key Koala trees will be identified and visually inspected prior to clearing to ensure that they are free of Koalas.	Proposed vegetation clearing sites	Prior to vegetation clearing and daily during clearing works	Supervised by a suitably qualified person	Koala presence recorded within Geocortex and the Arrow Sharepoint database. Spotter-catcher daily activity records	Koalas located	Trees containing Koalas retained until the animals have moved on.
	Hollow-bearing tree locations and patches of vegetation with a distinct canopy and a dense cluttered shrub layer will be recorded.	Proposed vegetation clearing areas within habitat for MNES	Prior to vegetation clearing	Supervised by a suitably qualified person	Hollow-bearing trees and preferred habitat patches recorded within Geocortex and the Arrow Sharepoint database	Hollow-bearing tree and preferred habitat patches identified	Spotter-catcher present and search for this species in these areas during clearing.

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
	Trees will be assessed for potential nesting hollows prior to felling.	Proposed vegetation clearing sites	Prior to clearing	Supervised by a suitably qualified person	Nesting hollows recorded within Geocortex and the Arrow Sharepoint database. Spotter-catcher daily activity records.	Nesting hollows identified	Trees will be felled in the presence of a FSC and rolled so that the hollows are facing upwards, allowing fauna to escape.
	Data collection, particularly of EVNT species identified during pre-clearance surveys, during trench checking or in other SGP related activities, will be ongoing until rehabilitation is complete. Pre-clearance surveys will include searches for EVNT species and communities.	Predicted and known EVNT species locations	During pre-clearance surveys and checking of open trenches	Arrow	Recorded within Geocortex and the Arrow Sharepoint database	Clearances proposed which would result in the SGP exceeding the maximum disturbance limit for any EPBC Act species or communities including any residual significant impact to any of these which are not included in Table 1 of the EPBC approval.	A more detailed assessment will be undertaken to identify if the EPBC Act species, habitat or community can be avoided or impacts minimised before the clearing takes place. Information on the findings and potential impacts will be prepared and notification provided to DotEE and DES. Approval for additional unavoidable residual significant impacts to any EPBC Act species or community (including any of these which were not in Table 1 of the EPBC approval) will be sought. Arrow also commits to providing offsets for any

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
							such additional residual significant impacts.
Monitoring for unauthorised clearing	Audits/checks will be undertaken during and after clearing activities to ensure no unauthorised encroachment has occurred. Buffer zones and the Project footprint will be regularly monitored using satellite imagery.	Vegetation clearing areas	At least daily during clearing and at the completion of clearing	Construction contractor (environmental representative)	The Construction Contractor is required to report any unauthorised clearing to the Arrow Environment Manager within 24hrs of becoming aware.	Unauthorised Clearing	Review of CEMP with Construction Contractor and amendment as required.
Fauna spotter-catcher monitoring	A FSC will be present during clearing. The number of FSCs on site at the time of clearing will depend on the number of machines being used at any given time.	Active vegetation clearing areas	At all times during clearing	Suitably qualified FSCs as per the definition provided in EPBC 2010/5344	All human/wildlife interactions or incidents involving EVNT Act fauna species will be reported to Arrow via the Fauna Incident Notification Form (FIN) within 24 hours, and will be detailed in the FSC report to be provided to Arrow at the completion of habitat clearing activities (or weekly if clearing activities are ongoing). The FSC report will also	Injury to or mortality of individuals of EPBC Act species.	An investigation into possible root causes would be undertaken as well as a review of relevant mitigation measures and the CEMP and refinement of these where necessary.

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
					detail all human/wildlife interactions or incidents with any species irrespective of their conservation status. Interactions are defined as observations of the species on the work site, captures, removals and relocations. Incidents are defined as any injury or death.		
Inspection for fauna entrapment	Trenches will be inspected and monitored as per the APIA Code of Environmental Practice and will be checked within two hours of sunrise and trapped fauna released. Additional inspections will be undertaken after rainfall events.	All open trenches	At least daily whenever trenches are open	Suitably qualified person	Fauna rescue records	Injury to or mortality of individuals of EPBC Act species	Construction of additional fauna exit ramps / ladders; installation of additional trench plugs; increased frequency of inspections.
EPBC fauna presence and frequency monitoring	Data collection, particularly of EVNT species identified during pre-clearance surveys, during trench checking will be ongoing until rehabilitation is complete.	Representative habitat areas in proximity to project disturbed areas or infrastructure	Data collection ongoing/Opportunistic. Statistical analysis annual	Supervised by a suitably qualified person	Annual EPBC Monitoring Report	Statistically significant reduction in EPBC fauna frequency attributable to the SGP	An investigation into root causes would be undertaken as well as a review of relevant mitigation measures and the CEMP and refinement of these where necessary.

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
Analysis of EPBC Act fauna species mortality records	EVNT fauna mortality (e.g. road kill) record database will be maintained and analysed.	All SGP areas	Incident based throughout the life of the project	Arrow	Recorded within Geocortex and the Arrow Sharepoint database and reported in Annual Compliance Report	Any EVNT fauna mortalities caused by SGP activities	Dependence on the cause of mortality responses could include installation of warning signs or fencing and reduction in speed limits in specific locations.
EPBC Act community condition monitoring	Inspections for EPBC community health will be undertaken in accordance with the Queensland Government Department of Environment and Heritage Protection's Guide to determining terrestrial habitat quality – A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (2017).	Representative TEC areas in proximity to project disturbed areas or infrastructure	Annual	Supervised by a suitably qualified person	Annual EPBC Monitoring Report	A whole number fall in average habitat quality score for a TEC	An investigation into root causes would be undertaken within 3 months of a corrective action trigger as well as a review of mitigation measures and CEMP and refinement where necessary.
Weed and pest monitoring	Weed surveys (and targeted weed control measures) will be undertaken within sensitive EVNT habitats (particularly threatened communities such as Brigalow). In accordance with the Pest Management Plan regular inspections for pest flora and evidence of pest fauna will be undertaken within Project disturbed areas.	Representative Project disturbance areas within areas known to contain MNES.	At least quarterly and reported at least annually	Arrow	Annual EPBC Monitoring Report	New weeds recorded. Higher weed cover within disturbed areas relative to adjoining areas.	Additional weed management measures at problem locations. Review of Weed and Pest Management Plan.

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
	Surveys will also search for any new weed and pest species being introduced to an area.						
Rehabilitation monitoring	Pipeline RoWs will be regularly inspected until ground stabilisation and natural revegetation or pasture grasses or crops are established. After decommissioning, rehabilitation areas will be inspected for regrowth similar to the surrounding environment. Regular checks of rehabilitation success will be carried out). A rehabilitation management plan for decommissioning will be developed and implemented which includes inspections and maintenance of rehabilitated areas until rehabilitation sign off criteria are met. Surveys/inspections of the rehabilitated areas will be undertaken to identify whether the general objectives of the rehabilitation strategy are being met, and whether a sustainable and stable landform has been achieved. Surveys/inspections will be conducted by suitably skilled and qualified persons at representative locations. Annual reviews of	All Project disturbed areas	Post-construction, at least quarterly and reported annually	Supervised by a suitably qualified person	Annual EPBC Monitoring Report	Rehabilitation data trending away from, and prior to, non-achievement of rehabilitation completion criteria	An investigation into root causes would be undertaken within 3 months of the corrective action trigger including a review of the suitability of rehabilitation methods being applied.

Monitoring Activities	Methods / commitments	Locations	Timing	Who	Reporting format	Corrective action trigger values	Adaptive management responses
	surveys/inspection data will be conducted during operations, and post closure, to assess trends and performance.						
Offset area monitoring	As per EPBC Approval Conditions for the SGP (EPBC 2010/5344), no Project Phases will commence until an Offset Strategy addressing offset obligations for that Project Phase has been developed by Arrow and approved by the Minister. Each Strategy will set out a program for monitoring and reporting on the effectiveness of the management measures, and identify the performance and completion criteria to be tracked for the offset areas.	Offset areas	During the life of each offset area	Arrow	Offset progress reports which will feed into the Offset Strategies for subsequent Project Phases	These will be identified within each strategy / offset area management plan	These will be identified within each strategy / offset area management plan.

Table 5.2 Description of mitigation measures, indicators of success and corrective actions

Mitigation	Commitment	Indicator of success	Corrective action
Pre-construction clearance surveys / minimise clearing	• When the project activities proceed through the detailed planning phase, a field inspection of the specified disturbance footprint (this is specified by a surveyor in the field) will be undertaken by a suitably qualified ecologist and the presence, absence and extent of environmental values will be verified and mapped in the field via GIS. The results of this step will be recorded within Geocortex and the Arrow Sharepoint database. • Where environmental values are confirmed, a 'framing trade-offs' session will be held with the project engineers, planners and ecologists to determine if the location of the activities can be modified to avoid and/or reduce the impact to environmental values. In the event that EPBC species or community habitat cannot be avoided, the actual area to be cleared will be surveyed to quantify the impacts. This data will be recorded and cumulative impact areas tracked. • The disturbance footprint and vegetation clearing will be minimised. • The land cleared for construction purposes will be kept to the minimum necessary, especially during the drier months of the year. • Land disturbance will be minimised with the smallest practical area of land being disturbed in the shortest practicable time. • All operations will be planned to ensure minimal damage on any vegetation, cropping or pasture areas outside the limits to be cleared. • Disturbance within the following areas will be avoided where possible: – Endangered EPBC Act TECs: Brigalow Ecological Community; Coolibah-Black Box Woodlands; Weeping Myall Woodlands). – Core habitat for EVNT species. • Pre-clearance surveys will be conducted to identify any additional areas that need to be avoided. As a minimum, these will include: – vegetation mapping at a scale suitable for site-specific planning. – identification of habitats for EVNT species. – identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers.	• Preconstruction clearance surveys by a suitably qualified ecologist are conducted at every site of proposed activities in areas mapped as habitat for MNES • There is documented evidence that the management hierarchy described in Section 2 has been implemented at every site of proposed activities in areas mapped as habitat for MNES • Linear infrastructure easements (right-of-way) will be within the limits authorised by the Environmental Authority (EA) • The MNES impact areas are equal to or less than the impact areas shown in Tables 1.2 of this document	• Undertake preconstruction clearance surveys by suitably qualified ecologist • Investigate the cause of non-conformance with the management hierarchy and amend the relevant processes / procedures to avoid future non-conformance • Investigate the cause of non-conformance with EA conditions and amend the relevant processes / procedures to avoid future non-conformance • Notify the Department of the Environment and Energy of impacts beyond those shown in Table 1.2 and make the necessary adjustment in the Offset Strategy / Plan for the subsequent phase

Mitigation	Commitment	Indicator of success	Corrective action
	• Wells, gathering lines and access tracks will be located within previous clearings or non-remnant vegetation if possible. • Infrastructure will be designed to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks will be designed to avoid dissection. • Access track location will avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts. • Vegetation disturbance will be minimised wherever practical. Corridors for linear infrastructure will be as narrow as practical, particularly when crossing linear corridors of vegetation. Areas cleared for field development will be as small as practical. • Habitat trees will be retained where practicable. • Removal of riparian vegetation will be avoided when directional drilling and reduction of right of ways where practical. • Access tracks and pipelines will deviate around sensitive vegetation where practicable. • Sensitive infrastructure design principles will be applied to avoid watercourse, drainage lines and riparian areas where practicable. • Pre-clearance surveys will be undertaken to determine the likelihood of the species (including weeds) occurring. • Where EVNT species are identified in proposed development areas, consideration will be given to mitigation measures such as translocation and/or propagation of flora species. Progress of any translocation programs will be monitored in accordance with the relevant translocation management plans. • The width of construction RoWs will be minimised within areas of sensitivity to the greatest extent practicable without compromising the safety of workers. • Buffer zones will be adopted for Project activities (with the exception of required creek crossings), in different areas of constraint, as defined by the project's constraints mapping. • Tracks will be restricted in riparian zones and durations of impacts minimised, except in the immediate vicinity of creek crossings.		

Mitigation	Commitment	Indicator of success	Corrective action
	• During the design and construction of waterway crossings, care will be taken to minimise the footprint of the structure and to avoid unnecessary disturbance to stream beds and banks. • Where practical the width of the easement will also be narrowed at these points, further reducing impacts on stream banks, beds and riparian zones by restricting the area of waterway that would be disturbed. • Gathering line and access road creek crossings will be kept to a minimum where possible. • Watercourse crossings will be minimised, where practicable, during route selection. Where required, crossing locations will be selected to avoid or minimise disturbance to aquatic flora, waterholes, watercourse junctions and watercourses with steep banks. • Watercourse crossings will be designed to enable passage of flows resulting from a 1 in 100 year average recurrence interval flood event, as a minimum. • Gathering lines and tracks will be designed to avoid watercourses, drainage lines and riparian areas (particularly permanent watercourses or perennial aquatic habitat), where practicable. • Pipeline RoWs widths will be designed to be narrower at watercourse crossings, where practicable.		
Construction activities as per plan (no-go areas)	• Delineation of disturbance boundary limits of works will be clearly established prior to commencement of clearing and soil stripping. • Disturbance exclusion zones (or management buffers) will be established and managed during construction and operations to effectively protect ESAs as defined by the project's constraints mapping. • Trees will be felled away from existing vegetation not identified for removal where practicable. • Damage to trees (e.g. through scraping of tree trunk or breaking of limbs by equipment) not identified for removal will be avoided where practicable. • Avoidance boundaries will be clearly delineated prior to clearing. • Audits/checks will be undertaken during and after clearing activities to ensure no unauthorised encroachment has occurred.	• There is documented evidence that the management hierarchy described in Section 2 has been implemented at every site of proposed activities in areas of MNES • Fauna spotter catcher will be on site during clearing of any MNES • As constructed impact areas (i.e. the actual area in which clearing of any MNES has occurred) are accurately documented	• Investigate the cause of non-conformance with the management hierarchy and amend the relevant processes / procedures to avoid future non-conformance • Ensure fauna spotter catcher is on site during clearing of any MNES • Ensure site works / clearing boundaries are accurately marked in the field

Mitigation	Commitment	Indicator of success	Corrective action
	• Construction activities in sensitive areas will be supervised to ensure appropriate methods (e.g., narrowing of RoW) are being implemented, where required. • Construction that will potentially affect waterways will occur during dry months (periods of low rainfall and low flow) where possible. The use of machinery and vehicles on stream beds and banks will be avoided wherever possible. • Trenching will be perpendicular to the creek where the gathering line crosses waterways. • Where possible trenching within or in the vicinity of watercourses will occur during the drier months of the year, which will reduce the potential for water quality decline as a result of sediment mobilisation. • Buffer zones and the Project footprint will be regularly monitored using satellite imagery. • Watercourse crossings will be constructed in a manner that minimises sediment release to watercourses, stream bed scouring, obstruction of water flows and disturbance of stream banks and riparian vegetation (i.e., the crossing location will be at a point of low velocity, and straight sections will be targeted, with the pipeline or road orientated as near to perpendicular to water flow as practicable). • Transport of equipment across watercourses will be avoided unless an appropriate crossing that minimises disturbance to the watercourse bed and banks and to riparian vegetation is available. • Construction and maintenance activities will be planned to minimise movement of plant and equipment between properties or areas with weed infestations.	• The MNES impact areas are equal to or less than the impact areas shown in Tables 1.2 of this document • Significant disturbance to watercourses will occur when there is no or low flow • High risk weeds are managed as per Arrow's Weed Management Procedure (ORG-ARW-HSM-PRO-00139)	• Early and clear communication of the tracking of actual versus authorised MNES impact areas and relocate future infrastructure to avoid MNES if actual impact is expected to exceed authorised impact • Revise plans of significant disturbance to watercourses to occur when there is no or low flow or improve erosion and sediment controls when such works occur during conditions of water flow • Reinforce the requirement to follow Arrow's Weed Management Procedure
Clear Communication	• Harassment of wildlife and the unauthorised collection of flora or fauna will be prohibited, unless directed by a suitably qualified and experienced person.	• Records of preconstruction 'tool box' sessions / advices provided to construction crews demonstrating compliance	• Investigate the cause of non-conformance and amend the relevant processes / procedures to avoid future non-conformance or apply appropriate measures if deemed a significant breach of conduct rules

Mitigation	Commitment	Indicator of success	Corrective action
Protection of topsoils	• Soil will be stripped according to designated profile depths, subject to further field investigations during stripping. • Where practicable, stripped material will be placed directly onto area to be rehabilitated and spread immediately (if rehabilitation sequences and weather conditions permit) to avoid the requirement for stockpiling. • Soils will be separated into windrows for later collection or re-spreading to minimise compression effects of heavy equipment. • Soil transported by dump trucks may be placed directly into storage. Soil transported by scrapers will be pushed to form stockpiles by other equipment (e.g. dozer) to avoid tracking over previously laid soil to minimise compaction. • Surface of soil stockpiles will be left in as coarsely structured a condition as possible to promote infiltration and minimise erosion until vegetation is established or suitable erosion controls have been applied, and to prevent anaerobic zones from forming. • Pipeline construction will be conducted in a manner that limits the duration of exposure of soils. Stripped and salvaged soil will be re-used within a short period of time (i.e. 28 days) in areas where rehabilitation immediately follows the installation of pipelines. • Erosion and Sediment Control Plans will be developed and maintained in accordance with the International Erosion Control Association (IECA) (2008) Best Practice Erosion and Sediment Control guidelines. All proposed erosion and sediment control measures will be implemented in advance of, or in conjunction with clearing activities. • Topsoil will be stripped, salvaged and stockpiled separately from subsoils. • Appropriate sediment and erosion control structures will be installed and maintained at work sites. • Best practice erosion and sediment control measures will be implement during decommissioning works in accordance with the requirements of the IECA (2008) Best Practice Erosion and Sediment Control manual.	• Erosion and Sediment Control Plans (inclusive of topsoil management specifications) in place and implemented prior to all clearing activities.	• Development and implementation of Plans
Open trench management	• Trenches will be inspected and monitored as per the APIA Code of Environmental Practice and will be checked within two hours of sunrise and trapped fauna released. Additional inspections will be undertaken following rainfall events.	• Site records / photographs demonstrating compliance	• Investigate the cause of non-conformance and amend the relevant processes / procedures to avoid future non-

Mitigation	Commitment	Indicator of success	Corrective action
	• The time a trench is left open will be minimised. Fauna exit points will be incorporated when construction is within 1 km of native vegetation, using appropriate material. Fauna refuges, such as sawdust-filled bags, will be provided regularly through areas of high fauna activity. • Harm to fauna from entrapment during construction and operation of dams will be prevented. • As soon as practical following pipe laying, the trench will be backfilled with excavated material, compacted and topsoil replaced and erosion controls implemented.		conformance
Fauna spotter catcher	• Suitably qualified fauna spotter-catcher (FSC) or ecologist will capture injured wildlife, where possible. Injured wildlife resultant from land clearing will be taken to a qualified veterinary surgeon or carer where practical (B153). The FSC will be at the site on the day of clearing. The FSC will be suitably qualified as per the definition provided in EPBC 2010/5344. The number of FSCs on site at the time of clearing will depend on the number of machines being used at any given time. • Trees will be assessed for potential nesting hollows prior to felling. If hollows are identified, trees will be felled in the presence of a qualified FSC and rolled so that the hollows are facing upwards, allowing fauna to escape. • Key Koala trees will be identified and visually inspect prior to clearing to ensure that they are free of Koalas. If Koalas are located, the tree will be retained until the animals have moved on, typically overnight. • Checks for identified EPBC Act fauna species breeding places will be undertaken immediately prior to commencing vegetation clearing. • Potential breeding places will be clearly marked in the field with spray paint, coloured flagging tape (unless not permitted by land owners, e.g. some cattle properties), or by other suitable methods.	• Review of spotter/catcher records / notes demonstrates compliance • Potential breeding places are clearly marked in the field	• Reinforce the requirement to follow Arrow's Fauna Spotter/Catcher Work Instruction document (ORG-ARW-AND-WOI-00001) • Investigate the cause of non-conformance and amend the relevant processes / procedures to avoid future non-conformance
Appropriate rehabilitation	• The cleared areas and stockpiles will be progressively rehabilitated through revegetation and/or mulching. • Areas will be cleared progressively and rehabilitation implemented as soon as practicable following construction and decommissioning activities.	• Inspection of site during and after installation of infrastructure demonstrates compliance • That the area has been returned to pre-disturbed	• Early and clear communication with the construction crew if inspections are not demonstrating compliance

Mitigation	Commitment	Indicator of success	Corrective action
	• Rehabilitation timeframes will be compliant with applicable Environmental Authority conditions and consider any landholder requirements/expectations. • Rehabilitation plans will be developed addressing ground preparation requirements, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates. • Rehabilitation of available areas will be undertaken that is consistent with pre-clearance habitats, to increase the rate of recovery. • Woody debris, logs and rocks will be retained for use in rehabilitation. Where practical, these will be piled along the edge of the cleared corridor. Where possible these features will be spread over all or part of the corridor to provide refugia for crossing fauna. Systematic removal of surface debris will be avoided and cleared timber will never be burnt. • Data collection, particularly of EVNT species identified during pre-clearance surveys, during trench checking or in other Project related activities, will be ongoing until rehabilitation is complete. • Site planning, preparation and management requirements will be implemented in accordance with a decommissioning and rehabilitation plan. • After decommissioning, rehabilitation areas will be inspected for regrowth similar to the surrounding environment. • Regular monitoring of rehabilitation success will be carried out. • During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality. • Excavations, particularly pipeline trenches and drilling sumps, will be backfilled and rehabilitated. Backfilling will be conducted in a manner that will promote successful rehabilitation, including capping of exposed subsoil with topsoil and replacement of the land surface to preconstruction levels to reduce trench subsidence and concentration of flow. Soils will be mounded where required to allow for settling. However, in laser-levelled paddocks, this may not be practicable, and backfilling will be carried out in consultation with the landowner.	condition (or better) as agreed with the landholder and as required by DES in order to grant progressive rehabilitation certification and EA surrender. • Progressive rehabilitation certification is granted by the Department of Environment and Science (DES) when requested. • The EA surrender application including the Final Rehabilitation Report and landholder signoff is granted by the DES.	• Continued remediation and rehabilitation of the disturbed areas until the progressive rehabilitation certification is granted • Continued remediation and rehabilitation of the disturbed areas until the EA surrender application is granted

Mitigation	Commitment	Indicator of success	Corrective action
	• A rehabilitation management plan for decommissioning will be developed and implemented which includes monitoring and maintenance of rehabilitated areas until rehabilitation sign off criteria are met. • Monitoring of the rehabilitated areas will be undertaken to identify whether the general objectives of the rehabilitation strategy are being met, and whether a sustainable and stable landform has been achieved. Monitoring will be conducted by suitably skilled and qualified persons at representative locations. Annual reviews of monitoring data will be conducted during operations, and post closure, to assess trends and performance. • A final rehabilitation report and a decommissioning plan, including a contaminated land assessment where required, landowner commitments and agreements, and rehabilitation status, will be prepared and submitted to the appropriate authorities for approval where required. • The area disturbed within the pipeline corridor during the laying of the pipelines will be progressively rehabilitated as soon as practicable after completion of the pipeline installation. Fences, roads and tracks and other existing infrastructure impacted during construction of the pipeline will be repaired and/or replaced as required. • At decommissioning, a suitable vegetation cover will be re-established to enable natural vegetation progression and minimal weed invasion. • Final ground conditions will be rehabilitated to a state that is conducive to support further natural regeneration at project closure.		
Reduce light spill	• Lighting will be designed in a manner that limits disruption on landscape character, views and visual amenity and lighting will be directed into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat.	• No lighting directed towards intact MNES habitat	• Lighting redirected or shielded away from intact habitat
Reduce project traffic speed	• Speed limits on Project controlled roads will be developed with due consideration to reduce the potential for vehicle collisions with wildlife.	• Review reports generated from Arrow's In-Vehicle Monitoring System (IVMS)	• Clear communication and warning for any IVMS breaches
Weed control	• A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species. This plan will include requirements for machinery washdown procedures to be followed during all clearing activities.	• Inspection of site after installation of infrastructure demonstrates compliance • High risk weeds are managed as per Arrow's Weed	• Reinforce the requirement to follow Arrow's Vehicle and Machinery Hygiene Procedure (ORG-ARW-

Mitigation	Commitment	Indicator of success	Corrective action
	• Weed monitoring and targeted weed control measures will be undertaken within sensitive EVNT habitats (particularly threatened communities such as Brigalow and native grasslands). Weed control methods within EVNT habitats will be selected on the basis of minimising the risk of adverse impacts on EVNT species or communities. • In accordance with the Pest Management Plan regular inspections for pest flora and evidence of pest fauna will be undertaken within Project disturbed areas. • Washdown facilities will be designed to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas. • When sourcing maintenance materials, materials such as bedding sand, topsoil, straw bales and sand bags will be brought to site only after it is ascertained that the materials are not contaminated with weeds and plant or animal pathogens. A weed hygiene declaration form will be requested from the supplier where there is possible risk of contamination in products. • All relevant personnel will be made aware of the location and extent of weed infestations in the vicinity of the work area and the risks involved in moving from one site or property to another. • A declared weed and pest management plan will be developed in accordance with the Petroleum Industry – Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion. The pest management plan will include, as a minimum, training, management of pest spread, management of pest infestations and monitoring effectiveness of control measures.	Management Procedure (ORG-ARW-HSM-PRO-00139)	HSM-PRO-00138) and Weed Management Procedure
Grazing	• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites.	• Livestock absent from infrastructure sites	• Reinstate integrity of exclusion fencing
Documentation	• A Water Management Plan, Erosion and Sediment Control Plan, and Waste Management Plan will be designed to avoid or minimise the potential impacts of Project. • Corrective actions will be undertaken in accordance with the outcomes of incident investigations, audits, monitoring results or advice given by the relevant regulatory authority.	• Water Management Plan, Erosion and Sediment Control Plan, and Waste Management Plan in place for the Project and Offset Strategy in place for	• Develop and implement required plans • Investigate the cause of non-conformance and amend the relevant

Mitigation	Commitment	Indicator of success	Corrective action
	• Arrow will develop emergency response plans in consultation with emergency services organisations that includes a list of required equipment, training and other resources, and foreseeable emergency and crisis situations (including escapes, blowouts, gas fire, bushfire, critical equipment failure, trapped or missing people, flooding, cyclones, power failure, security incidents and threats, and transport incidents). The plans will include safe evacuation procedures, communication protocols (internal and to emergency services, including the Petroleum and Gas Inspectorate), accounting for personnel and visitors, roles and responsibilities, and requirements for training. • Any residual impacts to EPBC Act species and communities will be offset. A detailed SGP Phase 1 Offset Strategy and additional offset strategies for the subsequent phases will be developed and implemented to add value rather than just compensating for impact.	relevant phase of the Project	processes / procedures to avoid future non-conformance
Hazardous materials management	• Appropriate international, Australian and industry standards and codes of practice will be applied for the handling and storage of hazardous materials, such as chemicals, fuels and lubricants. • Appropriate spill response equipment including containment and recovery equipment will be available onsite. • Staff will be trained on appropriate handling, storage and containment practices for chemical, fuels and other potential chemicals as relevant.	• Records of training provided to construction crews demonstrating compliance	• Undertake and record evidence of such training • Investigate the cause of non-conformance and amend the relevant processes / procedures to avoid future non-conformance
Bushfire	• Fire management plans will be developed for production facilities. • Radiation exclusion zones around flares will be designed according to API standard. • Enclosed spaces where flammable gas may accumulate will be minimised. • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards. • Gathering lines will be buried at a minimum depth of 600 mm. Where gathering lines are present above the ground (at wellheads and at vents or drains), a clear area will be maintained. The size of the cleared area will be determined on a site-by-site basis with consideration of the site-specific risk of bushfire. • Fire-safety equipment will be commissioned in the early phase of the construction period.	• Fire management plans in place and implemented prior for all production facilities	• Development and implementation of required plans • Investigate the cause of non-conformance and amend the relevant processes / procedures to avoid future non-conformance

Mitigation	Commitment	Indicator of success	Corrective action
	• All buildings and production facilities will be fitted with smoke or fire alarms. • Fire and gas detection systems will be installed to shutdown compressors. • Protocols will be developed for the control of operational activities during extreme fire danger periods, e.g., flaring or shutdowns. • Regular patrols and inspections of pipeline easements will be conducted, including status of signposting subsidence and of fire breaks. • Vegetation surrounding production facilities and wellheads will be maintained in a manner that limits the amount of combustible material in the area. The size of the cleared area will be determined on a site-by-site basis with consideration of the site-specific risk of bushfire. • Access tracks to well sites will be kept clear of dry grass and combustible material wherever practicable and where there is a higher risk of bushfire (to minimise the risk of dry grass being ignited by hot components of vehicles accessing the sites). • Project vehicles will not be driven or parked off-track in situations that are a high risk of igniting a grass fire. • Daily operations will be managed with consideration of the fire danger current at that time.		

6. Consistencies with relevant documents

Condition 7A(d): A description of how measures proposed in the EPBC Species Impact Management Plan are consistent with the measures in relevant conservation advice, recovery plans and threat abatement plans.

Table 6.1 Relevant documents for each of the MNES addressed by this SIMP

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
Terrestrial Species				
Curly-bark Wattle (*Acacia curranii*)	• Advice dated 1 October 2008 • Focuses on grazing and fire management	• Not Required – included on the 'Not Commenced' list	• The main identified threats to Curly-bark Wattle are habitat erosion, grazing by feral goats, stock, rabbits and macropods; clearing of vegetation for fire trail widening	• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards
Hando's Wattle (*Acacia handonis*)	• Advice dated 1 October 2008 • Focuses on inappropriate fire regimes	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards
Belson's Panic (*Homopholis belsonii*)	• Advice dated 1 October 2008 • Focuses on loss of populations via habitat clearing for agriculture and mining; grazing and weed invasion	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Inspect work sites and access routes for notifiable weeds and pest plants and animals prior to accessing the site • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
Lobed Blue Grass (*Bothriochloa biloba*)	• Advice dated 14 December 2013 • No current known threats. Potential threats are grazing and weed invasion	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Inspect work sites and access routes for notifiable weeds and pest plants and animals prior to accessing the site • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites
Kogan Waxflower (*Philotheca sporadica*)	• Advice dated July 2008 • Loss of large roadside populations is biggest risk due to insecure land tenure	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Pre-clearance surveys to avoid the species where possible • Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries
Prostanthera sp *Dunmore*	• Advice dated 1 October 2008 • Main threats habitat degradation via timber harvesting; inappropriate fire regimes	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards
Small-leaved Denhamia (*Denhamia parvifolia*)	• Advice dated 16 December 2008 • Main threats are the legacy of broad-scale clearing; changed fire regimes; grazing; weed	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
	invasion			• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Inspect work sites and access routes for notifiable weeds and pest plants and animals prior to accessing the site • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites
Calytrix gurulmundensis	• Advice dated 1 October 2008 • Main threats are clearing; fragmentation; changed fire regimes; quarrying; timber harvesting	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities
Finger Panic Grass (*Digitaria australe*)	• Advice dated 14 December 2013 • Main threats are clearing for agriculture; fragmentation; fire; trampling by livestock	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities • Grazing activities will be excluded from all Arrow gas and water processing and well head

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
				infrastructure sites
Austral Toadflax (*Thesium australe*)	• Advice dated 17 December 2013 • Main threats are lack of fire; grazing; clearing for development; weed invasion	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Minimise the disturbance footprint and vegetation clearing • Inspect work sites and access routes for notifiable weeds and pest plants and animals prior to accessing the site • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites
Acacia lauta	• Advice dated 1 October 2008 • Threats largely unknown. Susceptible to clearing for road widening and too frequent fire	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities
Cobar Greenhood Orchid (*Pterostylis cobarensis*)	• Advice dated 14 December 2013 • Main threats are grazing by feral goats; broad-scale clearing; changed hydrology and salinity; weed invasion	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Rehabilitation plans will be developed addressing ground preparation requirements, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length,

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
				vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates • Rehabilitation of available areas will be undertaken that is consistent with pre-clearance habitats, to increase the rate of recovery
Xerothamnella herbacea	• Advice dated 1 October 2008 • Main threats competition from invasive plants; road widening; trampling	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites
Hawkweed (*Picris evae*)	• Advice dated 1 October 2008 • The main threats are weed invasion; inappropriate fire regimes; habitat fragmentation; clearing of vegetation for cropping and grazing	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Fire management plans will be developed for production facilities • Minimise the disturbance footprint and vegetation clearing
Austral Cornflower (*Rhaponticum australe*)	• Advice dated 16 December 2008 • The main threats include broad-scale vegetation clearing; invasion by exotic weeds; grazing pressure and road works	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
Eucalyptus virens	• Advice dated 16 December 2008 • The main threats include timber harvesting; loss of habitat due to vegetation clearing	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries
King Bluegrass (*Dichanthium queenslandicum*)	• Advice dated 30 January 2013 • Focuses on habitat loss via agriculture and mining; grazing; weed invasion	• Recovery Plan is required	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites
Queensland White-gum (*Eucalyptus argophloia*)	• Advice dated 1 October 2008 • Main threat is habitat destruction for agriculture and grazing; timber harvesting; road widening	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts
South-eastern Long-eared Bat (*Nyctophilus corbeni*)	• Advice dated October 2015 • Protect known and potential habitat of key populations from habitat loss and	• Required – included on the 'Commenced' list • Recovery objectives are to increase understanding of	• No Plan has been identified as being relevant for this species • Key threats are provided in the	• No clearing will occur in the Eena, Bracker or Barakula State Forests • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
	fragmentation (Eena SF, Bracker SF and Barakula SF in Qld)	basic ecology and to clarify distribution and abundance	conservation advice	
Dunmall's Snale (*Furina dunmalli*)	• Advice dated April 2014 • Legacy of past broad scale land clearing for grazing and agriculture • Manage disruptions to water flow and modifications to wetlands; investigate conservation arrangements	• Not required – see Conservation Advice	• No Plan has been identified as being relevant for this species • Key threats are provided in the conservation advice	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Rehabilitation plans will be developed addressing ground preparation requirements, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates • Rehabilitation of available areas will be undertaken that is consistent with pre-clearance habitats, to increase the rate of recovery
Five-clawed Worm-skink (*Anomalopus mackayi*)	• Advice dated 26 March 2008 • Main threat is habitat clearing for agriculture and development; overgrazing; predation from foxes and feral cats; soil and water pollution	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES • Rehabilitation plans will be developed addressing ground preparation requirements, natural and

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
				constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates
Squatter Pigeon (*Geophaps scripta scripta*)	• Advice dated Oct 2015 • Nests on the ground • Manage habitat loss and fragmentation, overgrazing by livestock and rabbits, weeds, inappropriate fire regimes, predation by feral cats and fox and illegal shooting	• Not required – see conservation advice	• The *Threat abatement plan for predation by cats* (DoE, 2015a) is identified as relevant • *The threat abatement plan for competition and land degradation by rabbits* (DotEE, 2016) is identified as relevant • The *Threat abatement plan for predation by European red fox* (DEWHA, 2008c) is identified as relevant • Squatter Pigeon identified as a species being affected by rabbits	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites • Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES • Fire management plans will be developed for production facilities • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
			(through habitat degradation) and by feral cats (through predation).	
Regent Honeyeater (*Anthochaera phrygia*)	• Advice dated 8 July 2015 • Focuses on clearing of mature trees; fragmentation; inappropriate fire regimes	• Recovery Plan is required	• A broader plan targeting competition and land degradation from rabbits is linked to this species	• When clearing vegetation, seek to avoid clearing hollow-bearing trees, creating gaps in stands or patches or isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards
Collared Delma (*Delma torquata*)	• Advice dated 3 July 2008 • Main threats loss of habitat from urban and agricultural development; removal of surface rocks; weed invasion	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Rehabilitation plans will be developed addressing ground preparation requirements, retaining surface rocks, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion)
Yakka Skink (*Ergernia rugosa*)	• Advice dated 29 April 2014 • Main threats are legacy clearing; agricultural	• Not Required – included on the 'Not Commenced' list	• No Plan has been identified as being relevant for this species	• Rehabilitation plans will be developed addressing ground preparation requirements, retaining woody debris and surface rocks, natural and constructed drainage patterns, soil erodibility,

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
	development; removal of wood debris; inappropriate roadside maintenance; predation by feral animals			contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) • Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES
Australian Painted Snipe (*Rostratula australis*)	• Advice dated 30 May 2013 • Main threat is loss or degradation of wetlands; potential predation by foxes and cats	• Recovery Plan required	• No Plan has been identified as being relevant for this species	• Avoid totally, or where not possible minimise the disturbance footprint and clearing of wetlands • Rehabilitation of available areas will be undertaken that is consistent with pre-clearance habitats, to increase the rate of recovery • Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES
Koala	• Advice dated April 2012 • Manage habitat loss and fragmentation, vehicle strike, disease and predation by dogs	• Multiple National and State-based plans	• Multiple National and State-based plans	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife • Arrow will manage food, waste and other project activities to prevent or minimise the potential for

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
				these to transport or attract pest animals which may then impact MNES
Greater Glider	• Advice dated May 2016 • Cumulative effects of clearing and logging activities, current burning regimes and the impacts of climate change are a major threat to large hollow-bearing trees on which the species relies	• Recovery Plan required	• No Plan has been identified as being relevant for this species • Key threats are provided in the conservation advice	• Minimise the disturbance footprint and vegetation clearing • When clearing vegetation, seek to avoid clearing hollow-bearing trees, creating gaps in stands or patches or isolating parcels of remnant vegetation from more continuous tracts • Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk assessments and relevant legislation and standards
Painted Honeyeater	• Advice dated July 2015 • Habitat loss is the key threat to this species	• Recovery Plan required	• No Plan has been identified as being relevant for this species • Key threats are provided in the conservation advice	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries
EPBC Communities				
Brigalow (*Acacia harpophylla* dominant and co-dominant)	• Advice dated December 2013 • Qld Government *Brigalow and Other Lands Development Act 1962* and *Brigalow Development Scheme* encouraged and funded the clearing of Brigalow	• Recovery Plan required	• No relevant Plan • Links to the *Threat Abatement Plan for the biological effects* is provided on the DotEE webpage	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • Fire management plans will be developed for production facilities • Fire-fighting equipment will be installed, inspected and serviced in accordance with risk

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
	to increase cattle stocking rates • Key threats to remaining populations are clearing, fire, weeds, feral animals and grazing			assessments and relevant legislation and standards • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites • Arrow will manage food, waste and other project activities to prevent or minimise the potential for these to transport or attract pest animals which may then impact MNES • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites
Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregion	• Advice dated 10 February 2011 • Main threats clearing and fragmentation; changes to hydrology; grazing; weed invasion	• Recovery Plan required	• No Plan has been identified as being relevant for this species	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Rehabilitation plans will be developed addressing ground preparation requirements, natural and constructed drainage patterns, soil erodibility, contamination, slope steepness and length, vegetation cover, land use and landowner requirements. Partial rehabilitation of gathering lines and other linear infrastructure will be undertaken to reduce edge effects (including weed invasion) and maintain movement rates • Grazing activities will be excluded from all Arrow gas and water processing and well head infrastructure sites

MNES	Conservation Advice	Recovery Plan	Threat Abatement Plan	SIMP Consistency (Control measures included in Tables 3.1, 4.1 and 5.5 – the following are relevant to the particular MNES)
				• Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites
Weeping Myall Woodlands	• Advice dated December 2008 • Manage clearing and degradation for agriculture and from overgrazing, weed invasion and herbivory by caterpillars of the Bag-shelter Moth	• Recovery Plan required	• The *Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads* (DSEWPAC, 2011) is identified as relevant	• Minimise the disturbance footprint and vegetation clearing • Ensure construction activities do not extend beyond the work site boundaries • When clearing vegetation, seek to avoid creating gaps in stands or patches and to avoid isolating parcels of remnant vegetation from more continuous tracts • Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites

7. Commencement of Stage 1

Condition 7B: The approval holder must not commence Stage 1 until an EPBC Species Impact Management Plan has been approved by the Minister in writing. The approved EPBC Species Impact Management Plan must be implemented by the approval holder.

Arrow provides the commitment that the Surat Gas Project will not commence until this EPBC Species Impact Management Plan has been approved by the Minister or delegate and that this EPBC Species Impact Management Plan will be implemented.

8. References

Arrow Energy (2012). Surat Gas Project Environmental Impact Statement.

Arrow Energy (2013). Supplementary Report to the Surat Gas Project Environmental Impact Statement.

Biosecurity Queensland (2008). Petroleum Industry (Including Coal Seam Methane Gas) Minimising Pet Spread Advisory Guidelines.

Department of Environment and Heritage Protection (2017). Queensland Environmental Offsets Policy. Version 1.4.

International Erosion Control Association (IECA) (2008). Best Practice Erosion and Sediment Control Guidelines.

9. Document Administration

This document has been created using ORG-ARW-IMT-TEM-00003 v4.0

Revision history

Revision	Revision Date	Revision Summary	Author
0.1	28 August 2017	Draft	M. Ryan
1.0	5 June 2018	Final	M. Ryan
2.0	27 July 2018	Revised Final	M. Ryan
3.0	15 October 2018	SIMP only Draft	M. Ryan
4.0	20 November 2018	Final SIMP	M. Ryan

Key document location

Confidential Project Pearl Drive

Related documents

Document Number	Document title

Acceptance and release

Author

Position	Incumbent
Manager Approvals	Michael Ryan

Contributors and reviewers

Position	Incumbent
Principal Ecologist	Paul Finn
Projects Environment Manager	Alison Way
Environment Manager	Scott Nairn
Manager Tenements and Overlapping Tenure	Suzanne Ferguson
SGP FEDM	Nathan Blundell
SGP Development Planning Lead	Taco Viets
Development Planner IFL	Chris Wicks

Approver(s)

Position	Incumbent
General Manager Surat Opportunities	Guy Young

arrow energy
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APPENDIX A

Curriculum vitae of the suitably qualified ecologists that prepared the SIMP

Summary

Name	Qualifications	Years of Experience	Experience
Dr Michael Ryan (Author)	B. App. Sc; PhD (Ecology)	28	• 80 EIAs • 30 EPBC Referrals • 23 years of fauna field surveys
Dr Paul Finn (Technical Authority for SIMOP Review)	B. Sc (Hons); PhD (ecology)	19	• Detailed fauna and flora surveys • Targeted threatened species surveys and management plans • Migratory shorebird specialist
David Stanton (Flora surveys lead)	B. Sc (Hons)	24	• Professional and academic award winner • Extensive flora experience
Mark Sanders (Fauna surveys lead)	B. Sc (Hons)	20	• One of Australia's most respected field ecologists
Peter Hall (Future pre-clearance surveys)	B.Sc	20	• Flora surveys • Ecosystem assessment and validation • Habitat assessments • Land zone and soil classification

Dr Michael Ryan

Approvals Manager - Arrow Energy

Expertise

- Management of complex multi-disciplinary projects
- Advising and leading teams to deliver environmental impact and risk assessments
- Environmental legislation and approval processes

Summary

Dr Ryan is an experienced manager / director, having supervised and authored more than 80 environmental impact and risk assessments for development projects. Michael has an excellent working knowledge of Commonwealth and Queensland environmental approvals legislation for development projects (both primary and secondary approvals). For the last three years Michael has been the Approvals Manager for Arrow Energy and guest lecturer to post-graduate students at Bond University in Environmental Impact Assessment.

Michael sought and attained the collaboration of the Australian Government, the Queensland Government and the Western Australian Government in delivering joint half day pre-conference workshops on 'How to prepare a good EIS'. He is passionate about sharing knowledge and published the *Essentials Package for Successful Environmental Consulting*, a practical guidebook to assist practitioners on how to manage Environmental Impact Assessments, influence decision-makers and deliver agreed environmental outcomes.

He has excellent communication skills, both written and verbal, and has used these skills in negotiations and conflict resolution across all levels of government and non-government organizations.

Michael was selected by BHP Billiton to manage and author the Environmental Impact Statement (EIS) for the multi-billion dollar Olympic Dam mining and processing plant expansion in South Australia. He was also the Director and principal author for BHP Billiton's proposed Yeelirrie uranium mine in Western Australia. Michael was appointed as the Lead Environmental Consultant for Xstrata Copper (now Glencore) for the proposed Mount Isa Mines Open Pit Project in Queensland and the Tampakan Off Lease Linear Infrastructure Project in the Philippines.

Michael is innovative in his application of management standards to help organizations maximise socio-economic benefits, minimise impacts; comply with applicable laws and regulations; and develop frameworks for continual improvement via succinct guidelines, standards, management plans and monitoring programs.

Michael has extensive experience with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* having been an invited speaker on the EPBC Act for the Queensland Environmental Law Association, Environmental Protection Agency and the Queensland Resources Council. In October 2009, Michael was an invited speaker on achieving the balance between environmental legislation and company leadership at the China Mining 2010 Conference in Tianjin, China.

Qualifications

Bachelor of Applied Science, Queensland University of Technology, 1989
Doctor of Philosophy, Ecology, University of Queensland, 1996

Projects as Gamut Consulting

Olympic Dam Expansion Investigation Phase Study Reports

Year: 2013 - 2014

Location: Semi-arid central South Australia (Roxby Downs)

Client: BHP Billiton

Main project features: BHP Billiton is re-investigating the mining and processing options for the previously approved expansion project.

Position held: Lead Environmental Consultant

Activities performed: Michael is assisting the BHP Billiton Environment Group with their Investigation Phase Study by developing the following:

- a Legal and Regulatory Approvals Register
- initial HSEC risk assessments and a Risk Register
- to document the likely process, scope and requirements of a future whole-of-project Environmental and Social Impact Assessment (ESIA)
- a global benchmarking study report on heap leach facilities
- a strategy for the timing, purpose and key messages for engagement with the Australian and South Australian governments in relation to five different water supply options.

Olympic Dam Mine Expansion Environmental and Social Impact Assessment

Year: 2004 - 2011

Location: Semi-arid central South Australia (Roxby Downs)

Client: BHP Billiton

Main project features: Major expansion of an existing mine to increase production from 200,000 tonnes/annum (tpa) copper cathodes to 350,000 tpa copper cathodes, 1.6 Mtpa copper concentrate, 1M ounces of silver, 270,000 ounces of gold and 17,000 tpa of uranium oxide. Also included 72 Mtpa of ore processing; 280 mega litre (ML)/day coastal desalination plant; 320 km water supply pipeline; 50 ML groundwater wellfield; 270 km electrical transmission line; 400 km gas pipeline; on-site 550 MW gas power station; 105 km rail line; airport, 90,000 t copper concentrate handling and ship loading facility; rail/road intermodal freight terminal; 10,000 person camp and 6,000 person expansion to existing township.

Position held: Manager and Author

Activities performed: I was a hands on manager of a core team of 20 people to deliver all environmental, social and cultural heritage assessments; developed the scope of works for 17 work packages; managed and understood technical inputs from more than 300 specialists from 75 different environmental and engineering companies; conducted stakeholder engagement and consultation; and authored the EIS and Supplementary EIS.

Projects as Gamut Consulting

Tampakan Copper-Gold Mine Development – Off-Lease Infrastructure Environmental and Social Impact Assessment (ESIA)

Year: 2011 - 2014

Location: Southern Island of Mindanao, the Philippines

Client: Xstrata Copper (now Glencore Xstrata)

Main project features: 105 km copper-gold concentrate pipeline; 100 km electrical transmission line; copper-gold concentrate filtration plant.

Position held: Manager and Author

Activities performed: Manager for all environmental, social and cultural heritage disciplines and author of the Supplementary Report to address the International Finance Corporation (IFC) requirements and Equator Principles for an international ESIA.

415 MW Coal-fired Power Station and Copper Concentrate Loading Port Facility ESIA

Year: 2012 - 2013

Location: Southern Island of Mindanao, the Philippines

Client: Sagittarius Mines Inc. (SMI)

Main project features: 415 MW power station; coal unloading and copper concentrate loading port facilities.

Position held: Peer Reviewer and Advisor on Commercial Risk

Activities performed: Peer reviewer for an ESIA developed by in-country consultants to ensure it is developed in accordance with IFC requirements / Equator Principles; provision of advice regarding additional third party studies required to reduce commercial risk (and the subsequent scoping and management of air quality modelling, noise modelling and thermal plume modelling technical specialist studies). This project entailed liaison with SMI senior management regarding the outcomes of the commercial risk assessment to ensure SMI met their international and corporate responsibilities.

Mount Isa Open Pit Project (MIOP) Pre-Feasibility Study Environmental Studies

Year: 2011 - 2013

Location: Mount Isa, Queensland

Client: Xstrata Copper (now Glencore Xstrata)

Main project features: Major expansion of existing underground and small open pits into a single large open pit, expansion of copper, lead and zinc processing facilities and port facilities.

Position held: Lead Consultant, Manager, Peer Reviewer and Author

Activities performed: Authored the Pre-Feasibility Study environmental technical reports for the Project Description, Stakeholder Engagement Strategy, Surface Water, Closure and Environmental Design Criteria. Managed and peer reviewed technical reports from Amec (Ecology and Cultural Heritage), Klohn Crippen Berger (Groundwater and Geochemistry), SLR (Noise), PAEHolmes (Air Quality) and Arup (Traffic).

Projects as Gamut Consulting

Yeelirrie Uranium Mine Environmental Review and Management Plan (ERMP)

Year: 2010 - 2011

Location: Perth, Western Australia

Client: BHP Billiton

***Main project features*:** New greenfield uranium mine and associated infrastructure.

Position held: Lead Consultant, Project Director, Peer Reviewer and Author

Activities performed: Lead consultant to manage URS and SKM to a successful delivery of the ERMP for the proposed uranium mine in Western Australia. For this project, Michael was appointed the ERMP Project Director and Principal Author. In this role I reviewed all environmental, social and heritage technical reports and draft ERMP chapters and provided a technical review for the ERMP as Principal Author.

Essentials Package for Successful Environmental Consultants

Year: 2013

Location: Brisbane, Australia

Client: None – published to enhance general capacity building and skills

Main project features: Published practical guide to better influence key decisions and environmental outcomes for mining developments.

Positions held: Author / Publisher

Activities performed: I authored this publication to teach environmental practitioners and clients how to more efficiently manage an impact and risk assessment and put themselves and the mining company environmental representatives in a position to influence key decisions that promote better environmental outcomes. The book outlines the key steps in delivering an environmental and social assessment, and includes clear guidance on how to appropriately apply the two separate, but integrated, approaches to impact and risk assessments. The publication provides many of the management tools that I developed over the last 20 years to deliver projects on time and on budget.

Olympic Dam Closure Plan – Risk Assessment

Year: 2013

Location: Adelaide, South Australia

Client: BHP Billiton

Main project features: BHP Billiton reviews its Olympic Dam copper, gold, silver and uranium mine closure plan annually. For the current review, BHP Billiton has been requested by the South Australian Government to include a detailed environmental risk assessment for closure.

Positions held: Author/facilitator for the closure plan risk assessment

Activities performed: I have developed and authored the risk assessment component of the annual update to the Olympic Dam Closure Plan. This required liaison with numerous technical specialists from varying mining disciplines to identify and assess risk events/situations for the decommissioning and closure phase. Detailed tables where prepared for each risk event, identifying the source, pathway, receptor, initial risk rating, control / contingency measures and residual risk rating. Proposed closure outcomes, closure criteria and monitoring requirements where then identified for each risk event with a high or moderate residual risk rating.

Projects as Gamut Consulting

Gladstone Steel Making Facility EIS

Year: 2012 - 2013

Location: Gladstone, Queensland

Client: Boulder Steel (CQG Consulting)

Main project features: 5 Mtpa integrated steel plant, 17 km private haul road, rail loop and import/export port facilities.

Positions held: Advice and chapter author

Activities performed: Gamut was commissioned by CQG Consulting on behalf of Boulder Steel to assist in the timely delivery of this EIS. We authored the executive summary, hazard and risk assessment, nature conservation, traffic impact assessment, environmental management framework and cumulative effects chapters and provided peer review on all other EIS chapters and technical appendices.

Projects prior to forming Gamut Consulting

Gateway Motorway EIS Project

Michael was appointed as the environmental advisor to the Queensland Government (Main Roads) to assist in the determination of the preferred Federal and State legislative process under which to develop an EIS for the $1.6 billion Gateway Motorway Upgrade Project. Michael also developed the Initial Advice Statement to accompany the request for State Significant Project status and developed the Draft Terms of Reference for the EIS. Michael was also commissioned to undertake the technical review for the EIS and provide advice regarding the direction and compliance of the EIS as per Commonwealth and State legislation.

Enertrade North Queensland Gas Pipeline EIS Project

This was an EIS for a 400 km gas pipeline. This project was a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and a Project of State Significance under the Queensland Department of State Development's *State Development and Public Works Organsiation Act 1971*. Michael completed the development of targeted ecological documents and presentations for the then Commonwealth Department of Environment and Heritage and the Queensland Environmental Protection Agency in relation to endangered ecological communities, threatened species and migratory species. Michael also successfully negotiated environmental approvals and compliance for the project.

Tamil Nadu Road Sector Project, India

Michael was the author of the physical (Climate, Geology and Soils, Land Use) and biological (fauna, flora, water quality, air quality, noise, heritage) environmental components of the Feasibility Study and Sectoral Environmental Assessment reports assessing the potential impacts associated with upgrading 3,328 km of roads in south-eastern India. Michael also authored the project's Environmental Management Plan. All deliverables were written under the guidelines of, and gained the approval of, the World Bank.

Reef Cove Resort, False Cape

Michael was the Manager of the environmental assessments for this major coastal development in Cairns. The site is adjacent to the Great Barrier Reef World Heritage Area, Fish Habitat Reserve and the ecologically significant Trinity Inlet. The project was deemed a controlled action under the EPBC Act and Michael negotiated the environmental approvals for the project under both Commonwealth and State legislation.

Projects prior to forming Gamut Consulting

Port of Brisbane Motorway - Environmental Review

Michael completed a review of all the environmental documentation compiled for the Port of Brisbane Motorway, undertaking a gap analysis with regards to recently introduced and amended environmental legislation, and providing reports to promote environmental compliance of this major road infrastructure project. Environmental approvals were gained for this project in a timely manner and as such avoided potential construction delays.

Cerito Road Review of Environmental Factors (REF) and EMP

Michael was the Manager and completed the legislative review and fauna assessment for the new 22 km road link between the Mt Coolon - Collinsville Road and the Glenden – Newlands Road. This project included the assessment of all environmental aspects and provided mitigation measures to minimise impacts on Commonwealth endangered ecological communities and State listed threatened species.

Brisbane City Council Ecological Corridors Project

Michael was appointed as an ecological specialist to assist Brisbane City Council and Chenoweth & Associates to identify appropriate civil structures to maintain fauna movement along corridors throughout Brisbane City. A detailed case study was also completed for fauna movement across the Logan Motorway for safe passage between the Greenbank Military Training Area and Karawatha Forest.

Federal Government Legislative Reviews

Michael was commissioned to negotiate the implications of the Federal Government's environmental protection legislation on behalf of the Queensland Department of Main Roads. Following presentations to the Main Roads Senior Management Group, he was commissioned to review all projects being constructed on state-controlled roads for the period 2000 - 2002 and in the Brisbane Metropolitan District from 2000 - 2005. This was more than 160 projects, resulting in presentations to DEWHA (then DEH) regarding referrals for 80 projects.

WMC Fertilizers Ltd

Michael completed the ecological assessment for the High Analysis Fertilizer Plant at Phosphate Hill, north-west Queensland. This assessment included comprehensive field surveys of fauna and flora to determine potential impacts on ecosystems and to provide appropriate mitigation strategies to ameliorate identified impacts.

Rockhampton Airport EIS and EMP

Michael was the Manager and author of the EIS for a proposed runway extension to the Rockhampton Airport. The risk of bird strikes was the key issue to be resolved for this project, given the surrounding environs being dominated by wetlands.

Rationalisation of Council and State Government Vegetation Mapping

Michael undertook an assessment of the methodology employed for vegetation mapping as a means of assigning State and local ecological significance to freehold, leasehold and state controlled land. This project enabled Dr Ryan to identify the ‘building blocks’ of both the EPA’s Regional Ecosystem mapping and Local Government mapping and determined the advantages and disadvantages of each, with an objective of identifying appropriate mechanisms to identify and conserve significant vegetation communities.

Projects / employment prior to forming Gamut Consulting

Road Corridor Environmental Assessment (RCEA)

Michael wrote the GIS compatible methodology that enabled the collection and storage of data on ecological assets and corridor management issues within the road reserve for the 33,500 km of Queensland State-controlled roads. Michael subsequently implemented this methodology via field surveys for more than 3,500 km of these roads.

Townsville Field Training Area (TFTA) EIS and EMP

Michael was the Manager and author of the EIS and EMP for a road upgrade, airstrip extension and two major creek crossings within the TFTA. Detailed investigations were completed at Keelbottom Creek and Star River.

Environmental Impact Assessments / Review of Environmental Factors

Michael has been the Manager and author of more than 20 additional linear infrastructure assessments including the following studies: Townsville Port Access, Ipswich Motorway, Mt Lindsay Highway, Smith Street Extension, Hope Island Road, Mt Tamborine - The Sentinel, Gregory Developmental Road, Kuralboo Creek and Gilmore Pipeline (Cheepie to Adavale).

PRINCIPAL ADVISOR (ENVIRONMENT AND PLANNING) QUEENSLAND DEPARTMENT OF MAIN ROADS (MAY 1999 TO NOVEMBER 2000)

Dr Ryan's principal role was to manage the $1.2 M Technical Environment Program within the Department. This required the program management of over thirty-five road-related environmental projects, mentoring of graduate staff and direct project supervision of ten projects. Michael was also the Main Roads representative on several inter-government environmental committees including the Ministerial Committee on Net Gain 2010 and the Ministerial Committee that investigated the implications of the then soon to be enacted *Environment Protection and Biodiversity Conservation Act 1999*. Projects managed and/or supervised included:

Review of the Department's Road Project Environmental Management Processes Manual: This manual discusses the environmental documents to be prepared throughout the planning, design, construction and maintenance of a road project.

Compensatory Habitat Policy: Management of a project that identified the advantages and disadvantages of existing compensatory habitat policies so as to provide guidance to Main Road's Senior Management Group as to whether a similar policy should be adopted by Main Roads.

Revision of the Main Roads Environmental Legislation Register: This manual discusses all Commonwealth and State legislation relevant to road planning, design and construction. It provides a comprehensive reference guide for all legislative, permit and license requirements for Main Roads activities.

Revision of the Main Roads Cultural Heritage Manual: This manual discusses the preferred process for cultural heritage assessments for Main Roads. The revised manual was reviewed by the Environmental Protection Agency and accepted as appropriate for use by Main Roads in Queensland.

Waterways Guideline: This project aims to develop collaboration with the Department of Natural Resources in relation to permits under the *Water Act 2000*. Benchmarks were established so as to clearly identify and streamline the process for obtaining permits and licenses for construction activities.

Projects / employment prior to forming Gamut Consulting

Review of the Main Roads Environmental Management Specification: This specification (MRS11.51) represents the standard environmental specification for all Main Roads construction projects. Michael managed the review of this specification in an attempt to refine contractor's costing of environmental works.

Road Drainage Manual: Michael was on the management and technical committees for the development of this manual. The aim of the manual is to design and construct cross and longitudinal drainage structures in a practical, cost effective and environmentally sustainable manner.

Road Planning and Design Manual: Michael was the author of the Environmental Considerations chapter of this manual and technically reviewed the engineering and design chapters to ensure consistent and effective environmental outcomes in road design.

KBR (FORMERLY KINHILL), BRISBANE (SEPTEMBER 1996 TO MAY 1999)

As the Brisbane office's specialist fauna ecologist, Dr Ryan was involved in the following projects:

Kopps Road - Smith Street Extension

Michael was the manager and author for the Review of Environmental Factors for the proposed construction of a major connecting road between Smith Street and Kopps Road to the west of the Pacific Motorway.

Vegetation and Ecological Assessments, Ipswich City Council

Manager for two projects that provide ecological assessments and recovery plans to guide future Council management practices and land acquisitions.

Brisbane Technology Park, Eight Miles Plains

Principal author of an environmental assessment and rehabilitation programme for the proposed Stage II of the Brisbane Technology Park.

Mary River Sand and Gravel Extraction, Maryborough

Investigating the potential impacts associated with sand and gravel extraction in the Mary River on fauna.

Snapper Creek Dredging

Investigating the potential impacts on wader bird species associated with dredging in Snapper Creek.

Donnybrook, Caboolture Shire, Environmental Management Plans

Developing Environmental Management Plans for a vulnerable amphibian species and mammal species to mitigate impacts of a proposed development in an ecologically sensitive location.

Coolum Ridges, Maroochy Shire, Queensland

Designing and conducting a complete fauna survey in an area of proposed private subdivision.

Projects / employment prior to forming Gamut Consulting

Fauna Sensitive Road Design Publication

Michael was the author of the State Government publication: Fauna Sensitive Road Design - Volume 1 - Past and Existing Practices. This publication includes assessments of fauna movement pathways and provides recommendations to reduce highway impacts on native fauna.

PGT Pipeline, from south-central Queensland to North Brisbane

An extensive investigation of the proposed impact with respect to the environment associated with disturbance along a 480 km pipeline route.

CONSULTANT ECOLOGIST (1995 TO 1996)

Subconsultant for WBM Oceanics Australia on two projects. The first involved collation and review of existing information on and development of a sampling methodology for a Koala survey of the Buderim Mountain region. The second project involved mammal trapping and field identification of birds, mammals, reptiles and amphibians for a 4 week fauna survey of a site at Reedy Creek, Mudgeeraba.

UNIVERSITY OF QUEENSLAND (1993 TO 1995)

Dr Ryan was employed as Research Assistant on the following projects:

Revegetation advice for mining operations (Dr Clive Bell, Dr David Mulligan, the then Agriculture Department – now Centre for Mined Land Rehabilitation): Advice for environmental officers of Queensland's coal and bauxite mining operations (Weipa and Bowen Basin) on procedures for maximising forest revegetation following above-ground mining.

Green vegetable bug (Dr Gimme Walter, Entomology Department): Planning, experimental design and analysis of research on the ecology of the bug. Also assisted with practical classes in ecology, behaviour and genetics.

Queensland rainforest mites (Dr David Walter, Entomology Department): Field research to assess the biodiversity of mites in rainforest.

SELECT PUBLICATIONS

Ryan, M.A. and G.H. Walter (1992) Sound communication in *Nezara viridula* (L.) (Heteroptera: Pentatomidae): further evidence that signal communication is substrate-borne. *Experentia* **48**: 1112-1115.

Ryan, M.A. (1994) Damage to papaw trees by the banana-spotting bug, *Amblypelta lutescens lutescens* (Distant) (Hemiptera: Coreida), in north Queensland. *International Journal of Pest Management* **40(3)**: 280-282.

Ryan, M.A., C.J. Moore and G.H. Walter (1995) Individual variation in pheromone composition in *Nezara viridula* (Hemiptera: Pentatomidae): how valid is the basis for designating "pheromone strains"? *Comparative Biochemistry and Physiology* **111B(2)**: 189-193.

Ryan, M.A., A. Cokl and G.H. Walter (1996) Differences in vibratory sound communication between a Slovenian and an Australian population of *Nezara viridula* (L.) (Heteroptera: Pentatomidae). *Behavioural Processes* **36(2)**: 183-193.

Ryan, M.A. (1996) An investigation of discontinuities in the sexual behaviour of green vegetable bugs, *Nezara viridula* (Linnaeus) (Heteroptera: Pentatomidae). Doctor of Philosophy Thesis. University of Queensland. Australia.

Kinhill (1997) Brisbane Technology Park Stage II: Environmental Assessment and Rehabilitation Programme. Prepared for Brisbane City Council. Principal Author: Dr Michael Ryan.

Kinhill (1998) Kopps Road – Smith Street Extension Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (1999) *Environmental Legislation Register – Version 2.* Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (2000) *Road Project Environmental Management Processes Manual – Version 2.* Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (2000) *Fauna Sensitive Road Design: Volume 1 – Past and Existing* Practices. Queensland Department of Main Roads, Technology and Environment Division. Brisbane. Principal Author: Dr Michael Ryan.

Kinhill (2001) Townsville Port Access Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan.

Kinhill (2001) Ipswich Motorway Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

Kinhill (2001) Tamil Nadu Road Sector Project, India: Feasibility Study and Sectoral Environmental Assessment. Prepared for the Government of India under World Bank funding. Principal Author of the Climate, Geology, Soils, Land Use, Fauna, Flora, Water Quality, Air Quality, Noise and Heritage sections: Dr Michael Ryan

Kinhill (2002) Mt Lindsay Highway Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2002) Gregory Developmental Road Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Smith Street Extension Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Townsville Field Training Area (TFTA) Keelbottom Creek and Star River: Environmental Impact Statement and Environmental Management Plan. Prepared for the Department of Defence. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Rockhampton Airport Environmental Impact Statement and Environmental Management Plan. Prepared for the Rockhampton Regional Council. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2004) Hope Island Road Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2004) Mt Tamborine - The Sentinel Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

BHP Billiton (2009) Olympic Dam Expansion: Draft Environmental Impact Statement. Principal Author: Dr Michael Ryan

Ryan, M.A. (2009) Environmental Protection Through Leadership and Law. Presentation. China Mining 2010 Conference. Tianjin. China.

Ryan, M.A. (2010) The Expanding Role of an EIS Project Manager. Presentation. EIS For Resource Projects Conference. Brisbane. Queensland.

Wilkinson, L. and M.A. Ryan (2010) What Makes a Good Environmental Impact Statement: A Government Perspective / A Consultant's Perspective. Presentation. Environment Institute of Australia and New Zealand Conference. Wellington. New Zealand.

BHP Billiton (2011) Olympic Dam Expansion: Supplementary Environmental Impact Statement. Principal Author: Dr Michael Ryan

Ryan, M.A. (2011) Managing Environmental Impact Assessment Requirements. Presentation and Pre-conference Workshop. Environmental Management in Resources Conference. Perth. Western Australia.

BHP Billiton (2011) Proposed Yeelirrie Development: Environmental Review and Management Programme. Draft. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Uranium Projects Approval Process Guideline. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Olympic Dam EPBC Act Assessment Report – Pre-commitments. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Mount Isa Open Pit Pre-Feasibility Study: Environment Stakeholder Engagement Strategy. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Mount Isa Open Pit Pre-Feasibility Study: Environmental Design Criteria. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Draft Terms of Reference for the Mount Isa Open Pit Project Environmental Impact Statement. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Sagittarius Mines Incorporated and Gamut Consulting (2012) Tampakan Off-Lease Linear Infrastructure Project: Environmental and Social Impact Assessment. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

CQG Environmental (2013) Environmental Impact Statement: Gladstone Steel Plant Project. Prepared for Boulder Steel Limited. Principal Author of the Executive Summary, Hazard and Risk Assessment, Nature Conservation, Traffic Impact Assessment, Environmental Management Framework and Cumulative Effects chapters: Dr Michael Ryan

Ryan, M.A. (2013) *Essentials Package for Successful Environmental Consulting*. ISBN (hardcopy): 978-0-9874942-1-4. ISBN (electronic copy): 978-0-9874942-0-7

Ryan, M.A. (2013) How to Develop and Effective EIS. Presentation and Pre-Conference Workshop. Permit Approvals Queensland Conference. Brisbane. Queensland.

Gamut Consulting (2013) Olympic Dam Expansion Investigation Phase Study: Environmental Inputs. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2013) Tampakan Copper-Gold Mine Off-Lease Infrastructure (OLI) Project: Addressing International Environmental and Social Sustainability Standards. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2014) Olympic Dam Heap Leach Processing Environmental Benchmarking Study. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2014) Olympic Dam Water Supply Government Engagement Strategy. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Paul Gerard Finn

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ACADEMIC QUALIFICATIONS

Doctor of Philosophy (2009)
Griffith School of Environment and Centre for Innovative Conservation Strategies
Griffith University
Scholarship: Strategic Partnerships with Industry, Research and Training (SPIRT); funded by Griffith University and The Federal Government (Environment Australia).

Bachelor of Science with First Class Honours (1996)
Australian School of Environmental Studies
Griffith University
Undergraduate major: Ecology and its Applications.

EMPLOYMENT HISTORY and WORK EXPERIENCE

Paul is a CEnvP (Ecology Specialist) with over 18 years' experience in project management, community consultation, research, environmental monitoring, experimental and statistical design, data management, analysis and interpretation, ecological and biodiversity assessment, fauna and flora surveys, and GIS mapping.

Paul has a background in ornithological research, obtaining his PhD in 2009, and has published a number of refereed and popular articles (including a chapter in a CSIRO book on shorebird feeding ecology and habitat selection), and presented his research at local and international conferences, workshops and public lectures. Paul has collaborated on many research projects, taking responsibility for experimental design, field work, data analysis and publishing on a diverse range of projects incorporating population biology, community ecology and conservation of birds.

Paul's consulting experience includes targeted threatened species surveys, significant species management plans, ecological impact assessment, legislation and environmental authority interpretation and negotiation with government agencies. He is a skilled consultant and field ecologist, and is experienced in leading teams to undertake fauna and flora surveys. Paul has a particular interest in natural resource management, conservation, terrestrial and coastal ecology, coastal management, animal behaviour, and ornithology.

Currently Paul is working as a biodiversity technical advisor and ecology subject matter expert in the coal seam gas industry, managing ecological assessments, providing clarity on federal and state legislated species impact management and offsets, and delivering reports to support various approvals.

Principal Ecologist, Arrow Energy Pty Ltd (June 2013–present)
Employed by Arrow as a Principal Ecologist, I am accountable for the delivery of technical advice and maintaining ecology standards in order to service exploration and appraisal, well delivery and the production of domestic gas. This position involves the management of ecology resources (internal staff and external contractors) across Arrow's tenements within both the Surat and Bowen Basins to deliver compliance and best practice ecology standards and work practices. The responsibilities of this position include:

- Promoting Health, Safety and Environment (HSE) standards;
- Managing a team by planning, coordinating and scheduling work to be completed;
- Recruiting, mentoring, training and developing personnel, and associated performance management;
- Providing technical advice, appropriate ecological survey methods, work scopes and reporting to solve compliance issues;
- Liaising and engaging with leadership personnel, external clients, contractors, and government regulators; and,
- Developing lean initiatives to increase quality and productivity of the ecology function, and improve profitability of projects.

Senior Ecologist, Sinclair Knight Merz (May 2012–May 2013)
Employed by Sinclair Knight Merz (SKM) as a Senior Ecologist and Project Manager, I delivered projects for clients in both the private and government sectors, related to infrastructure, energy and resources, environment and urban growth. This role included leading teams of ecologists in the field and actively training and mentoring junior staff in the field and the office, to ensure professional outcomes and effective project delivery. Key skill areas include: project management, stakeholder engagement, research, environmental monitoring, experimental and statistical design, data management, analysis and interpretation, review of scientific papers and reports, ecological and biodiversity assessment, fauna and flora surveys, significant species management and interpreting government legislation.

Selected project experience:

- **New Acland Coal Mine Stage 3 Expansion (New Hope Group)** – Targeted Koala (*Phascolarctos cinereus*) surveys for EPBC Act advice/referral including habitat assessments and Spot Assessment Technique (SAT), groundtruthing of threatened flora (*Bothriochloa biloba*, *Digitaria porrecta*, *Homopholis belsonii*, and *Stemmacantha australis*).
- **Surat Pipeline Header (Arrow Energy Pty Ltd)** – Detailed ecological assessment including fauna trapping, nocturnal fauna surveys including harp trapping for bats, bird surveys, targeted threatened species searches and micro-habitat assessments.
- **Nathan Dam Ecological Assessment (SunWater)** – Targeted Koala (*Phascolarctos cinereus*) surveys for EPBC Act advice/referral including habitat assessments, line-transect searches and SAT, groundtruthing of a threatened ecological community (Coolibah - Black Box Woodlands), and wetland assessments.
- **New Parallel Runway (Brisbane Airport Corporation)** – Project management, monitoring birdlife and associated habitat use, data analysis and interpretation, environmental management.

- **Pumicestone Road Interchange Upgrade (Department of Transport and Main Roads)** – Environmental assessment, ecological advice on detailed design, environmental management plan, and significant species management plan.
- **Roma Flood Levee (Maranoa Regional Council)** – Groundtruthing of EPBC Act MNES and NC Act listed species and breeding places, detailed assessment of a threatened ecological community (Weeping Myall Woodlands), regional ecosystems and high value regrowth verification, and EPBC Act referral advice.
- **Sibelco Taragoola Limestone Project (Sibelco Australia Limited)** – Property vegetation management plan (PVMP), and negotiation with the Queensland Department of Environment and Heritage Protection (DEHP).

Technical Advisor, Holcim Australia Pty Ltd (July 2005–February 2013)
Employed by Holcim as a Shorebird Expert on the Technical Advisory Panel (TAP) for a sand extraction operation at Donnybrook, Queensland. The formation and use of the TAP (consisting of three experts in their fields) was a requirement of the operation, triggered by the *Environment Protection and Biodiversity Conservation Act 1999* and imposed by the Department of the Environment. The main aim of the TAP is to ensure the maintenance of Ramsar wetland values and includes:

- Assisting with the design and implementation of intertidal wetland monitoring programs; and,
- Reviewing subsequent data collected by independent environmental consultants.

Senior Ecologist, RPS Group (February 2010–April 2012)
Employed by RPS Australia East Pty Ltd as a Senior Ecologist and Project Manager, I delivered projects for clients in both the private and government sectors, related to infrastructure, energy and resources, environment and urban growth. This role included leading teams of ecologists in the field and actively training and mentoring junior staff in the field and the office, to ensure professional outcomes and effective project delivery. Key skill areas include: project management, stakeholder engagement, research, environmental monitoring, experimental and statistical design, data management, analysis and interpretation, review of scientific papers and reports, ecological and biodiversity assessment, fauna and flora surveys, vegetation offsets, landscape rehabilitation, bushfire management, interpreting government legislation and GIS mapping.

Selected project experience:

- **Coal Seam Gas Exploration Gunnedah Basin (Santos)** – Detailed ecological assessment including fauna trapping, nocturnal surveys, habitat assessments and bird surveys, targeted threatened species searches, EPBC Act referral for a threatened ecological community (Box Gum Woodland).
- **Ecological Scouting in South-west QLD (Origin Energy)** – Undertaking pre-clearance ecological surveys for future coal seam gas infrastructure in cooperation with other team members including surveyors, cultural heritage monitors, geologists and Origin Energy staff.
- **New Parallel Runway (Brisbane Airport Corporation)** – Project management, monitoring birdlife and associated habitat use, data analysis and interpretation, environmental management.

- **GLNG Facility, Curtis Island, Gladstone (Bechtel)** – Significant species management plan including spotter-catcher procedures for the construction phase.
- **Queensland to South Australia / New South Wales Link Gas Pipeline (QSN Link) Looping Project (Epic Energy Queensland Pty Ltd)** – Targeted surveys for weeds of national significance and other declared pest plants.
- **QCLNG Pipeline, Curtis Island (Queensland Gas Company)** – Targeted Water Mouse (*Xeromys myoides*) surveys for EPBC Act clearance including habitat assessment, diurnal searches and nocturnal trapping.
- **Moranbah to Peak Downs and Goonyella Mines, Transmission and Water Lines (BMA – BHP-Mitsubishi Alliance Coal Operations Pty Ltd)** – Regional ecosystems verification, targeted threatened species searches, tertiary vegetation assessment, vegetation offset calculations and EPBC Act advice.
- **Pinkenba Review of Environmental Factors (Port of Brisbane Pty Ltd)** – Project management, ecological assessment, detailed fauna and flora surveys, regional ecosystems verification, vegetation mapping.
- **Sewage Pipeline (Redlands Water and Waste)** – Vegetation assessment and management plan, development approvals processing, consultation.
- **Bald Hills Quarry (Neilsen's Quality Gravels Pty Ltd)** – Ecological impact assessment, detailed fauna survey, vegetation survey and management plan, riparian condition assessments, rehabilitation planning, GIS mapping, consultation.
- **Redlands land developments (Harridan Pty Ltd and Sentinel Pty Ltd)** – Field surveys of Koala habitat including identification of food trees and SAT, desktop assessments of corridor connectivity and SPRP Koala habitat mapping, GIS mapping, reporting in regards to legislative requirements, environmental management plans, bushfire management plans.
- **Brisbane north shore development, Hamilton (Urban Land Development Authority)** – Project management, marine vegetation management plan, consultation.
- **Ipswich land developments 'Paradise Waters' (Stocklands Developments)** – Project management, environmental assessment, property map of assessable vegetation (PMAV), vegetation management plan, detailed tree survey, targeted searches for threatened species, GIS mapping.
- **Benaraby landfill expansion (Gladstone Regional Council)** – Species management plan, detailed fauna and flora surveys, GIS mapping.
- **The Village at Redcliffe (Hardev Property Development)** – Environmental offsets, habitat offset packaging, rehabilitation planning, GIS mapping.
- **Deception Bay land development 'Brolga Lakes' (Erneve Pty Ltd)** – Monitoring birdlife and associated habitat use, data analysis and interpretation, environmental management.
- **Willawong land development (Maximus Industrial Pty Ltd)** – Vegetation management plan, detailed tree survey, rehabilitation planning, GIS mapping, environmental approvals processing.
- **Murrarie land development (Incitec Pivot Limited)** – Due diligence environmental assessment, fauna and flora surveys, GIS mapping.

Conservation Officer / Program Coordinator, Seagrass-Watch, Moreton Bay Marine Park (October 2002–December 2009)

Employed by the Department of Environment and Resource Management's, Queensland Parks and Wildlife Service, the Wildlife Preservation Society of Queensland and the Queensland Conservation Council to set up and coordinate 'Seagrass-Watch', a community-based habitat monitoring program, in Moreton Bay.

The responsibilities of this position included:

- assisting with writing grant applications;
- establishing and maintaining effective volunteer involvement;
- locating suitable survey sites and coordinating the collection, collation, evaluation, analysis and interpretation of data;
- preparing a range of multi-media extension material including newsletters, public presentations, technical and administrative reports, and scientific conference and journal papers;
- training new volunteers (on-site and through workshops) and assisting volunteers with field work;
- maintaining and servicing equipment used in the sampling program;
- liaison, consultation and negotiation with government agencies, local stakeholders and interest groups;
- working with various legislative documents including, but not limited to: the *Nature Conservation Act 1992*, *Environmental Protection Act 1994*, *Coastal Protection and Management Act 1995*, *Environment Protection and Biodiversity Conservation Act 1999* and *Marine Parks Act 2004*;
- managing staff and university students on industrial placement; and,
- undertaking various administrative, budgeting and financial duties.

Doctor of Philosophy Candidate, Consultant Ecologist, Research Assistant and Tutor, Griffith University (January 1994–December 2009)

- **Doctor of Philosophy Candidate:** My research covered many aspects of habitat selection and feeding ecology with Eastern Curlews (*Numenius madagascariensis*) in Moreton Bay, Queensland. The aim of my research was to identify characteristics of important habitats for conservation of the Eastern Curlew on its non-breeding grounds. During my PhD I gained skills in many areas including: project management, logistical planning, working within a budget (approx. $30,000), experimental design, data management, statistical analyses and targeted dissemination of results through scientific reports, conference papers, journal articles and community consultation. I developed good analytical and practical ecological skills and employed various ecological methods including: population census, behavioural observations of focal individuals, benthic invertebrate sampling and GIS mapping.
- **Consultant Ecologist:** Employed to conduct monthly surveys of all birds at the Luggage Point wetland reserve for the Brisbane City Council (May 2001–April 2003) and at the Fisherman Islands reclamation area for the Port of Brisbane Corporation (March 2001–June 2002). The focus of these consultancies was to assess and monitor the habitat use by shorebirds. Thereby facilitating the ecologically sustainable management of the focal areas by identifying threats to the birds' long term survival and making recommendations for their long term protection and management.

- **Research Assistant:** I have collaborated on many research projects, assisting with experimental design, field work, data analysis and publishing on a diverse range of projects incorporating population biology, community ecology and conservation of birds, and biodiversity assessments of remnant vegetation. My collaborators included but were not limited to: Prof. Carla Catterall, Dr. Peter Driscoll, Prof. Jane Hughes, Dr. Darryl Jones, Prof. Roger Kitching, Dr. Jeff Miller, Mr. Clive Minton and Dr. Kees Hulsman. Projects included: **Shorebird ecology** (surveying, cannon netting, banding and biometrics) in Moreton Bay, The Great Sandy Strait, Mackay and the Swaines Reefs; **Landscape ecology** (distribution, abundance and dynamics of mixed species foraging flocks within a large habitat matrix) of birds in south-east Queensland, involving mist-netting, banding, seasonal surveys and behavioural observations; **Population assessment and monitoring** of seabird breeding colonies over five years on all coral cays throughout the Capricorn and Bunker Island groups; **Biodiversity** studies at Eungella National Park, north Queensland, incorporating vegetation survey and invertebrate sampling techniques; and, Seabird research on Raine and neighbouring Islands as the 1995 recipient of the **Brian R. King Research Award** for seabird research (administered by the Raine Island Corporation).
- **Tutor:** Employed as an avian ecology tutor by Griffith University for a 3rd-year field course in tropical ecology conducted in Danum Valley, Borneo (2 weeks in January 2007). Also employed as an ecology tutor by Griffith University for 1st-3rd year field and laboratory courses (1994–2002).

PUBLICATIONS

Journal Articles

1. **Finn, P.G.** and Catterall, C.P. Does foraging success explain choice of feeding sites by a deep-probing shorebird on its non-breeding grounds? Manuscript in preparation.
2. **Finn, P.G.**, Udy, N.S., Baltais, S.J., Price, K. and Coles, L. 2010. Assessing the quality of seagrass data collected by community volunteers in Moreton Bay Marine Park, Australia. Environmental Conservation. 37, 83-89.
3. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2008. Prey versus substrate as determinants of habitat choice in a feeding shorebird. Estuarine, Coastal and Shelf Science. 80, 381-390.
4. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2007. Determinants of preferred intertidal feeding habitat for Eastern Curlew: A study at two spatial scales. Austral Ecology. 32, 131-144.
5. **Finn, P.G.**, Driscoll, P.V. and Catterall, C.P. 2002. Eastern Curlew numbers at high tide roosts versus low tide feeding grounds: a comparison at three spatial scales. Emu. 102, 233-239.
6. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2001. The low tide distribution of Eastern Curlew on feeding grounds in Moreton Bay, Queensland. Stilt. 38, 9-17.
7. **Finn, P.G.** and Hughes, J.M. 2001. Helping Behaviour in Australian Magpies, *Gymnorhina tibicen*. Emu. 101, 57-63.
8. Jones, N.D. and **Finn, P.G.** 1999. Translocation of aggressive Australian Magpies: a preliminary assessment of a potential management action. Wildlife Research. 26, 271-279.

Book Chapter

9. **Finn, P.G.** 2007. Feeding ecology and habitat selection. Pp. 51-59 in Geering, A., Agnew, L. and Harding, S. (eds.) Shorebirds of Australia. CSIRO Publishing, Victoria.

Theses

10. **Finn, P.G.** 2009. Habitat selection, foraging ecology and conservation of Eastern Curlews on their non-breeding grounds. PhD Thesis. Griffith University, Brisbane.
11. **Finn, P.G.** 1996. Why do helpers help, in cooperatively breeding Australian Magpies?: a test of the indirect fitness benefits hypothesis using microsatellite DNA. BSc (Honours) Thesis. Griffith University, Brisbane.

Major Reports

12. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2002. Key habitats for conservation of the Eastern Curlew on its feeding grounds. PhD report prepared for the Wetlands Unit, Biodiversity Group, Environment Australia (Commonwealth of Australia, Department of the Environment), Canberra. 100 pp.
13. Jones, D.N. and **Finn, P.G.** 1998. Translocation of Aggressive Australian Magpies as a Potential Management Option: A Preliminary Assessment. Report prepared for the Suburban Wildlife Research Group, Australian School of Environmental Studies, Griffith University, Brisbane. 35 pp.

CONFERENCE PRESENTATIONS

1. **Finn, P.G.** and Catterall, C.P. 2009. Choice of feeding sites by Eastern Curlews (*Numenius madagascariensis*) on their non-breeding grounds. Australasian Shorebird Conference, Hobart, September. (Spoken).
2. **Finn, P.G.** and Catterall, C.P. 2009. Choice of feeding sites by a global migrant shorebird on its austral wintering grounds. International Congress of Ecology, Brisbane, August. (Spoken).
3. **Finn, P.**, Udy, N., Baltais, S., Price, K. and Maxwell, P. 2007. Distribution and status of seagrasses in Moreton Bay and an evaluation of community based monitoring (Seagrass-Watch). Queensland Coastal Conference, Bundaberg, September. (Poster).
4. **Finn, P.**, Udy, N., Baltais, S., Price, K. and Maxwell, P. 2007. Seagrass-Watch Moreton Bay: Community based monitoring of seagrass resources. Australian Marine Sciences Association Conference, Melbourne, July. (Spoken).
5. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2005. Relationship between Eastern Curlew predation and intertidal prey availability on wintering grounds in subtropical eastern Australia. Ecological Society of Australia Conference, Brisbane, December. (Spoken).
6. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2002. Characteristics of key feeding habitat for Eastern Curlew at two spatial scales in subtropical eastern Australia. Ecological Society of Australia Conference, Cairns, December. (Spoken).
7. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2000. Feeding Distribution of Eastern Curlew in Moreton Bay. Griffith University Ecology and Evolution Postgraduate Symposium, Brisbane, October. (Spoken).
8. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2000. Distribution and site selection in Eastern Curlew at feeding grounds in Moreton Bay. Southern Hemisphere

Ornithological Congress and Australasian Shorebird Conference, Brisbane, July. (Spoken).

9. **Finn, P.G.**, Driscoll, P.V. and Catterall, C.P. 1999. The low tide distribution of Eastern Curlew at feeding grounds in Moreton Bay. Griffith University Ecology and Evolution Postgraduate Symposium, Brisbane, October. (Spoken).
10. **Finn, P.G.**, Driscoll, P.V. and Catterall, C.P. 1999. The low tide distribution of Eastern Curlew at feeding grounds in Moreton Bay. Australasian Shorebird Conference, Victoria, June. (Spoken).
11. **Finn, P.G.** and Hughes, J.M. 1996. Do Australian Magpie 'Helpers' Gain Indirect Benefits? Griffith University Ecological Review Postgraduate Symposium, Brisbane, November. (Spoken).
12. **Finn, P.G.** and Hughes, J.M. 1996. Helping Behaviour in the Australian Magpie (*Gymnorhina tibicen*). Australasian Society for the Study of Animal Behaviour Conference, Canberra, September. (Spoken).
13. **Finn, P.G.** and Hughes, J.M. 1995. Relationship of Helpers to Offspring in the Australian Magpie (*Gymnorhina tibicen*). Australasian Society for the Study of Animal Behaviour Conference, Brisbane, April. (Poster).

LICENCES and ATTAINMENTS

- Manual C- and R-class open driver's and recreational shipmaster's licences.
- Construction Industry White Card.
- GIQ Coal (Standard 11) and Coal Board Medical.
- Origin Energy Modules 0 and 1 HSE Leadership Programs.
- Arrow Energy, Epic Energy, Santos, Queensland Gas Company, BHP-Mitsubishi Alliance, Macarthur Coal and New Hope Coal safety inductions for contractors.
- APPEA Introduction to the Petroleum Industry.
- ASIC authority for working airside at the Brisbane Airport.
- Fauna Handling (Spotter/Catcher) and Venomous Snake Handling training.
- National accreditations include: 'SAIEMS604A - Conduct and Environmental Management Systems Audit'; 'SAIEMS605A - Evaluate an Organisation's Environmental Management Systems Audit'; and, 'AHCFAU301A - Respond to Wildlife Emergencies'.
- Australian Bat Lyssavirus vaccination.
- QLD Herbarium training courses including: Vegetation Structure; Regional Ecosystems; Plant Identification; and, BioCondition Version 2.1.
- Department of Environment and Heritage Protection approved suitably qualified person under the *Flora Survey Guideline – Protected Plants*.
- Senior First Aid and Remote Area First Aid qualifications.
- Defensive four-wheel driving qualifications including: 'PMASUP236B - Operate vehicles in the field'; 'RIIVEH201B - Operate light vehicle'; and, 'AHCMOM211 - Operate side by side utility vehicles'.

- 'Elements of Shipboard Safety' qualification and the accrual of a total of 21 'days at sea' as a 'deckhand' operating various commercial vessels from 5 to 12 m in length and 37 to 232 kW in power, within 'smooth' and 'partially smooth' waters of Moreton Bay.

PROFESSIONAL MEMBERSHIPS

- Certified Environmental Practitioner (CEnvP) Scheme: Ecology Specialist since 2014.
- Environment Institute of Australia and New Zealand: member since 2012.
- Ecological Society of Australia: member since 2000.
- BirdLife Australia and Threatened Bird Network: member since 1999, on the management committee of BirdLife Australia Southern Queensland from 2010-2012.
- Australasian Wader Studies Group: member since 1999.
- Queensland Wader Study Group: member since 1993, on the management committee from 1996-2005 and 2015-present.

ADDITIONAL SKILLS

Bird banding: I hold a current A-class bird banding authority with the Australian Bird and Bat Banding Scheme and have had experience banding all types of birds from small passerines to large seabirds and using various catching techniques (trapping, mist- and cannon-netting).

Field skills: I have well-developed skills in animal identification, trapping and handling. I am experienced in a wide range of sampling/trapping techniques for both plants and animals. I have very good field knowledge of birds, particularly shorebirds. I have extensive experience working in urban and rural landscapes, forests, coral cays and intertidal wetlands.

Computer skills: I have developed a high level of computer literacy, using computers extensively for data analyses, word processing and desktop publishing during the writing of scientific papers, presentations, theses and reports. Additionally, I am skilled in the application of computers for data management and a wide range of statistical analyses. I am familiar with several statistical packages including SAS, PATN, SPSS and PRIMER, and GIS programs such as 'ArcMap' and 'MapInfo'.

Laboratory skills: I have experience sorting and identifying benthic marine fauna and flora. I have a good understanding of, and practical experience in, a wide range of genetic techniques, especially allozyme electrophoresis and mini- and micro-satellite DNA analysis. I am proficient in general laboratory and equipment maintenance.

REFEREES

Available on request.

Curriculum Vitae- David James Stanton

Date of Birth: 10/ 04/ 1970

Business Address:

44 Henzell Terrace, Greenslopes, Qld, 4120.

Mob: 044 7822119

Email: davidstanton@3denvironmental.com.au

CURRENT POSITION

Principal Landscape Ecologist - 3D Environmental

ACADEMIC QUALIFICATIONS

BSc Hons: Geology / Biology/ Geomorphology (Hons Class 1-Geology) completed at James Cook University, 1993.

PROFESSIONAL CERTIFICATIONS

MEIANZ: Certified Environmental Practitioner – Ecology Specialist (Certification Number: 0906E)

PROFESSIONAL AWARDS

Planning Institute of Australia, Queensland Division (2005) '*Award of Excellence'* for the Caboolture Shire Councils Bushfire and Hazard Assessment Study. The award was given in the categories of Disaster Mitigation and Biodiversity Conservation and Planning in recognition of work completed in the Caboolture Shire Vegetation Mapping Project, 2004.

Planning Institute of Australia, National Division (2006) '*National Award of Excellence'* for the Caboolture Shire Councils Vegetation Mapping Project. National winner in the category of 'Biodiversity and Conservation Planning'

ACADEMIC AWARDS

Geological Society of Australia Gold Medallion (1993) for outstanding academic achievement in studies of earth science.

PROFESSIONAL SUMMARY

David has a professional career that spans 24 years, which including 3 years' working as regional exploration geologist in the Louisade Archipelago of PNG, He has extensive experience in the disciplines of resource mapping (geology and geomorphology), floristic assessment, groundwater and dependent ecosystems, conservation planning and impact and ecological risk assessment. His expertise has been utilised across several industry sectors which include mining, infrastructure as well as a consultant to government and indigenous organisations throughout Queensland, the Northern Territory, north-Western Australia and Papua New Guinea. David has particular expertise in landscape scale ecology and ecological processes including the relationships between vegetation geology, geomorphology, hydrology and hydrogeology. David has published vegetation mapping for the Wet Tropics World Heritage area and the Torres Strait Island's on behalf of the Australian Government and has worked extensively on the management of terrestrial biodiversity in northern Australia, co-authoring a number of technical papers on issues relating to landscape ecology and fire management.

PROJECT SUMMARY

ENVIRONMENTAL IMPACT ASSESSMENT FOR LINEAR INFRASTRUCTURE AND WATER

- Northern Australia – Northern Territory
  - PNG to Queensland Gas Pipeline Project, Weipa to Gove Pipeline Lateral Biophysical Assessment: Preparation of floristic mapping (1:25 000 scale), landform and geomorphic analysis and threatened flora assessment of the proposed Weipa (Qld) to Gove (NT) Lateral sections of the proposed pipeline. Included assessment of several pipeline landfall options in the Gove Peninsula / Nhulunbuy region of the Northern Territory. Enesar 2006.

- AGL Petronas Corporation –PNG to Queensland Gas Pipeline Project: Provision of botanical and landform assessments along sections of the proposed pipeline easement. Large sections were completed using helicopter survey with foot survey at selected localities. The subsequent reports for these sections provided the information necessary for incorporation into a broader environmental impact assessment. Enesar, 2005, 2006. Sections investigated included:
  - Landfall on Cape York to the Jardine River
  - Charters Towers to Muttaburra.
  - Stonehenge to Windorah
  - South-west of Windorah to Cameron's Corner on the QLD/ SA / NT junction.
- TRIP Weir Project, Flinders River: Floristic surveys over the 200 km^2 TRIP Weir Project inundation area and associated pipelines. Flinders River in the Gulf Plains Bioregional Area. Studies included assessment of potential threatened flora, review of RE Mapping and general floristic survey for the purpose of Environmental Impact Assessment. Stanbroke Holdings Ltd, November 2014 to May 2015.
- Copperstring EIS: Comprehensive floristic mapping (regional ecosystems and threatened ecological communities) at 1:40 000 scale of a 150 km^2 section of the Copperstring Powerline in the Mt Isa, Cloncurry and Selwyn Ranges sections of the proposed 1km wide study easement. Survey also included a flora and mapping survey of the Charters Towers, Pentland, Hughendon and Cloncurry sections of the proposed powerline alignment.

- Wet Tropics – North-east Queensland
  - Ella Bay Integrated Resort Development: Floristic baseline assessment of the proposed Ella Bay Integrated Resort development site within the Wet Tropics World Heritage Area.
  - False Cape Development: A detailed aerial photographic interpretation and classification of vegetation communities and regional ecosystems, including rare and threatened species search on the False Cape development site to the east of Cairns. HLA Envirosciences Pty Ltd, 2004.
  - Powerlink –Cardstone Powerline Easement Study: In conjunction with Peter Stanton, carried out an ecological and botanical assessment of the Cardstone – Kareeya powerline easement to determine the environmental impact of a proposed powerline upgrade. The study included a detailed aerial photographic interpretation and map at 1:25 000 scale. This formed part of a broader impact assessment commissioned by Powerlink through C&B Consultants. 2003.
  - Main Roads Southern Access Planning: Alongside Peter Stanton, mapped in detail the vegetation communities within the proposed access corridor south of Cairns using 1:7500 scale aerial photographs. The project assessed the presence of rare and threatened plant species and vegetation communities. Sub-contracted to Sinclair Knight Merz, 1997, 1998.
  - Chevron Asiatic Gas Pipeline Project: An aerial photographic interpretation of the botany of the Northern Cape York region. The project assisted in the location of a route for a proposed gas pipeline. Sub contracted to NSR consulting group through Peter Stanton. NSR Consulting Pty Ltd, 1997.
- Central Queensland
  - Queensland Nitrates Pipeline Project: Floristic survey along the 18 km length of the proposed Queensland Nitrates Gas Pipeline near Moura, southern Bowen Basin. Survey focused specifically on assessment of EPBC Act significance of vegetation communities encountered along the pipeline route as well as intensive searches for Protected Plants (following Protected Plants Survey Guidelines) within the project impact area. Contracted to Queensland Nitrates Pty Ltd (September 2014).
  - Connors River Dam and Pipelines Environmental Impact Assessment: Provision 1:20 000 scale vegetation mapping, baseline floristic assessment and environmental impact assessment of the proposed Connors River Dam inundation area and proposed pipelines. Brigalow Belt North Bioregion. Contracted to Sunwater, 2009-2012.
- South-east Queensland
  - Gateway Motorway Assets and Expansion Project: Floristic mapping and assessment of habitats potentially impacted by the Gateway Expansion Project, Brisbane, over a 12 km stretch of road alignment (September 2014).
  - Traveston Crossing Dam –Terrestrial Flora Survey: Provision of baseline floristic assessment and supplementary 1:10 000 scale vegetation mapping for the purpose of assessment of environmental impact. Queensland Water, 2006-2009.
  - Wyaralong Dam –Terrestrial Flora Survey: Provision of baseline floristic assessment and supplementary 1:10 000 scale vegetation mapping for the purpose of assessment of environmental impact. Sub-contracted to BAAM Pty Ltd on behalf of Queensland Water, 2006-2009.
  - Emu Swamp Dam and Pipelines – Terrestrial Flora Survey: Terrestrial floristic assessment of the proposed inundation area and pipeline routes. Emu Swamp on the Severne River, Stanthorpe.

ENVIRONMENTAL IMPACT ASSESSMENT AND CONSTRAINTS PLANNING FOR MINING

- Northern Australia / Northern Territory
  - Ergon Energy – Mua Island Floristic Analysis: Preparation of dossiers for 18 threatened flora species recorded on Mua Island (Torres Strait) to assist infrastructure planning and facilitate protected plant surveys. The report required comprehensive review of databases, compilation of ecological information and species photographs (contracted to Ergon Energy, 2016).
  - MMG Century – Phantom Hills Prospect Floristic Baseline Survey: Baseline floristic survey and vegetation mapping over the 150 km^2 Phantom Hills Prospect. North-west Highlands Bioregion (2014 Ongoing), 50 km east of the Queensland / Northern Territory border. Prepared for MMG Century.

- Brigalow Belt
  - Arrow Surat Basin Advanced Exploration Project – Ecological Surveys: Intensive floristic and vegetation mapping surveys over Arrow Energy's advanced project tenements in the region between Miles and Cecil Plains. Assessments were undertaken over a 2500 km^2 assessment area (contracted to Arrow Energy, 2016 – 2017).
  - Arrow Bowen Basin Advanced Development Project – Ecological Surveys: Intensive floristic and vegetation mapping surveys over Arrow Energy's advanced project tenements to the north of Moranbah. Detailed surveys were completed over a 450 km study area including the Roy's Hill and Lancewood gasfield development areas which are contiguous with the North Goonyella Mine ML boundary. Survey included comprehensive desktop assessments as well as the provision of both dry season and wet season survey reports. Contracted to Aecom Pty Ltd and GHD Pty Ltd on behalf of Arrow Energy (November 2014 to June 2015).
  - Arrow Energy – Daandine Lease (PL230): An assessment of EPBC values as they relate to flora and threatened ecological communities for Arrow's Daandine Lease (PL230) in the Surat Basin. Sub-contracted to Ecosmart Ecology 2014.
  - Arrow –Surat Gas Project Supplementary EIS Study: Preparation of a supplementary terrestrial ecology study including bio-condition assessments at selected sites and habitat mapping for the 80 flora and fauna species listed under state and federal legislation. Habitat mapping was undertaken for the purpose of biodiversity offset planning. Prepared for Coffey Environments, June 2013.
  - Supplementary EIS Assessment of Arrow Energy's LNG Facility Site, Curtis Island (SEQ): Review of EIS chapter and terrestrial ecology assessment of the proposed site facility to inform requests for supplementary information. Included assessment of terrestrial flora and fauna on mainland and island portions of the project. Prepared for Coffey Environments, June 2013.
  - Acacia Coal / EPC1230: Floristic baseline survey, preparation of 1:50 000 scale regional ecosystem and EIS assessment of the EPC 890 Resource Area to the south of Blackwater. Mapping was undertaken to accurately identify the distribution of regional ecosystems across the EPC to inform requirements for ecological offset (October 2013).
  - Coffey Environments / Moultrie ESA Mapping: Preparation of 1:50 000 scale regional ecosystem mapping over the Hillalong Resource Area, north-west of Nebo. Mapping was undertaken to accurately identify the distribution of Environmentally Sensitive Areas over the Mineral Development Lease (Coal). Revised mapping facilitated ecologically sensitive planning for a forthcoming exploratory drilling project (August 2013).
  - Arrow Bowen Gas Project: Floristic impact assessment including detailed baseline ecological assessment of the Arrow Energy's 7800 km2 petroleum lease and exploration tenements in the Northern Brigalow Belt, Queensland. The project involved revision of regional ecosystem mapping over a selected 1 000 km2 area at a scale of 1: 40 000 for the purposes of constraint analysis. Contracted to Arrow Energy, 2012.
  - Surat Gas Project EIS - Arrow Energy: Floristic impact assessment including detailed baseline ecological survey of the Arrow Energy's 8200 km2 petroleum lease and exploration tenements in the Southern Brigalow Belt, Queensland. The project involved revision of regional ecosystem mapping over a selected 1 800 km2 area at a scale of 1: 40 000 for the purposes of constraint analysis. Contracted to Coffey Environments, 2009 -2013.
  - Byerwen Coal: Floristic survey and mapping assessment of the Byerwen Coal exploration lease including project 1:50 000 scale revision of mapping over the 60km2 site. Byerwen Property in the Northern Brigalow Belt. Unidel 2010, 2012.

- Curragh North Coal Development Project: Provision of baseline floristic assessment, 1: 25 000 scale vegetation mapping and environmental impact assessment of the proposed Jellinbah development area (November, 2011).
- MCG Resources: Floristic survey and mapping assessment of the MCG Groups MLA's in the Blackwater area, the Brigalow Belt South Bioregion of central Queensland. The study area covered approximately 25 km2 as smaller sections of the larger MDL 152 (Curragh Extended and Curragh South). Contracted to Tecsol (2012).

- Papua New Guinea
  - PNG Biomass Project: Assessment of the 250km2 PNG Biomass (Markham Valley- Morobe Province) project for the purpose of forestry plantation. Assessment included detail floristic analysis, vegetation mapping and assessment of impacts against IFC Standards (BAAM P/L, Aligned Energy)
  - Wafi-Golpu Gold-Copper Mine Project Terrestrial Flora and Fauna Assessment: Floristic baseline assessment and environmental impact assessment for the Wafi-Golpu advanced exploration project. Contracted to BAAM Pty Ltd on behalf of Morobe Mining JV (February 2015 ongoing).
  - Marengo PNG – Yandera Prospect Floristic Environmental Impact Assessment: Ecological baseline study and Environmental Impact Assessment of habitats and species affected by development of the proposed Yandera Prospect, Bismarck Ranges, Marengo Province PNG. Included comprehensive analysis of ethnobotanical and faunal resources. Coffey Environments, 2012.
  - Kantobo to Mubi River Road Project: A survey of significant floristic values along an 11km section of proposed road alignment. The survey required assessment of floristic values associated with virgin lowland rainforest in the Southern Highlands/ Gulf Province, Papua New Guinea. Subcontracted to Coffey Environments, 2010.
  - Solwara Project – East New Britain PNG: Habitat assessment, floristic analysis and mapping of the 80km2 lease area on the East New Britain Coast-Papua New Guinea. Included comprehensive analysis of ethnobotanical and faunal resources. Contracted to Coffey Natural Systems, 2008.

- Central Queensland Coast
  - McFarlane Oil Shale Project-Central Queensland: Detailed baseline botanical assessment and environmental impact assessment of the 252km2 mineral lease area in the central Queensland Coast Bioregion. The project included 1:40 000 scale aerial photographic interpretation of regional ecosystems and vegetation communities. Contracted to URS Australia (2008 – 2009).
  - Supplementary EIS Assessment of Arrow Energy's LNG Facility Site, Curtis Island (SEQ): Review of EIS chapter and terrestrial ecology assessment of the proposed site facility to inform requests for supplementary information. Included assessment of terrestrial flora and fauna on mainland and island portions of the project. Prepared for Coffey Environments, June 2013.
  - Stuart Oil Shale Floristic Impact Assessment: Baseline floristic assessment, vegetation community/ regional ecosystem mapping and floristic impact assessment of the Stuart Oil Shale Project Area, Gladstone. Revision of RE mapping undertaken over a 120 km2 area at 1:25 000 scale. Queensland Energy Resources (QER), 2012.
  - Red Mud Dams Vegetation Assessment: Completion of an RE and vegetation community assessment of the Red Mud Dams area, Boyne Island. The map and complementary report was an aid to planning for future tailings disposal in the area. QAL (sub-contracted through BAAM Pty Ltd), 2005.

- Desert Uplands
  - Eromanga Basin / Desert Uplands vegetation and floristic constraints analysis: Provision of floristic and landform constraints analysis and mapping over a 5000km^2 ATP area to assist sensitive location of a proposed comprehensive seismic survey (500km of proposed survey line). Galilee Energy, 2010.

BIODIVERSITY OFFSET PLANNING AND ASSESSMENT

- MMG Century – Lawn Hill Station Biodiversity Offsets Project: Habitat biocondition and vegetation mapping assessment of a 6km stretch of river frontage on Lawn Hill Creek contiguous with Lawn Hill National Park on the Queensland / Northern Territory border. The assessment provided baseline information to assist preparation of a biodiversity offset plan for Lawn Hill Station (July 2014).
- Exco Resources Biodiversity Offsets Project: Habitat bio-condition, ecological equivalence assessment, vegetation mapping and general floristic survey of a 42 km^2 portion of Lawn Hill Station to identify suitable habit for Purple-necked Rock Wallaby.

MINESITE REHABILITATION MONITORING AND ASSESSMENT

- MMG Century Rehabilitation Monitoring Project: Implementation of a baseline monitoring program to assess rehabilitation progress on stabilised waste rock dumps. Prepared to identify trends in vegetation development toward the meeting of mine closure criteria. North-West Highlands (March 2014 ongoing).
- Arrow Energy - Review of Environmental Authority Conditions for Rehabilitation, ATP 676: A review of EA conditions for ATP 676 to assess the achievability of current EA requirements for vegetation rehabilitation. The review report was utilised for internal Arrow Energy purposes. Prepared with assistance from Vegetation Management Science (March 2014).

CONSERVATION PLANNING

- North-eastern Australia
  - Wet Tropics Management Authority Vegetation Mapping Project: A 1: 25 000 scale aerial photographic interpretation and complementary 1:50 000 map of the structural characteristics, vegetation communities and geology of the Wet Tropics Bioregion, an area of over 30 000 km2. The project required the detailed classification of both remnant and non- remnant vegetation communities and the completion of 38 resource management reports for various regions within the project area. During this time, expert advice was provided to the authority in regard to management aspects of the World Heritage Reserve. The completed mapping product forms the basis for RE mapping and assessment within the Wet Tropics Bioregion (incorporated into Version 5.2 digital RE data produced by EPA). (1997 – 2012, work is ongoing to date of publication expected in August 2012)
  - Upper Bridge Creek Conservation Area Timber Assessment Report: Provided an assessment of timber resoures within the 160 km^2 Upper Bridge Creek Conservation Area to the north of Hopevale. Project facilitated negotiations between Traditional Owners and the Queensland Government to agree to terms of transfer to Conservation Reserve. Contracted to DATSIMA (Qld Govt, April 2015).
  - Mandingalbay Yidinji Lands Biodiversity Planning and Management Project: Development of biodiversity and land management profile for the Mandingalbay – Yidinji Lands, Wet Tropics World Heritage Area. Biodiversity profile has been applied to guide land management programs for the 'Working on Country' ranger program. Contracted to Djunbunji Ltd. June 2013 ongoing.
  - Torres Strait Island Biodiversity Planning Project: Development of biodiversity and land management profiles for 14 selected islands in the Torres Strait, Northern Australia. Biodiversity profiles are being applied to guide land management programs for the 'Working on Country' ranger program. Contracted to Torres Strait Regional Authority, Australian Government). November 2010 to December 2012.
  - Torres Strait Islands Regional Ecosystem and Vegetation Community Mapping: A 1:25 000 aerial photographic interpretation of the vegetation, structural associations and regional ecosystems of the islands of the Torres Strait. Spatial data produced during the vegetation survey has been successfully incorporated into the Version 6.0 RE digital database produced by DERM. The survey and mapping project assessed a total land area of 860 km^2 within the Cape York Peninsula Bioregion (Contracted to Torres Strait Regional Authority, Australian Government).
  - Queensland Herbarium – Wet Tropics Bioregion Regional Ecosystems Classification: Expert advice provided to the Queensland Herbarium concerning descriptions and classification of regional ecosystems in the Wet Tropics Bioregion. Advice was specific to the release of revised regional ecosystem mapping throughout the state relevant to the implementation of Queensland's "Vegetation Management Act". Queensland Herbarium, 2009.
  - Queensland Herbarium Non Remnant Vegetation Classification: An assessment of the remnant status of highly disturbed vegetation communities within the Wet Tropics Bioregional zone, relevant to the implementation of Queensland's "Vegetation Management Act" EPA, 2004- 2005.
  - Wet Tropics Management Authority Timber Resource Assessment Project (2004): A resource and timber assessment of freehold tenure within the World Heritage area to provide a means to adequately assess landowner compensation claims. Wet Tropics Management Authority, 2004.
  - Dawnvale Station Vegetation Mapping Project: A land management report and detailed aerial photographic interpretation of vegetation within the Dawnvale Grazing Leasehold. The study was commissioned to assist traditional owners in their application for leasehold renewal. Centre for Appropriate Technology, 2001.
  - Mt Molloy Vegetation and Land Systems Mapping: Report on the environs of the Mt Molloy Wetlands including a 1:25 000 aerial photographic interpretation of landform, geomorphology and vegetation. Mitchell River Catchment Management Group, 1999.

- Brigalow Belt / Central Queensland
  - Newlands Nature Refuge / Wollumbi Brigalow Conservation Reserve ecological assessment: Detailed vegetation mapping and florisitic analysis of vegetation communities and regional ecosystems on the Newland Nature Refuge and Wollumbi Brigalow Conservation Reserve, Brigalow Belt North Bioregion (total area of 100km^2). The study was commissioned for compliance with EPBC offset requirements. XStrata Coal / Footprints Ecology, 2009.

- South-east Queensland
  - Seqwater Advanced Offsets Project: Identification of suitable advanced habitat offsets within Seqwater's water infrastructure estate in south-east Queensland. Assessment included the identification habitats suitable for offset at Ewan Maddock, North Pine and Hinze Dam sites to the north and south of Brisbane (contracted to GHD, 2017).
  - Caboolture Shire Council Vegetation Mapping Project: Detailed 1:25 000 scale and 1:10 000 scale mapping of vegetation communities, land zones, and regional ecosystems of the Caboolture Shire Council (SEQ) using aerial photograph analysis. Total project area of 1200 km2. The project included detailed floristic sampling of all intact communities identified and the development of a classification scheme to allow assessment of highly disturbed vegetation types. Contracted to Rob Friend and Associates, 2004.
  - Reedy Creek Conservation Area (Agnes Waters): Detailed 1:10 000 scale aerial photographic interpretation and map of the vegetation communities in the Reedy Creek Conservation Area relevant to conservation and fire management with a proposed eco-development site (Bush Heritage Trust, 2005).

FIRE / ECOLOGICAL MONITORING PROJECTS

- Mandingalbay Yidinji / Djunbunji Aboriginal Corporation Fire Monitoring Project: Implementation of a fire monitoring program to assess the ecological impacts of both wildfire and traditional burning practice on MY Lands. Wet Tropics Bioregion, Yarrabah, Cairns (January 2014 ongoing).
- East Trinity Monitoring / Wetlands Rehabilitation Project: Completion of a detailed mapping and flora survey on reclaimed estuarine wetland, including mapping and categorisation of secondary vegetation communities. The study was based aerial photograph interpretation (1:10 000 scale aerial photography). Department of Environment and Resource Management (DERM), 2002 to 2009.
- Wet Tropics Phytophthora Mapping / Monitoring Project: Contracted to map rainforest die back resulting from Phytophthora outbreak within the wet tropics rainforest communities. The study was completed with detailed 1:25000 aerial photographic interpretation over át risk' areas. James Cook University/Rainforest CRC (1999 - 2001).

FIRE PLANNING PROJECTS

- Mandingalbay Yidinji / Djunbunji Aboriginal Corporation Fire Management Planning: Development of a fire management strategy for Mandingalbay Yidinji Lands within the Wet Tropics World Heritage Area. Prepared for the purpose of engaging traditional owners in the on ground management of traditional lands (October 2013 ongoing) and direct ecologically sensitive application of fire to the landscape.
- Reedy Creek Conservation Reserve Fire Management: Five-year review of the endorsed fire plan for the Reedy Creek Conservation Reserve, Agnes Water. Included recommendations to accommodate changes in the surrounding urban landscape whilst considering the results and lessons from the previous management period. Bush Heritage Trust 2014.
- Torres Strait Island Fire Management Project: Development of fire management plans for biodiversity conservation on Badu, Mua, Saibai, Boigu, Dauan, Mabuiag, Mer and Erub Islands in the Torres Strait. Work was completed in conjunction with Peter Stanton. Contracted to Torres Strait Regional Authority (2012 -2013).
- Cape York Fire Project: A fire scar and floristic structural mapping project to assess changes in vegetation communities that have resulted from shifting fire regimes over the past 30 years. Project utilised current and historical aerial photography for interpretation. Balkanu Cape York Land Development Agency (April to June 2003).

GROUNDWATER DEPENDENT ECOSYSTEMS / GAS MIGRATION ASSESSMENT AND MONITORING

- GDE Site Characterisation – Arrow Surat Gas Project: Implementation of GDE assessment execution plan involving characterisation of chosen GDE localities through drilling and bore construction (Sonic), isotope analysis of soil and xylem water and leaf water potential. Arrow Energy 2017 / 2018.

- GDE Study Execution Plan – Arrow Surat Gas Project: Execution plan for detailed characterisation of GDE's throughout the Surat Gas Project Area including plans for groundwater assessment, ecological characterisation, leaf, soil and groundwater sampling.
- Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Surat Gas Project: Detailed description, characterisation and mapping of GDEs throughout the Surat Gas Project assessment area. Study was commissioned to assist development of the Water Monitoring and Management Plan (WWMP). Contracted to Arrow Energy 2016 and 2017.
- Banksia Beach Borefield – Groundwater Dependent Ecosystem (GDE) Monitoring: Monitoring of wet coastal heath to detect impacts of groundwater drawdown on vegetation composition, structure and ecology. Biannual reporting includes an analysis of NDVI datasets to support assessments of vegetation condition. Seqwater (2016 ongoing).
- Condamine River Gas Seeps Vegetation Monitoring: Assessment of the impacts of gas migration into soil on the health and vigour of intact riparian vegetation on the Condamine River frontage. Required assessment of the current condition and status of vegetation as well as implementation of a long-term vegetation monitoring program.
- Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Surat Gas Project: An assessment of the potential groundwater dependency of ecosystems in Arrow Energy's Surat Project tenements to inform federal requirements for a Groundwater and GDE Management Plan . The project required detailed assessment and integration of groundwater, geology and ecological databases,spring characterisation and recommendations for an ongoing monitoring program (Arrow Energy 2016 ongoing).
- Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Bowen Gas Project Development Area: An assessment of the potential groundwater dependency of ecosystems in Arrow Energy's Bowen Gas Project tenements to inform federal requirements for a Groundwater and GDE Management Plan . The assessment focused on the potential groundwater dependency of ecosystems in areas contiguous with the North Goonyella, Suraji, Newlands and Suttor Creek Mining Lease areas
- with the focus on developing an ecological assessment program to monitor the effects of groundwater drawdown on vegetation condition (Coffey Environments 2015).
- Sunshine Coast Regional Airport – GDE Assessment: Assessment of the effects of altered groundwater hydrology on the ecology of wet heath and associated populations of the Endangered *Allocasuarina emuina*. Preliminary review of environmental conditions for the Sunshine Coast Airport Upgrade. Sub-contracted to BMT – WBM (June 2010).

LANDFORM / SOIL AND GEOMORPHOLOGY PROJECTS AND ASSESSMENTS

- Mornington Wildlife Sanctuary Landform, Geology and Vegetation Community Mapping Project: A 1: 50 000 aerial photograph interpretation and descriptive landform, soils geological and floristic mapping assessment of the Mornington Wildlife Sanctuary, Kimberley Region, North Western Australia. The report and complementary map provided a baseline study into the factors influencing the area's ecology and diversity. Assisted with preparation of vegetation maps for the property as well as preparation of a floristic inventory. Total survey and mapping area of 3 200 km^2. Contracted to Australian Wildlife Conservancy (2004).
- Mt Zero Wildlife Sanctuary Landform and Geological Mapping Project: A 1:25 000 scale aerial photographic interpretation, map, and descriptive report on land systems soils and geology of the Mt Zero/Taravale Wildlife Sanctuary, North Queensland. Total survey and mapping project area of 650 km^2.
- Agnes Water Geomorphic and Land Zone analysis: Provision of a geomorphic and soil assessment of a 300ha site south of Agnes Water. The study formed the basis for appraisal of regional ecosystems in the study area. EPA certified regional ecosystem mapping was successfully challenged. Mariner Awaken/ Midell Joint Venture, September 2009.
- Geomorphological assessments on major river crossings on the proposed PNG to Queensland gas pipeline for the purpose of assessing crossing stability.

GENERAL ECOLOGY, REHABILITATION AND VEGETATION MANAGEMENT ASSESSMENTS FOR DEVELOPMENT

- Property Map of Assessable Vegetation: Preparation of and application for a PMAV over the 250km2 Burdekin Downs property in the Einasleigh Uplands. Includes detailed field site survey, historical aerial photographic interpretation, preparation of supporting material and submission to DNRM. Burdekin Downs Pastoral Ltd, Charters Towers, 2017.
- Ecological Assessment Report – Seton College, Brisbane: Assessment of development impacts on the ecology of remnant woodland mapped as having High Ecological Sensitivity. Response to an information request by Brisbane City Council.

- Vegetation Management Plan – Rehabilitation Plan, Hymix Concrete Batching Site, North Pine River: Vegetation and Rehabilitation Management Plan for the 250 Bald Hills Road, a 10 ha former industrial site adjacent to the North Pine River to be rehabilitated under court order. Duggan and Hede Pty Ltd for Hymix Australia.
- Ecological Assessment Report – Yandina Waste Disposal Facility (Sunshine Coast Regional Council): Floristic survey and assessment of vegetation condition at proposed waste disposal facility, Yandina on the Sunshine Coast. Prepared for Sunshine Coast Regional Council on behalf of Duggan and Hede Pty Ltd (August 2014).
- Ecological Assessment Report – Warwick Landfill: Floristic survey and general ecological assessment of the proposed extension of the Warwick Landfill Site. Prepared for Duggan and Hede Pty Ltd (November 2013).
- Wooyung Developments, NSW – Ecological assessment of a proposed Eco-Tourism Facility at Wooyung Beach, Northern NSW. Assessment of a 100ha development site including mapping and assessment of Critically Endangered Littoral Rainforest communities, listed under the Federal and State (NSW) legislation.

WATERWAYS MANAGEMENT PROJECTS

- Redlands Waterways Reach Management and Riparian Condition Assessment: A reach and catchment characterisation including riparian habitat assessment, for waterways in the Redland Shire Council area (SEQ). The project involved aerial photograph classification of reach, and field assessment of riparian habitats (Hydrobiology, 2011).
- Caboolture Waterways Management Project: Provided a reach and catchment characterisation, including riparian habitat assessment, for waterways in the Caboolture Shire area (SEQ). The project involved aerial photograph classification of reach, and field assessment of riparian habitats (Natural Systems, 2006 - 2007).

EXPERT WITNESS

- Provision of expert advice to Rob Friend and Associates / Iwasaki Resorts in regard to charged breaches against the Vegetation Management Act. Evidence was presented for the defence in Queensland Planning and Environment Court Proceedings.
- Expert witness duties for the case of Queensland Government versus Strathmore Station in regard to charged breaches against the Vegetation Management Act. Contracted to Preston Law, Cairns. Trial is ongoing.

OTHER RELEVANT PROFESSIONAL EXPERIENCE

Feb. 1995 - August 1997

Regional Exploration Geologist – Louisade Archipelago P.N.G: The position required the development of remote epithermal gold prospects on Placer Dome's (now Barrick Gold Corporation) exploration tenements on Misima Island and regional areas. Major tasks included detailed geological mapping, remote sensing and reconnaissance drilling (diamond core). The supervision of exploratory drilling on advanced gold prospects, including resource delineation drilling in the mine vicinity, was also required on a regular basis.

Feb. 1994 - February 1995

Exploration Geologist - Osborne Gold Mine: The major task was to supervise the Osborne regional exploration program during the construction phase of the Osborne Cu-Au Mine (Mt Isa Inlier). Project requirements included the planning and implementation of exploratory drilling programs to test geophysical targets, supervision of RC and Diamond Core drilling rigs, logging of RC chips and diamond core. Project management tasks included the planning of a regional exploration program around a budget of $350K.

PEER REVIEWED PUBLICATIONS

Stanton J. P., Stanton D.J., Stott M. & Parsons M. (2014). Fire Exclusion and the Changing Landscape of Queensland's Wet Tropics Bioregion 1. The Extent and Pattern of Transition. Australian Forestry V77 No.1 51 – 57.

Stanton J. P., Parsons M., Stanton D.J.& Stott M. (2014). Fire Exclusion and the Changing Landscape of Queensland's Wet Tropics Bioregion 2. The Dynamics of Transition Forests and Implications for Management. Australian Forestry V77 No.1 58 – 68.

Fell D.G., Stanton D. J (2015). Vegetation and Flora of Mabuyag Island, Torres Strait, Queensland. Memoirs of the Queensland Museum, Volume 8, Part 1.

Stephenson PJ, Burch AT, Stanton DJ & Whitehead PW (1998). *Three long lava flows in north Queensland. Journal of Geophysical Research-Space Physics,* 103, 27359 – 27370.

SPECIALIST TECHNICAL TRAINING

Australian Groundwater School: Four-day intensive training course dealing with technical and management aspects of groundwater in an Australian context. Flinders University, Canberra, 2017.

PUBLISHED VEGETATION MAPPING

Stanton J. P and Stanton D. J (2005) *'Vegetation of the Wet Tropical Bioregion of North Queensland',* published at 1:50 000 scale in co-operation with the Wet Tropics Management Authority, Cairns, Queensland.

Stanton D.J, Fell D. F, Gooding D. O (2009). '*Vegetation of the Torres Strait and Kaurareg Islands'.* 1:25 000 scale vegetation mapping produced in co-operation with Torres Strait Regional Authority, Australian Government.

PRESENTATIONS

IAVCEI (International Association of Volcanology and Chemistry of the Earths Interior) conference, Canberra 1993, "*Using Remote Sensing to Detect Geochemical Heterogeneity within the Kinrara Lava Flow, McBride Lava Province, N.Q."*

EIANZ conference '*Achieving Real Biodiversity Outcomes during the EIS Process*', April 2010. The presentation was titled ' *The Importance of Accurate Regional Ecosystem and Vegetation Mapping in the Assessment of Impact to Biodiversity*'.

ADDITIONAL RELEVANT SKILLS, INTERESTS and CERTIFICATIONS

- Proficient in the Tok Pisin PNG language
- Professional experience as a Lifeguard for Queensland Surf Life Saving Association;
- Former Queensland representative swimmer and current record holder for the Magnetic Island to Townsville swimming race.
- Senior First Aid Certificate Current.
- Above Ground Coal Core and Coal Seam Gas inductions
- Advanced 4wd training certification current.

REFERENCES

Steven Goosem: Principal Scientist, Wet Tropics Management Authority. Ph: 07 4052 0563: Email: steve.goosem@wetma.qld.gov.au

Barton Napier: Principal - Coffey Environments. Trenerry Crescent, Melbourne. Ph: 03 9473 1450. Email: Barton.Napier@coffey.com

Dale Mundraby: CEO Mandingalbay Yidinji Aboriginal Corporation. Ph: 07 4056 8283. Email: dale@djunbunji.com.au

MARK SANDERS

Position: Director/Principal Ecologist, EcoSmart Ecology Pty Ltd
Qualifications: Bachelor of Advanced Science (Zoology) (First Class Honours)

Areas of Expertise

- Environmental planning and constraints analysis
- Vertebrate fauna survey and identification
- Rapid assessment of terrestrial habitats
- Design and implementation of research projects, particularly monitoring programs
- Threatened species survey and assessment
- Wildlife management
- Biodiversity planning and offset management
- Scientific communication

Overview

Mark Sanders is a highly respected and well known ecologist with over 20 years field expertise and first-hand knowledge of more than 1600 of Australia's terrestrial vertebrate species. His enthusiasm for natural history has led to surveys in every state and territory within the Australian continent from across a vast range of habitats.

Mark combines his ecological knowledge and experience with strong industry understanding and management skills. His project-related experience has included linear infrastructure (roadways, rail corridors, transmission lines etc), mining (inc metalliferous and coal), oil and gas, energy and transport projects, and small and large scale infrastructure (town development, master plan projects, airports etc). He has also prepared management plans for threatened species and offset areas, and provided detailed assessment for regulatory review. His broad industry experience enables him to evaluate ecological resources and make effective strategy recommendations based on scientific understanding and industry knowledge.

Marks recent work has included a large-scale airport development located on the Sunshine Coast of Queensland. The work involved rapid ecological assessment to identify potential ecological constraints, targeted long-term (12+ months) research on high conservation taxa, and baseline (inventory) surveys. Multidisciplinary understanding has been fundamental in developing environmentally sustainable solutions, which has included evaluation and identification of offset priorities and targets. Due to the sensitive location and nature of the works, Mark has been required to regularly liaise with government bodies, research institutions and community groups, often requiring the communication of complex ecological issues.

Mark has extensive experience in remote area work, four-wheel drive training and maintenance skills and has worked with traditional land owners. His photography skills are renown, and his highly sort after images have been used in a variety of publications.

Professional History

2009 - present Director/Principal Ecologist
EcoSmart Ecology Pty Ltd

2008 Principal Ecologist
Matrixplus Consulting Pty Ltd

2005 - 2008 Senior Ecologist
BAAM Pty Ltd

2001 – 2005 Senior Ecologist
Australasian Resource Consultants Pty Ltd, Brisbane Qld.

2000 Environmental Scientist
Blue Mountains Wilderness Trust, Sydney NSW.

Selected Project Experience

- Baseline (seasonal) inventory survey of terrestrial fauna at MMG Century, located near Lawn Hill National Park in north-west QLD, 2013-14,
- Fauna assessment and community fauna awareness project within the Mandingalby Yidinji IPA, Yarrabah, Cairns. Surveys involved teaching survey methods and sharing information with local Traditional Owners, 2013-14.
- Baseline (seasonal) inventory survey for terrestrial fauna on Curtis Island for Arrow Energy CSG, 2012/13. Works included the survey of mangrove communities, intertidal communities, headlands and coastal dune vegetation (e.g., littoral rainforest),
- Baseline terrestrial fauna survey at Pisolite Hills, north of Weipa, QLD, 2012-2013
- Baseline vertebrate assessment of the Red Mud Dam area, Boyne Island for QAL (2005). Works included coastal dune complex with littoral rainforest.
- Team leader for the (fauna) assessment of Arrow Energies Surat basin CSG tenements. Works included high-level assessment to establish areas of primary conservation value, and the development of a risk-based approach to infrastructure planning. 2010 to present
- Fauna survey for South Murrin Murrin mining operations, WA. 2012.
- Pest Management Action Plan – Feral Pig and Red Fox. Action Plan prepared for Redland Shire Council. June 2005.
- Team Leader for two successive flora and fauna surveys (2001 and 2003) for the North Curragh Coal Project, Central Queensland. The project included assessing and managing impacts on three Nationally Vulnerable species along a proposed transport corridor.
- A 6 day (5 night) survey in a remote area for Matrix Metals near Kajabbi in far north-west Queensland. The survey found several threatened species and added small range extensions for several common species.
- Project Manager and Team Leader for a comprehensive survey and assessment of environmental values of Tarong State Forest in south-eastern Queensland.
- Flora and fauna assessment of coastal vegetation in north-eastern NSW. The survey located eight threatened fauna species.
- Survey of flora and fauna species on a 400ha site near Mt Glorious, south-east Queensland. Habitats surveyed include rainforest, wet sclerophyll forest and dry sclerophyll forest.
- Team Leader for an intensive 10-day survey of an area north of Clermont, Central Queensland. Confirmed the presence of several Endangered Regional Ecosystems and Threatened species.
- An extensive 8 day baseline survey study for Selwyn Mines in the Selwyn Ranges. During the study, *Pseudantechinus mimulus* was discovered. This species has been seen on the mainland of Australia only five times since its description in 1906.

Targeted Surveys

- Ground Parrot Research (2012-2014 and 2017) at the Sunshine Coast Airport. Monthly works to establish habitat use and population size,
- Targeted Purple-necked Rock-wallaby research and monitoring; MMG Dugald River. Ongoing works,
- Targeted survey, including trapping and active searches, for the vulnerable Water Mouse (*Xeromys myoides*) around Port Curtis (Gladstone) including Curtis Island (2012). The works located a number of nesting holes and increased local knowledge/distribution of the species.
- Targeted survey and assessment of the distribution of the Brigalow Scalyfoot on Boyne Island (for Queensland Alumina) (2006).
- Targeted survey and management plan for the federally Vulnerable Black-breasted Button-quail, Boyne Island Gladstone (QAL, 2006). This work was commissioned following baseline surveys which rediscovered the species within littoral rainforest on coastal dunes. Prior to the discovery the species had only been known in the local area from records in the early 1900's.

- Team leader for the survey of threatened wallum frogs (particularly Wallum Sedgefrog) near Caloundra, south-east Queensland (2012 – ongoing). Work included sampling tadpoles and water parameters to evaluate breeding success across a variety of pools located in a variegated and disturbed landscape.
- Assistant to field ecologist on a study into the population, distribution and abundance of Plains Wanderers (*Pedionomus torquatus*) in grasslands of southern central NSW.
- Field Team Leader in the assessment of the presence and extent of Black-breasted Button-quails (*Turnix melanogaster*) in Tarong State Forest, south-east Queensland.
- Microchiropteran bat fauna of Clermont Coal Project north of Emerald. The survey was designed to determine the presence/absence and distribution of the Little Pied Bat (*Chalinolobus picatus*) and Greater Long-eared Bat (*Nyctophilus timoriensis*).
- Team Leader for an assessment of the presence/absence of the Threatened *Delma torquata* in south-east Queensland.

Research and Monitoring

- Carpentarian Pseudantechinus (*Pseudantechinus mimulus*) research to establish best survey methods and evaluate their distribution. Co-supervisory role with the University of Sunshine Coast.
- Team leader for the twelve month monitoring to determine area of occupancy and habitat preference of the vulnerable Ground Parrot, Sunshine Coast Airport, Marcoola.
- Research into the methods of habitat utilisation and differentiation between four sympatric species of low-foliage gleaning bird species (White-browed Scrubwren, Superb and Variegated Fairy Wren and the Southern Emu-wren).
- Leader of the team that developed a biannual monitoring program for Pacific Coal's Kestrel Project in central Queensland. The aims of the program are to determine the affect of cattle grazing and subsidence on biodiversity values of natural grasslands and riparian ecosystems. The program was specifically designed so that later publication of results would be possible.
- Design and implementation of biannual monitoring program to document the success of rehabilitation strategies at Peak Downs Coal Mine.
- Comprehensive 8 day fauna study for the Ernest Henry Copper/Gold Mine as part of their yearly monitoring program. Aims of the program are to statistically show the effect of rehabilitation techniques on facilitating recolonisation by fauna.
- Heavy metal accumulation in aquatic macro invertebrates at Ernest Henry Copper/Gold Mine.
- Development of a monitoring program of the Vulnerable Ornamental Snake (*Denisonia maculata*) including population estimates (micro-chips) and radio-tracking. In particular, the program was designed to determine the effect of a road through a known population and if specifically designed underpasses facilitated movement and flow within the population. The program was accepted by the Department of Environment and Heritage.
- Research into shelter site characteristics of the Purple-necked Rock-wallaby (*Petrogale purpureicollis*) during summer.

Selected Technical Papers

McNab, A., and **Sanders, M.G.** (2014). Consumption of exotic grass seeds (Poaceae: Cynodon dactylon by the Eastern Ground Parrot (*Pezoporus wallicus*). *The Queensland Naturalist* Vol 52, 82-84.

McNab, A., **Sanders, M.G.,** and Vanderduys, E. (2014). New records of blind snakes resembling the Robust Blind Snake Anilios ligatus (Peters 1879), on Cape York Peninsula, *Memoirs of the Queensland Museum*. 59, 8.

McNab, A., and **Sanders, M.G.** (2014). An occasional carnivore, Diadem Leaf-nosed Bat (*Hipposideros diadema reginae*). *The Australasian Bat Society Newsletter*.

Lloyd, P., **Sanders, M. G.,** Reis, T. and Abbott, A. (2013). Targeted trapping surveys shed new light on the distribution and habitat requirements of the Carpentarian Pseudantechinus (*Pseudantechinus mimulus*), a threatened dasyurid marsupial. *Australian Mammology*. **35**: 220-223.

Sanders, M. G., Filewood, L. W. and Fox, B. J. (2005). Differential use of habitat aids local coexistence of three species of wrens (Maluridae) and the White-browed Scurbwren *Sericornis frontalis*: Pardalotidae in Myall Lakes National Park. *The Australian Zoologist.* **33**: 223-232

Sanders, M.G. (2004). Notes on a mass aggregation of *Illyria burkei* (Goding & Froggatt) (Hemiptera: Cicadidae) in central Queensland. *The Australian Entomologist.* 31 (2):79-80

Sanders, M.G., and Slater, L. (2004) New habitat and distributional data for the Vulnerable *Pseudantechinus mimulus*. *Memoirs of the Queensland Museum* **49**: 740.

Macey P. C., McKiernan, C. and **Sanders M. G**. (2002). Is there any science in the Environmental Protection and Biodiversity Conservation Act 1999? A review of the Migratory Species List. Presentation for the 4th Environmental Engineering Conference, May 2002, Brisbane.

A full CV can be provided upon request.

RESUME

Name: Peter Thomas Hall

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Qualifications:

Bachelor of Applied Science (Biology)
Central Queensland University
Completed 1995.

Certificate IV in Investigations.
June 2003 Moreton Institute of TAFE

Other skills and Qualifications.

DSEWPac Accredited Ecologist. (Terrestrial Flora and Fauna) 2012

Construction Industry OH&S Induction (White Card)

Experience in using GIS programs, (principally ESRI ArcGIS and GBM), and GPS technology.

Heavy Vehicle Driver's Licence

Agricultural Chemical Distribution and
Control Act, Operator's Licence (Restricted).

Level 2 Chainsaw Operator.
Computer and word processing skills.

Workplace Trainer Qualifications 2000

Advanced First Aid Remote Area Operations (refresher training) 2014

In Service Training: Communications Skills 1984

Fire Training 1986

Supervisor Training 1987

Law Enforcement School 1989

Forest Interpretation Workshop 1993

Recreation Training workshop 1994

Customer Service Training 1994

Summer School of Park Management
Canberra University 1995.

Public Speaking Course through Toastmasters International 1998.

Aboriginal Cultural Heritage Awareness 1999 and 2004

Regional Ecosystem Training 1999 and 2002.

Map Amendment Request Training 2003

Tactical Communications 2004.

Detecting Deception 2004.

Decision Making Training 2005

Technical Report Writing 2005.

Acid Sulphate Soils Training 2005

QGC Induction 2011

4WD training and defensive driving 2011

Vehicle washdown and weed hygiene certification (Certificate II in Conservation and Land Management –National Code RTD20102) 2011

Origin Energy induction 2012

All Terrain Vehicle drivers' course. 2012

Remote area first aid 2012

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Helicopter landing officer 2012

Erosion and Sediment Control Training 2012

Laing O'Rourke Induction 2013

WDS Induction 2013

Origin Energy Foundation Training 2014

Most Recent Salary: $100K including superannuation or $60/hour plus costs for contract work.

Employment History

January 2016 to present.

Contract Ecologist with Naturecall Environmental Pty Ltd.
This a contract position. Naturecall engages my services when they require specialised ecological advice.
I have worked on two projects in this role,

One was determining and mapping the extent of threatened grasslands on the Army Aviation Base at Oakey. The job included other ecological surveys as well.

The second job was mapping the occurrence of an endangered plant, *Melaleuca irbyana* on a sports reserve in Logan City Council.

April 2015 to present.

Consulting Ecologist with First Steps Environmental (employed on a casual basis).

Duties and responsibilities; principally conducting field surveys of native vegetation in North, West New South Wales under various codes relating to clearing for agricultural purposes under the *Native Vegetation Act 2003.*

June 2014 to April 2015

Field Environmental Advisor with Origin Energy.

Duties and role description; refer to my time in the same role January 2012 – September 2013

September 2013 to June 2014

Senior Vegetation Management Officer, Central West NRW Region.

Duties and role description; refer to my time in the same role January 2008 – March 2011

November 2012 until March 2014

Ecologist and expert witness with First Steps Environmental Pty Ltd, for the Turnbull Case, Croppa Creek. (This work was undertaken concurrently with other employment).

This case involved preparing an ecological report to address the federal *Environmental Protection and Biodiversity Protection Act* (*EPBC*) requirements of a tree clearing application over a large farming property near Moree in NSW.

Additionally, the case involved preparing an affidavit and giving evidence in the Sydney Land and Environment Court in the capacity of an expert witness ecologist for the Defence, in a tree clearing prosecution under the *Native Vegetation Act 2003.* The case was heard in March 2014.
The case had a favourable outcome for the client in that the Court considerably reduced the fine that the Office of Environment and Heritage (OEH) originally sought. Also, based on my affidavit, potential charges under the EPBC Act and for clearing an Endangered Ecological Community under *The National Parks and Wildlife Act 1974* were not pursued.
Details of the Land and Environment Court Judgement are available at the web address below.

http://www.caselaw.nsw.gov.au/decision/54a63ede3004de94513dc50f

In June 2014an appeal against the Remediation Directions imposed on the landholders by NSW Office and Heritage were also heard in the Sydney Land and Environment Court.
The Court directed that the expert witnesses for the Prosecution and Defence should agree on a compromise Remediation Plan. This plan formed the basis for the eventual Remediation Direction that was imposed by the Court.
Based on my evidence and negotiations with OEH, the Court agreed that rather than order remediation of the entire cleared area, the property owners should be allowed to restore offset areas to high ecological condition and continue to farm some of the unlawfully cleared areas in order to meet the costs of implementing the remediation plan.

The judgement is available at the link below.

http://www.caselaw.nsw.gov.au/decision/54a63ed53004de94513dc23c

January 2012 to present until September 2013

Field Environmental Advisor with First Steps Environmental Pty Ltd, contracted full time to Origin Energy.

Duties included;

- Conducting reports and pre-clearance surveys for properties where Origin intended to locate CSG gathering infrastructure.
- Field scouting disturbance footprints for infrastructure associated with the upstream gathering network for the Australia Pacific Liquefied Natural Gas (APLNG) project in SW Queensland.

- Field scouting disturbance footprints for infrastructure associated with exploration wells for APLNG.
- Skills required for field scouting and ecology/pre-clearance reports are, the ability to recognize plant and animal species, including weeds, in the field, ability to conduct watercourse assessments, the ability to recognise regional ecosystems and a basic knowledge of gas field design.
- Ability to recognise soil and geology types, together with a basic knowledge of gas field infrastructure construction and to use this knowledge to identify potential soil erosion issues.
- Writing and reviewing Environmental Constraints Assessments (ECA) capturing the results of field scouting assessed against the various bits of legislation pertaining to the APLNG project. These pieces of legislation and policy include, Queensland Government Environmental Approvals, The Co-ordinator General's Report, Federal Government Approvals, APLNG Environmental Management Plans and miscellaneous pieces of legislation and codes such as those pertaining to land access and Strategic Cropping Land.
- Writing and reviewing ecology reports and pre-clearance survey reports for individual properties.
- Carrying targeted species surveys for rare and threatened plants occurring within development areas as well as complete botanical assessments for disturbance sites.
- Conducting surveys to ground truth regional ecosystems and threatened ecological communities (as described in federal legislation)
- Delivering accredited Regional Ecosystem and Vegetation structure Training to Origin environmental staff.

While working in this role I consistently met Key Practice Indicator targets for the project.

<u>March 2011 until January 2012</u>

Land access consultant with Flinders Group, contracted to the Queensland Gas Corporation (GGC).

Duties included;

- Negotiating Consent to Enter Agreements with landholders on behalf of QGC, to allow coal seam gas exploration on their properties.
- Negotiating Compensation Agreements with landholders to ensure the interests of both landholders and QGC are addressed when determining compensation amounts.
- Ensuring all negotiations are consistent with the Qld Government Land Access Code – November 2010.
- Attending field operations to assess seismic, clear vegetation and carry out seismic operations to ensure compliance with landholder access rules, including certifying weed washdown procedures.
- Attending pegging parties to locate potential appraisal well sites to ensure landholder interests are addressed.
- Assisting in the preparation of Notices of Preliminary Activity and Notice of Intent to negotiate under the *Petroleum and Gas (Production and Safety) Act 2004* where a voluntary agreement with a landholder cannot be achieved.

- Serving as a contact for landholders to address issues with QGC.
- Acting as an advocate for landholders in their dealings with QGC.

January 2008 until March 2011

Senior Vegetation Management Officer, Central West NRW Region.
Duties included,

- Managing the technical, personnel management and training aspects of the Vegetation Management Program within the CW Region.
- The Vegetation Management Program assesses applications made under the *Vegetation Management Act 1999* and *The Integrated Planning Act 1995* for developments that involve the clearing, or potential clearing, of native vegetation. These applications include requests to clear for operational works, weed control, livestock fodder, and material change of use and reconfiguration of properties. The Vegetation Management Unit also assesses and provides comment on major projects, e.g. gas pipelines and major water infrastructure projects. The unit also assesses application for property maps of assessable vegetation (PMAVs), where landholders can produce individual maps showing the vegetation on their properties.
- Training and mentoring staff involved in vegetation management assessment.
- Undertaking desktop and field assessment of major project application through the use of GIS programs, aerial photographs satellite imagery and field observations.
- Providing policy advice and serving on policy development forums
- Answering queries from interested groups and individuals, including delivering addresses to industry groups.
- Dealing with complex inquiries and difficult clients.
- Drafting replies for ministerial correspondence on vegetation management issues.
- Assisting with budget preparation and forward planning.

January 2007 until January 2008.

Senior Vegetation Management Officer, Property Map of Assessable Vegetation (PMAV) Project.
This project involves clearing a backlog of PMAV applications in a short period of time.
Duties included

- managing and motivating staff involved in the project,
- monitoring progress of the project and preparing reports,
- Providing policy advice on PMAVs.

During this period I also relieved in the Vegetation Policy Unit in Brisbane.
Duties in this relieving period included,

- providing policy advice to staff throughout Queensland
- answering ministerial inquiries
- Developing policy positions for, and interpreting vegetation legislation.

January 2005 until January 2007.

Senior Natural Resource Officer (Regional Ecosystems) with the Queensland Department of Natural Resources & Mines, Vegetation Management Unit.

My duties under this position included;

1. Undertaking Regional Ecosystem Map amendments.
   This is done by;

- conducting field assessments of species present,
- sampling and measuring vegetation height and percentage crown cover using Queensland Herbarium guidelines to determine whether the vegetation in question is remnant or non-remnant as defined under *The Vegetation Management Act 199,*
- assessing aerial photos and satellite imagery to determine the clearing history of the vegetation in question. (Sometimes the imagery and or air photos can be used to determine the remnant status of an area without the need for a field survey).
- After gathering the evidence I prepare an assessment report to forward to the Queensland Herbarium. Part of the report process involves using a GIS program to prepare maps.

2. Managing the RE map amendment program within the Central West Region of Natural Resources. The Central West Region covers 28 shires and is roughly defined in the south by a line running from Gladstone to Birdsville, and in the north by a line running from Proserpine through Winton to the NT border.

Management duties included;

- maintaining a database of RE map amendment requests,
- checking assessment reports submitted by other officers,
- training other staff in vegetation structure, species identification and report preparation,
- preparing and supervising work programs to complete RE map amendments.

3. Providing expert advice to the public and other sections of the department on vegetation issues.

Examples of such advice;

- checking EI Statements for major projects and advising the assessment manager whether or not vegetation issues have been sufficiently addressed,
- assisting vegetation officers with RE and plant identification when assessing tree clearing permit applications,
- reporting on vegetation issues that arise from applications under *Integrated Planning Act* for subdivision or Material Change of Use,
- preparing statements and giving evidence in court hearings for prosecutions under vegetation legislation.
- Answering phone and counter queries from the public in regard to complex vegetation issues.
- Meeting with consultants and project managers for large development operations to discuss vegetation issues.
- Giving expert advice on plant identification and monitoring techniques for the Mount Morgan mine rehabilitation project.
- For my work on this project, I received a ‘Highly Commended” award from the Director General of the Department of Mines and Energy.

June 2001 until January 2005

Regional Investigator, Natural Resources & Mines Compliance Unit.

Duties included;

- Investigate suspected breaches of the *Vegetation Management Act 1999, The Land Act 1994, and The Integrated Planning Act 1995, The Water Act 2000, The Aboriginal Cultural Heritage Act 2003* and *Land Protection (Pest and Stock Route Management) Act 2002.*
- Undertaking site inspections and surveys, taking out warrants, interviewing suspected offenders, taking witness statements and preparing court briefs in the course of investigations.
- Acting as a prosecutor in Magistrate's Court callovers.
- Assisting Crown Law solicitors to prepare cases for hearings and giving evidence at such hearings.
- Prioritising, managing timelines and maintaining case files. Collecting and managing evidence that may be used as exhibits.
- Preparing rehabilitation plans and restoration orders for areas cleared illegally. Monitoring the rehabilitation of these areas.

During my time in this role I investigated and prosecuted some major contested cases.

Hall v Glasgow was an investigation into one of the largest area of illegally cleared endangered vegetation to be prosecuted under the *Vegetation Management 1999.* This case attracted media interest and was attended by Senator Len Harris.

All of the cases I investigated that proceeded to court resulted in a successful prosecution.

As well as the above mentioned legislation, I have gained familiarity with a number of other acts through gathering evidence as an ex officio investigator. These include the federal *Environmental Protection and Biodiversity Conservation Act,* and the Queensland *Environment Protection* and *Nature Conservation Acts.*

April 1999 until June 2001

Forestry Environmental Management Officer.
The purpose of this position was to monitor and audit logging operations and quarry sales on state land as per the Commonwealth National Forests Policy.

Specific tasks included;

- Conducting surveys prior to logging operations to identify rare, endangered and vulnerable species, cultural heritage sites, potential weed and pest animal infestation, potential threats to the interests of other operators and lessees and identifying threats to the aesthetic and recreational qualities of the land in question. These surveys were done by both field inspections and desktop analysis, i e consulting EPA databases and maps.
- Conducting environmental audits of ongoing operations to ensure that they complied with various industry codes. The codes stipulate how the operation should meet guidelines relating to soil erosion, watercourse protection, habitat tree retention, safety, cultural heritage, endangered, rare and vulnerable species, waste management, fire protection and protection of the remaining forest from logging damage.

- Preparing management plans for specific species. An example is a management plan I prepared for a vulnerable plant, *Acacia gittinsii.* The plan dictated measures that would allow logging operations in areas where this plant occurred, at the same time ensuring that the species was preserved. This plan was endorsed by EPA.
- Contributing to the development of industry codes under ISO 14001 standards.
- Conducting fauna and flora surveys on state forests.
- Reporting sightings of vulnerable, rare and threatened species for inclusion in the EPA database.

March 1993 until April 1999

Forest Ranger Recreation and Extension, Byfield.

This position involved the management of three camping and day use areas on Byfield State Forest, as well as other sites in the Central Queensland Region.

Byfield State Forest averaged 20,000 visitors per year.

Specific tasks included;

- Managing staff and contractors involved in construction, maintenance and servicing.
- Conducting patrols and law enforcement.
- Budgeting and planning.
- Managing capital works projects.
- Providing advisory services to landowners on forestry issues.
- Delivering talks to school and tertiary students and other interested groups.
- Writing a regular column for a local newspaper.
- In this position I spoke on behalf of the department in several television and radio interviews.

February 1979 until March 1993.

Forest Officer in various parts of Queensland.

During this time I was employed in North, South and Central Queensland in both native forests and plantations.

Among the tasks I performed in this role;

- Site design and preparation, weed control, pruning, planting, harvesting, control burning and fire protection in exotic pine and hoop pine plantations.
- Timber assessment, tree marking, log assessment, sale preparation and site rehabilitation in native forests including North Queensland rainforests.
- Supervising sales of round timber and quarry material, floral and seed harvesting, and grazing permits on state forests and other crown land.
- Forest inventory studies in plantations and native forests.
- Seed and pollen collections in plantations and native forests. Managing an artificial pollination program in exotic pines.
- Soil surveys to determine suitability for plantation establishment.

- Surveying.
- Prescribed burning and fire fighting.
- Law enforcement.

In 1991 I designed, implemented and supervised a program to monitor the harvesting of *Bowenia serrulata,* a plant used for floral arrangement.
The data gathered in this study is still used to determine harvesting levels for this resource.

Prior to 1979.

Grew up on rural properties near Clermont Qld and on Queensland's Sunshine Coast.

Worked as a stockman and sharefarmer during high school and afterward.

Origin referees

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Attachment 5. - EcoSmart Ecology Report

SURAT GAS PROJECT

Terrestrial Ecology Report

PREPARED FOR ARROW ENERGY PTY LTD
June 2017

Surat Gas Project

Terrestrial Ecology Report

June 2017

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DOCUMENT CONTROL

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APPENDICES

EXECUTIVE SUMMARY

At the request of Arrow Energy, EcoSmart Ecology and 3D Environmental undertook seasonal terrestrial flora and fauna surveys throughout the Surat Gas Project study area. This study area has a total extent of 202,915 ha, which for the purposes of the ecological survey was divided into three distinct regions (Figure 2.1):

- The northern region encompassing an area of 7,601 ha located just south of Wandoan,
- A central region of 53,048 ha located to the north-east of Miles, and
- A southern region of 142,266 ha located to the west of Dalby

Remnant vegetation in the northern (Wandoan) region was sparse, representing 2.8% (164.7 ha) of the area. However large continuous patches of remnant vegetation are present within the central (67%; 35,554 ha) and southern (28.7%, 104,035.8 ha) regions. Survey effort predominantly focused on these later two regions.

Survey Methods

A desktop assessment was undertaken prior to field investigations to gather relevant information and literature for the Surat Gas Project study area. This work included a gap assessment to identify areas, species or features which required targeted or additional field survey.

The flora gap assessment rated areas of interest at a property scale as follows:

1. Priority 1 – Properties with mapped Endangered or Of Concern vegetation, prior records of EVNT Flora species, Protected Plant high risk trigger areas, mapped as Core Habitat Known in the SGP Supplementary EIS (3d Environmental 2013),
2. Priority 2 – Properties with well-preserved remnant vegetation, limited prior sampling and strong indications of habitat suitability for a range of threatened flora species although no prior records, and
3. Priority 3 – Properties with intact, least concern remnant vegetation not recognised as hosting populations of EVNT species or habitats of any specific legislative significance, and
4. Priority 4 – Properties subject to intensive sampling effort during previous survey events.

In total, 114 Priority 1, 74 Priority 2, 65 Priority 3 and 31 Priority 4 properties were identified. Field surveys aimed to sample vegetation on all priority 1 and priority 2 properties throughout the course of the 'wet' and 'dry' season surveys, though access limitations prevented sampling some properties (i.e. 86 of 114 Priority 1 and 66 of 74 Priority 2 properties were sampled).

The flora field survey was consistent with Queensland Herbarium standards (Neldner *et al* 2012) and included secondary, tertiary and quaternary sites. In total 218 secondary, 17 tertiary and 2,223 quaternary flora survey sites have been sampled throughout the Surat

Gas Project study area (including sites sampled in previous work identified during the desktop assessment).

The fauna gap assessment used sampling locations from existing works to identify large areas of remnant vegetation which had not been subject to previous fauna survey. Once identified, Broad Vegetation Group mapping by the Queensland Herbarium (version 3.0) was used to identify the location and extent of Broad Vegetation Groups at a 2 million scale. The contribution of each Broad Vegetation Group to the extent of remnant vegetation was calculated and theoretical trap effort distributed accordingly.

The terrestrial fauna surveys used a variety of recognised survey methods consistent with relevant federal and state survey guidelines. These included trapping (Elliot, pitfall, funnel and Harp), observation (spotlighting, bird survey, and active search), remote sensing (Anabat ultrasonic bat detection and camera trapping), and targeted methods (Koala [SAT] and Glossy Black Cockatoo ort searches, tripline, artificial shelter).

Desktop Results

The desktop assessment identified the following ecological values:

- Two major wetlands of High Ecological Significance; i) Lake Broadwater, a major lacustrine Wetland of National Significance and ii) Long Swamp, a palustrine wetland which follows a shallow sinuous path to the north of Lake Broadwater,
- Protected Plant 'High Risk Buffers' (see Section 4.1.3), and
- The following Environmentally Sensitive Areas:
    - Category A - National Parks and Conservation Parks, specifically Lake Broadwater Conservation Park (Lot 68/SP139357),
    - Category B – Regional Ecosystems scheduled as Endangered (Biodiversity Status) by Queensland Department of Environment and Heritage Protection, and
    - Category C – which includes the following:
        - Lake Broadwater Resources Reserve (Lot69/DY6009),
        - Regional Ecosystems with 'Of Concern' Biodiversity Status,
        - State Forest areas (detailed Section 2.3), and
        - Essential Habitat (see Section 4.1.2).

Flora Survey Results

The flora surveys identified three Threatened Ecological Communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* within the study area including:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) (Endangered),
- Weeping Myall Woodlands (Endangered), and

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (Endangered).

These communities occupied 954.3, 0.9 and 22.6 hectares respectively.

Twenty Regional Ecosystems were recorded, three are listed as Endangered and six as Of Concern, with the remainder being classed as Least Concern under the *Vegetation Management Act 1999*. Endangered Ecosystems include:

- Regional Ecosystem 11.3.1 – *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains. Total extent within the study area = 217.5 hectares,
- Regional Ecosystem 11.4.3 - *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains. Total extent within the study area = 388.7 hectares, and
- Regional Ecosystem 11.9.5. *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks. Total extent within the study area = 4.3 hectares.

Of Concern Ecosystems include:

- Regional Ecosystem 11.3.17 - *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains. Total extent within the study area = 213.5 hectares,
- Regional Ecosystem 11.3.2. *Eucalyptus populnea* woodland on alluvial plains. Total extent within the study area = 580.7 hectares,
- Regional Ecosystem 11.3.3c. Palustrine wetland (e.g. vegetated swamp). *Eucalyptus coolabah* woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels. Total extent within the study area = 26.8 hectares,
- Regional Ecosystem 11.3.4. *Eucalyptus tereticornis* and/or *Eucalyptus spp*. tall woodland on alluvial plains. Total extent within the study area = 898.6 hectares,
- Regional Ecosystem 11.9.7. *Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks. Total extent within the study area = 1.5 hectares, and
- Regional Ecosystem 11.9.10. *Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks. Total extent within the study area = 15 hectares.

A total of 438 flora species were recorded during the flora surveys including 38 exotic species, 2 Conifers, 2 ferns, 90 grasses, 2 species of grasstree and a balance of trees, shrubs and forbs across 65 plant families.

Only one threatened flora species, *Philotheca sporadica* (Near Threatened under the *Nature Conservation Act 1992* and Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*), has been recorded within the study area during previous assessments completed by Arrow Energy and the current 2016 – 2017 surveys. However database records (Herbrecs and Australia's Virtual Herbarium) indicate a number of

additional threatened species have been recorded either within the Surat Gas Project study area including:

- *Crytandra ciliata* (Near Threatened, *Nature Conservation Act 1992*),
- *Solanum papaverifolium* (Endangered, *Nature Conservation Act 1992*),
- *Fimbristylis vagans* (Endangered, *Nature Conservation Act 1992*), and
- *Digitaria porrecta* (Near Threatened, *Nature Conservation Act 1992*).

Based on historic records these four species are considered present, though it is noted that some have no contemporary records despite extensive searches in suitable habitat.

Fauna Survey Results

The terrestrial fauna surveys identified a total of 266 vertebrate species within the Surat Gas Project study area including 20 amphibians, 55 reptiles, 151 birds and 40 mammals.

The likelihood of thirty-nine threatened species known to occur within the local area (i.e. the study area plus a 50km buffer) was assessed based on record relevance (i.e., record location and date) and habitat suitability. Based on results from the current 2016-17 surveys, six were recognised as occurring within the study area including:

- *Strophurus taenicauda* (Golden-tailed Gecko) – Near Threatened, *Nature Conservation Act 1992,*
- *Hemiaspis daemeli* (Grey Snake) – Endangered, *Nature Conservation Act 1992,*
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable, *Nature Conservation Act 1992,*
- *Phascolarctos cinereus* (Koala) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,*
- *Petauroides volans* (Greater Glider) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,* and
- *Nyctophilus corbeni* (South-eastern Long-eared Bat) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992.*

The following five species were assessed to be either likely or possible within the study area:

- *Jalmenus eubulus* (Pale Imperial Hairstreak) – Vulnerable, *Nature Conservation Act 1992*,
- *Acanthophis antarcticus* (Common Death Adder) – Vulnerable, *Nature Conservation Act 1992*,
- *Furina dunmalli* (Dunmall's Snake) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,*
- *Rostratula australis* (Australian Painted Snipe) – Endangered, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,* and

- *Grantiella picta* (Painted Honeyeater) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992.*

Three Migratory species, listed under the *Environment Protection and Biodiversity Conservation Act 1999*, were recorded during the 2016-17 surveys including:

- Rufous Fantail (*Rhipidura rufifrons*),
- White-throated Needletail (*Hirundapus caudacutus*), and
- Fork-tailed Swift (*Apus pacificus*).

Thirteen other Migratory species are known to occur, most are vagrants restricted to habitats around Lake Broadwater.

1.0 INTRODUCTION

Arrow Energy (Arrow) has received Federal and State government approval for its Environmental Impact Statement (EIS) for the Surat Gas Project (SGP). The approval includes Federal conditions requiring flora and fauna surveys in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) survey guidelines (or as otherwise agreed with the Commonwealth Department of the Environment and Energy) and State (Department of Environment and Heritage Protection) survey guidelines.

To meet these obligations Arrow engaged EcoSmart Ecology, in conjunction with 3D Environmental, to undertake seasonal terrestrial flora and fauna surveys. This work aimed to:

- Complete detailed seasonal terrestrial ecological surveys sampling the range of habitats within the SGP study area and targeting likely threatened species to satisfy State and Federal survey guidelines. Surveys considered:
    - Environmentally Sensitive Areas (ESAs),
    - Wetlands and watercourses, particularly wetlands of High Ecological Significance,
    - Endangered or Of Concern Regional Ecosystems (REs), or Threatened Ecological Communities (TECs),
    - Essential Habitat,
    - Areas of high connectivity,
    - Protected plants high risk areas, and
    - *Core Habitat Known* and *Core Habitat Possible* identified in the SREIS for EPBC listed taxa.
- Validate and refine existing RE mapping, including wetlands of High Ecological Significance, and
- Refine *Core Habitat Known and Core Habitat Possible* mapping for *Environment Protection and Biodiversity Act 1999* (EPBC Act) and *Nature Conservation Act 1992* (NC Act) taxa.

This document supports a separate GIS package which includes revised RE mapping, location records of significant taxa and features, and revised threatened species habitat mapping (see Appendix A for list of contents).

2.0 STUDY AREA DESCRIPTION

2.1 STUDY AREA AND EXTENT

The SGP Study Area has a total extent of 202,915 ha, which for the purposes of this ecological study has been divided into three distinct regions (Figure 2.1):

- The northern region encompassing an area of 7,601 ha located just south of Wandoan,
- A central region of 53,048 ha located to the north-east of Miles, and
- A southern region of 142,266 ha to the west of Dalby

Remnant vegetation in the northern (Wandoan) region is sparse, representing 2.8% (164.7 ha) of the area. However large continuous patches of remnant vegetation are present within the central (67%; 35,554 ha) and southern (28.7%, 104,035.8 ha) regions, and as such, survey effort has predominantly focused on these later two regions.

2.2 GEOLOGY AND WATER RESOURCES

Geology

The SGP study area is characterised by relatively gentle topography. In the larger southern region, the dominant landform is the expansive alluvial deposits of the Condamine River. These deposits form a gently undulating fertile clay to sandy clay plain geologically referred to as the 'Condamine Alluvium' which covers the south-eastern portion of the SGP study area stretching northwards to near Chinchilla. The Condamine Alluvium is bound to the west by low hills formed by indurated exposures of the Kumbarrilla Beds, a thick sequence of Jurassic to Cretaceous aged sandstones and fine grained sedimentary rocks. Small indurated sandstone caprock occurs in some localities which form suppressed jump-ups and low mesas.

The Kumbarilla Beds outcrop dominates the central area, overlain in some localities by a weakly consolidated blanket of Tertiary aged alluvial and colluvial sediments to form a gently undulating landscape of low stony rises and gently incised gullies and intermittent streams.

A major change in topography occurs between the central (Miles) and northern (Wandoan) sections where a steep breakaway escarpment exposes the fine grain metasedimentary and volcanic rocks of the Injune Creek Group. The landscape in the vicinity of Wandoan has much more pronounced topography with low rounded hills formed on fine grained sedimentary rock with characteristic heavy clay soils and rounded rocky lag deposited on the soil surface.

Water Resources

Drainage systems in the SGP study area are divided into those contributing to the west flowing Condamine River (part of the Murray River Catchment) and the Dawson River catchment (part of the Fitzroy River catchment).

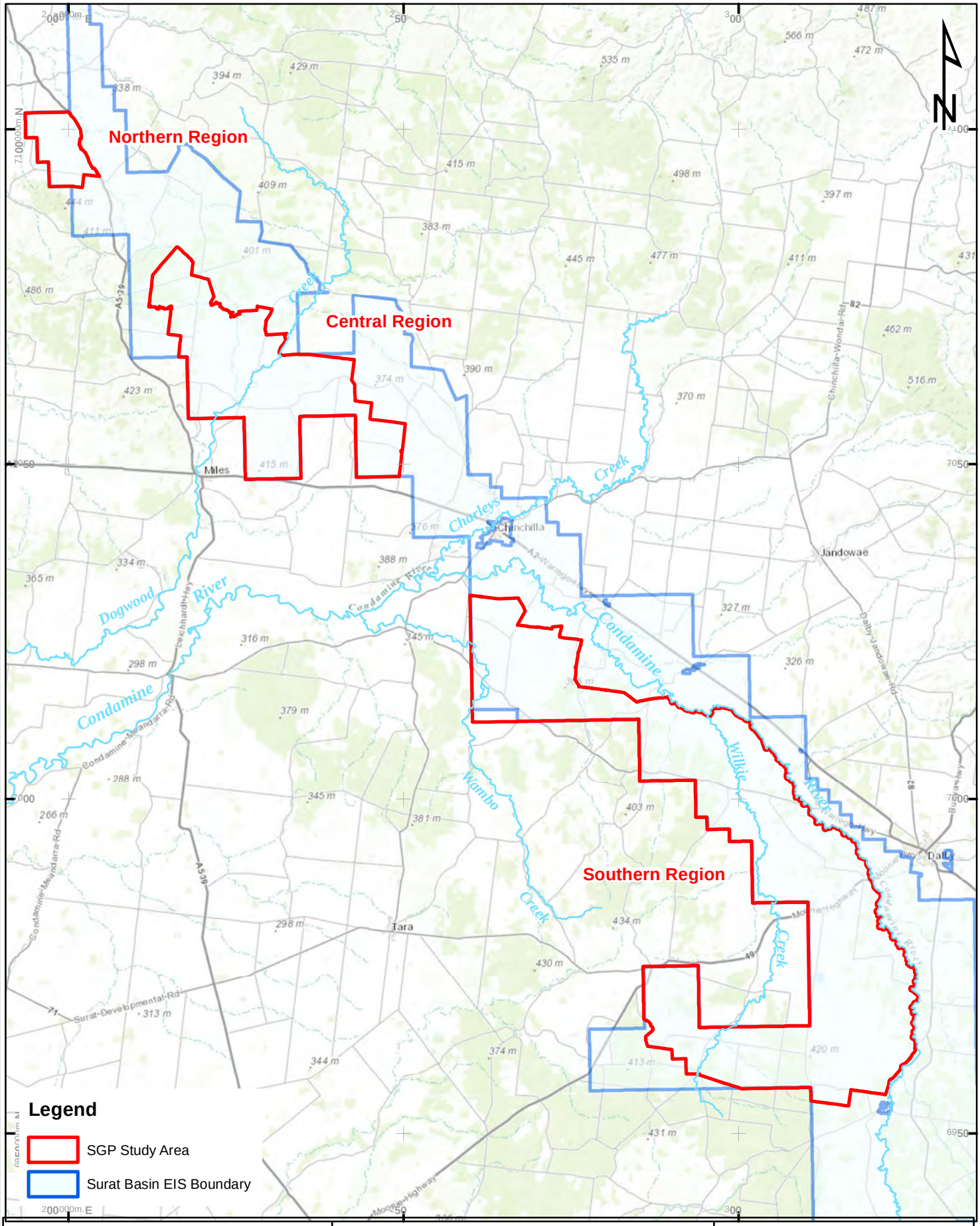

FIGURE 2.1 SGP study area location

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

3D Environmental
Vegetation Assessment
& Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Mobile: 0447 822 119

www.3denvironmental.com.au

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Within the SGP study area the Condamine River is by far the largest catchment, supplemented by the tributaries of Wambo, Wilkie, Charleys and Dogwood Creeks. The fertile alluvial soils of the Condamine River floodplain provide an extremely productive agricultural area that has been historically sustained and supplemented by an abundant source of groundwater within the underlying Condamine Alluvium aquifer.

In contrast, the Dawson River catchment forms only a minor portion of the study area and is characterised by Juandak Creek which flows through the township of Wandoan.

2.3 PROTECTED ESTATE

The SGP study area and nearby surrounds includes numerous State Forests and Conservation Reserves (Figure 2.2). In the southern (Dalby) region of the study area this includes:

- The Kumbarilla State Forest area (including the adjacent Waar Waar and Vickery State Forests), located immediately south of the Moonie Highway,
- Dunmore, Western Creek, and Boondandilla State Forest areas, which form a large continuous patch of remnant vegetation connected to the southern boundary of Kumbarilla State Forest, extending south to near the Gore Highway,
- Lake Broadwater Resource Reserve and Conservation Park, a small area of vegetation connected by remnant vegetation to Kumbarilla State Forest,
- Braemer State Forest to the north of the Moonie Highway, and
- Dalby State Forest just east of Kogan.

Together these areas of state forest, and intervening vegetation, form a large near-contiguous tract of remnant vegetation separated only by roads and highways.

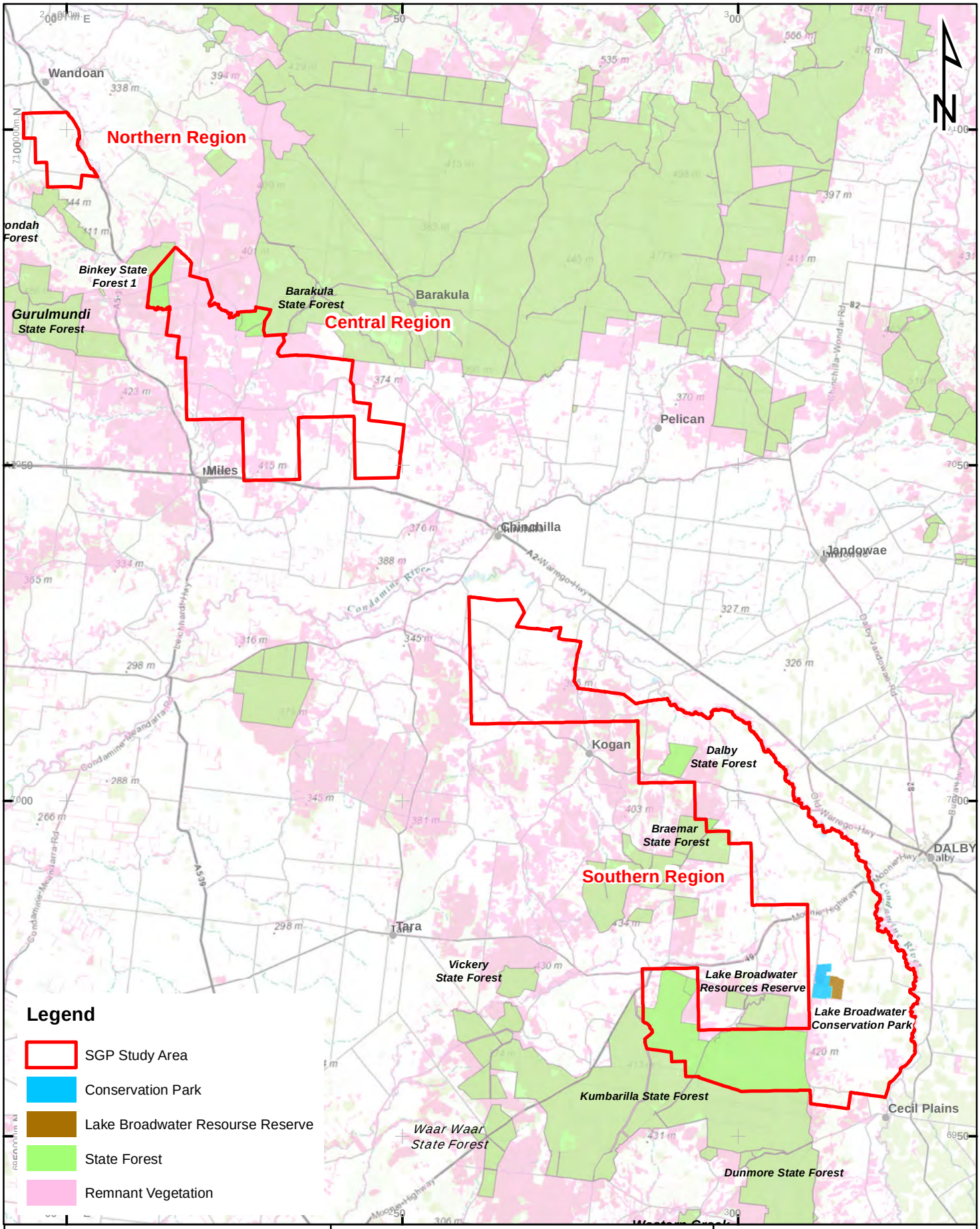
Protected Estate within or adjacent the central (Miles) region includes:

- Barakula State Forest to the immediate north-east,
- Blinkey State Forest 1 in the north of the SGP study area,
- Cherwondah State Forest to the north-west, and
- Gurulmundi State Forest to the west.

These forested areas and the intervening vegetation form a very large near-continuous patch of remnant vegetation separated only by roads and highways.

2.4 FIRE HISTORY

Vegetation within the SGP study area has been subjected to repeated fire events spaning several decades, though most fires have occurred between 2012 and 2014. With the exception of three, historic fires were limited in their extent (Figure 2.3) and, based on current vegetation condition, cool fires which did not cause extensive canopy death or damage. These cooler fires are likely to have little long-term impact on ecological values.



NOTES:
Biodiversity status of pre-clearing and 2015 remnant regional ecosystems - version 10.0 - South East Qld. Department of Science, Information Technology and Innovation

FIGURE 2.2 Protected Estate within and surrounding the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

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Two hot wildfires, one extending from Barakula State Forest south to near Miles, and a second within Kumbarilla State Forest, affected large areas of vegetation in 2012. A third wildfire occurred in the eastern portion of Kumbarilla State forest in December of 2016 (i.e., between spring and summer sampling for this work).

These wildfires caused extensive canopy damage, and in many locations complete canopy loss. While the vegetation and habitat should recover in time (provided there are no subsequent wildfires), the damage will affect flora and fauna community composition with fire sensitive species likely to be absent for many decades.

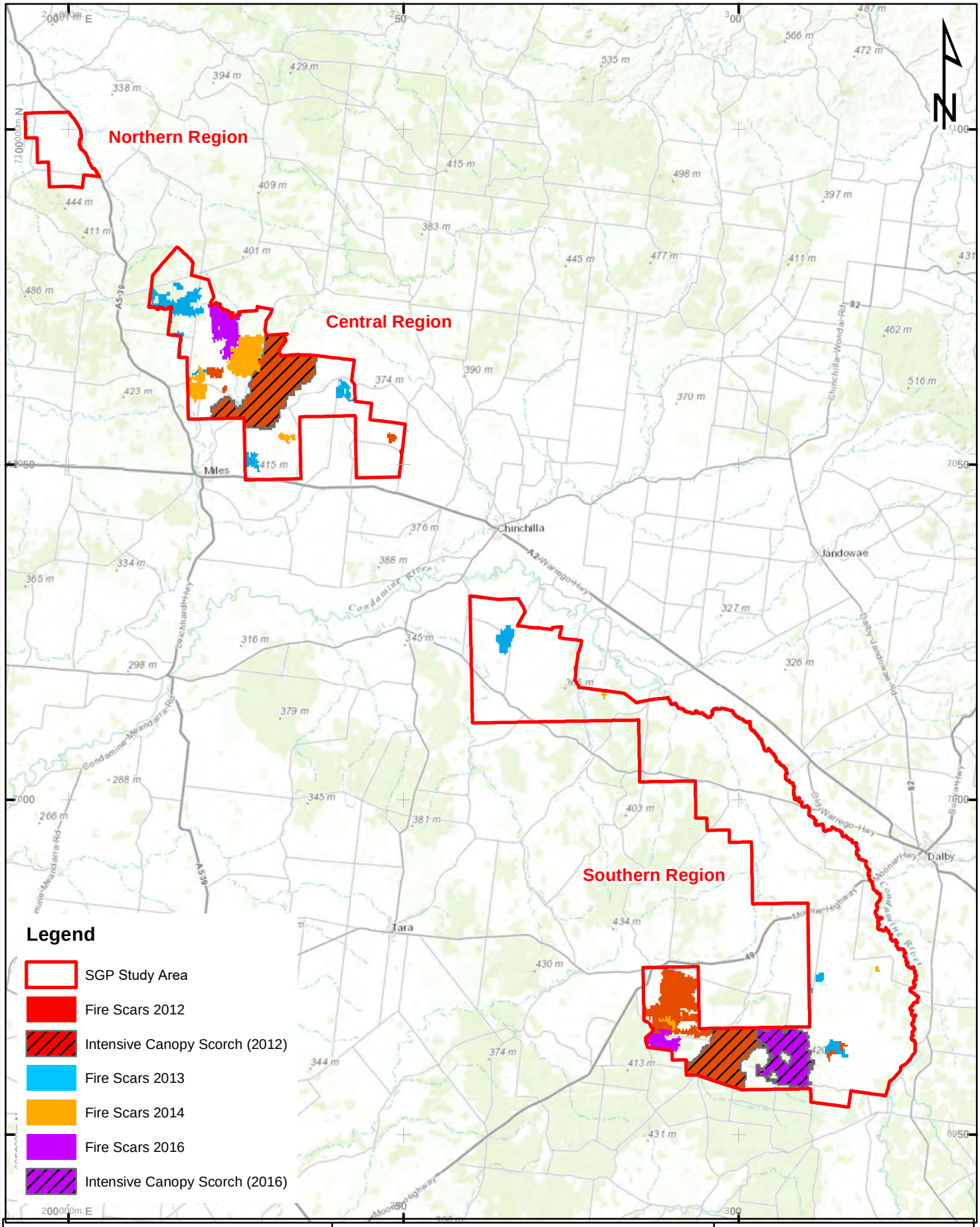

FIGURE 2.3 Historic fire scars within the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 | **Drawn By** DG | **Date** 21-May-17 | A4

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3.0 METHODS, SURVEY CONDITIONS AND LIMITATIONS

3.1 DESKTOP DATA

A detailed desktop review of available ecological information was undertaken as part of the SGP Supplementary EIS Terrestrial Ecology Assessment (3D Environmental/EcoSmart Ecology 2013). The results from this earlier assessment, as well as the data contained therein, has been used throughout this work. However several sources have been re-inspected to ensure the data is current. Data sourced during this work included:

- The Essential Habitat spatial layer,
- Birdlife atlas database, including geo-referenced data for threatened taxa,
- Wildnet database, including inspecting threatened species profile data to gather geo-referenced locations (where possible),
- The EPBC Act Protected Matters Search Tool,
- Queensland Herbarium Herbrecs database of vouchered specimen collections within a 50km buffer surrounding the assessment area,
- *Vegetation Management Act 1999* (VM Act) Status and Biodiversity Status of Pre-clearing and Remnant Regional Ecosystems Queensland - Version 10.0 (EHP 2015),
- Queensland Wetland Data Version 4.0 (EHP 2016),
- Matters of State Environmental Significance datasets (EHP 2014),
- Australia's Virtual Herbarium (AVH 2016) for vouchered specimen records sourced from a number of Australian Herbarium,
- Nature Conservation Act protected plants flora survey trigger map spatial layer – Version 4.1 (EHP 2016),
- Prior flora and fauna assessment within or in close proximity to the SGP study area including:
    - The SGP EIS Terrestrial Ecology Specialist Report (3D Environmental 2011),
    - The SGP Supplementary EIS Terrestrial Ecology Specialist Report (3D Environmental 2013),
    - Surat Gas Pipeline Project surveys (Aecom 2009) and addition field data collected by various consultants including Ecosure, RPS and SKM between 2009 and 2013, and
    - The Daandine CGPF and Daandine Phase 1 Projects (EcoSmart Ecology 2014a, b).

The assessment included a compilation of survey data from prior surveys.

3.2 Flora Field Survey Methods

Flora surveys were conducted under license Number WISP10337Grey011 (non-protected estate), TWB/14/2016 (State Forests) and WITK17580216 (Lake Broadwater National Park). Table 3.1 provides details of the survey team.

Table 3.1. Terrestrial Fauna Field Team Qualifications and Experience

Name	Qualifications	Exp (yrs)	Role	Survey
David Stanton	BSc (Hons)	22	Team leader/field ecologist	Dry/wet season
Paul Williams	BSc (Hons), PhD (Ecology)	22+	Team leader/field ecologist	Dry/wet season
David Fell	Associate Diploma of Applied Science	25+	Team leader/field ecologist	Dry
Eleanor Collins	BSc (Hons)	22+	Field Ecologist	Dry/wet season
Peter Wagner	BSc (Hons), MSc	5+	Team leader/field ecologist	Wet season
Lincoln Smith	BSc (Env)	15	Field ecologist	Dry/wet season
Bill Hoskins	BSc (Hons). Grad Dip Environmental Rehabilitation	30+	Field ecologist	Dry/wet season

3.2.1 Survey Overview and Site Selection

Prior to field surveys the 284 properties which make up the SGP study area were assessed using desktop resources for:

- The presence and extent of remnant vegetation,
- The presence of 'Of Concern' or 'Endangered' REs under the VM Act or TECs under the EPBC Act,
- Prior records of threatened flora taxa on, or in close proximity to, the property including Protected Plant high risk trigger areas,
- The quality of habitat including disturbance, vegetation structure and contiguity with larger remnant patches, and
- The spatial location and intensity of prior floristic surveys (see Section 3.1)

With the further aid of aerial imagery, properties were prioritised for access based on the following criteria:

5. Priority 1 – Properties with mapped Endangered or Of Concern vegetation, prior records of EVNT Flora species, Protected Plant high risk trigger areas, mapped as Core Habitat Known in the SGP Supplementary EIS (3d Environmental 2013),
6. Priority 2 – Properties with well-preserved remnant vegetation, limited prior sampling and strong indications of habitat suitability for a range of threatened flora species although no prior records,

7. Priority 3 – Properties with intact, least concern remnant vegetation not recognised as hosting populations of EVNT species or habitats of any specific legislative significance, and
8. Properties subject to intensive sampling effort during previous survey events.

In total, 114 Priority 1, 74 Priority 2, 65 Priority 3 and 31 Priority 4 properties were identified. While the field assessment aimed to sample all Priority 1 and Priority 2 properties throughout the course of the 'dry' and 'wet' season surveys, not all of these were able to be sampled due to access limitations (i.e. 86 of the 114 (or 75%) Priority 1 and 66 of the 74 (89%) Priority 2 properties were sampled).

3.2.2 Flora Survey Techniques

Surveys collected floristic data consistent with Queensland Herbarium standards (Neldner *et al* 2012) and included secondary, tertiary and quaternary sites. The location of these sites was selected using aerial photograph analysis, or opportunistically during traverse, to ensure that the field survey targeted a representative range of habitats.

Secondary sites consisting of 50 m x 10 m plots were located within the vegetation to avoid sampling across community boundaries. Crown intercept transects were extended to 100 m for the purpose of providing sufficient data for reference sites where an assessment of remnant / non-remnant status was required. Full species lists for all strata were established during the secondary sampling procedure, and supplemented by a detailed search of the nearby vicinity. The abundance of all species within the plot was recorded by stem counts, or by visual assessment as a 1-5 cover-abundance ranking using the braun-blanquet method (Neldner *et al.* 2012). Groundcover was assessed using five 1x1 m subplots placed at 10 m intervals along transects with visual cover estimations of dominant species. Ecological and structural data together with full species lists were compiled. In some instances identification to species level was not possible due to the lack of fertile material, particularly for grasses. Unidentified species were classified to the next highest denominator (typically genus level) and would account for <1% of all identifications.

Tertiary sites were completed in a similar fashion to the secondary procedure, although non-woody species were not recorded. Quaternary sites included a description of floristic structure, composition, and associated landform, and were used specifically for the purpose of mapping unit verification.

During the 'dry' season survey (September 2016) a total of 896 floristic survey sites were established including 58 secondary, 1 tertiary and 837 quaternary survey points. The wet season assessment completed in early February 2017 (plus an additional 3 day survey in late March 2017) resulted in a further 47 secondary and 682 quaternary survey points. In total, 1,625 floristic survey sites were established by 3D Environmental during this work, and combined with previous works, a total of 2,458 locations have been subject to structured floristic survey within the SGP study area (Table 3.2). The distribution of these survey points in relation to survey events is shown in Figure 3.1.

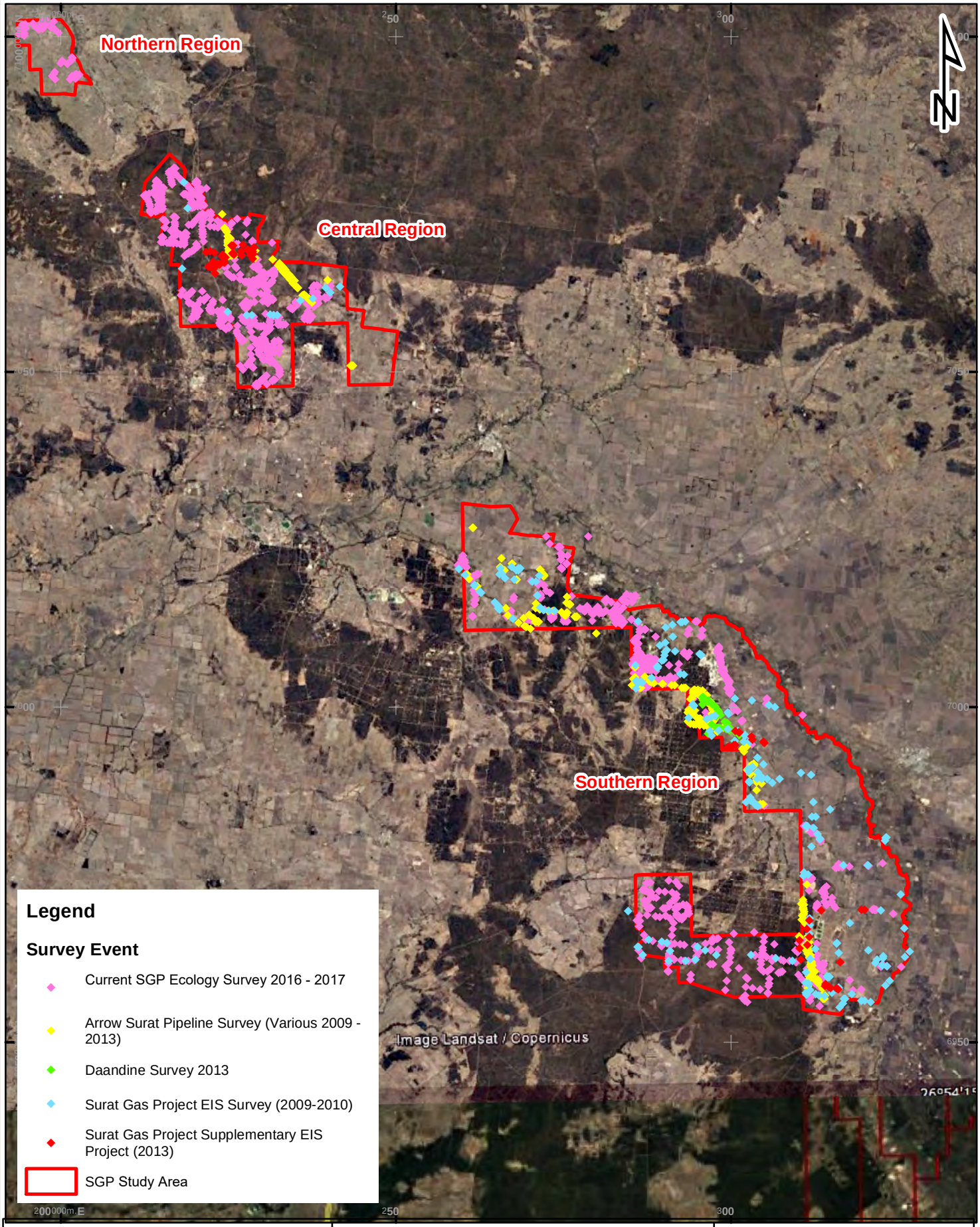

FIGURE 3.1 Floristic survey locations within the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 | **Drawn By** DG | **Date** 21-May-17 | A4

3D Environmental
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Table 3.2. The contribution of individual floristic surveys to overall survey effort within the SGP study area

Survey/Project	Year	Seasonal Effort	Undertaken By	No of Survey Sites			Total Sites
				Sec	Tert	Quat	
Current SGP Ecology Survey	2016	Dry	ESE/3DE*	58	1	837	896
Current SGP Ecology Survey	2017	Wet	ESE/3DE	47	0	682	729
Daandine CGPF and Phase 1 Project (EcoSmart Ecology 2014a, b)	2014	Late Wet	ESE/3DE	5	1	32	38
Surat EIS (3d Environmental 2011)	2009/10	Dry/Wet	3DE	46	2	170	218
SGP Supp. EIS (3d Environmental 2013)	2013	Wet	3DE	28	3	37	68
Arrow Surat Pipeline (Aecom 2009 - 2013)	2009/13	Mostly Wet	Ecosure/ Aecom	34	10	465	509
Totals				**218**	**17**	**2,223**	**2,458**

*EcoSmart Ecology and 3D Environmental

3.2.3 Mapping Scale and Attributes

Vegetation linework was established at a scale of 1:25,000 providing an accuracy of hard boundaries of +/-25 m and a minimum polygon size of 0.5 ha. A polygon of 0.5 ha represents the minimum patch size threshold for both the Brigalow and Weeping Myall Woodlands Ecological Communities, listed an Endangered under the EPBC Act and known to occur within the SGP Ecology Survey area.

A seamless GIS dataset has been produced to incorporate mapped REs, TECs and habitat mapping for all threatened species (flora and fauna) known from the study area including the mapping of Core Habitat Known and Possible. The habitat mapping will assist in locating future project infrastructure to minimise impacts and the determination of offset requirements where avoidance cannot be achieved.

GIS shapefiles of all floristic survey sites within the surveyed area have been provided to Arrow in a separate package to accompany this report, which also includes the locations and findings of previous and current survey efforts.

3.3 FAUNA FIELD SURVEY METHODS

Fauna surveys were conducted under licenses WISP14610914 (non-protected estate), TWB/14/2016 (State Forests) and WITK17580216 (Lake Broadwater National Park). Table 3.3 below provides details of the terrestrial fauna survey team's qualifications and experience.

Table 3.3. Terrestrial Fauna Field Team Qualifications and Experience

Name	Qual	Exp (yrs)	Role	Survey
Mark Sanders	BSc (Hons)	20+	Team leader/field ecologist	Dry/wet
Terry Reis	BSc (Hons)	22+	Team leader/field ecologist	Dry/wet
Greg Ford	B. App. Sc.; Grad. Dip. Res. Mgt.	25	Team leader/field ecologist	Dry/wet
Dr Ed Meyer	BSc (Hons), PhD (Zoology)	20+	Team leader/field ecologist	Dry/wet
Angus McNab	BSc (Hons), MSc.	10+	Field ecologist	Dry
Anders Zimny	BSc (Hons)	8+	Field ecologist	Dry
Dr Katrine Lowe	BSc (Hons), PhD	10+	Field ecologist	Dry/wet
Lincoln Smith	BSc (Env)	15	Field ecologist	Dry/wet
Jesse Rowland	BSc (Env Man)	10+	Field ecologist	Wet
Kate Grundy	BSc (Hons)	7+	Field ecologist	Wet

3.3.1 Stratification, Survey Design and Site Selection

3.3.1.1 Spatial Stratification

Remnant vegetation mapping shows the bulk of land within the northern region of the SGP study area is cleared, with remaining vegetation fragmented and minor in extent. The likelihood of significant terrestrial fauna values within this section is greatly reduced, lessening the need for detailed seasonal surveys. Further, those threatened taxa most likely to occur in these fragmented areas (e.g., Squatter Pigeon, Painted Honeyeater) can be detected using rapid survey methods. Detailed trapping was not therefore deemed necessary for the northern region of the SGP study area. By contrast the central and southern regions retain large areas of remnant vegetation, and while some detailed fauna work has occurred, fauna values in these two regions remains poorly known.

Within the central and southern regions areas of vegetation with little, or no, historic survey effort was identified by overlaying the locations of previous fauna work (see Section 3.1) on pre-existing RE mapping (Queensland Herbarium V10.0) (Figure 3.2). The identified areas were the focus of the current SGP fauna survey.

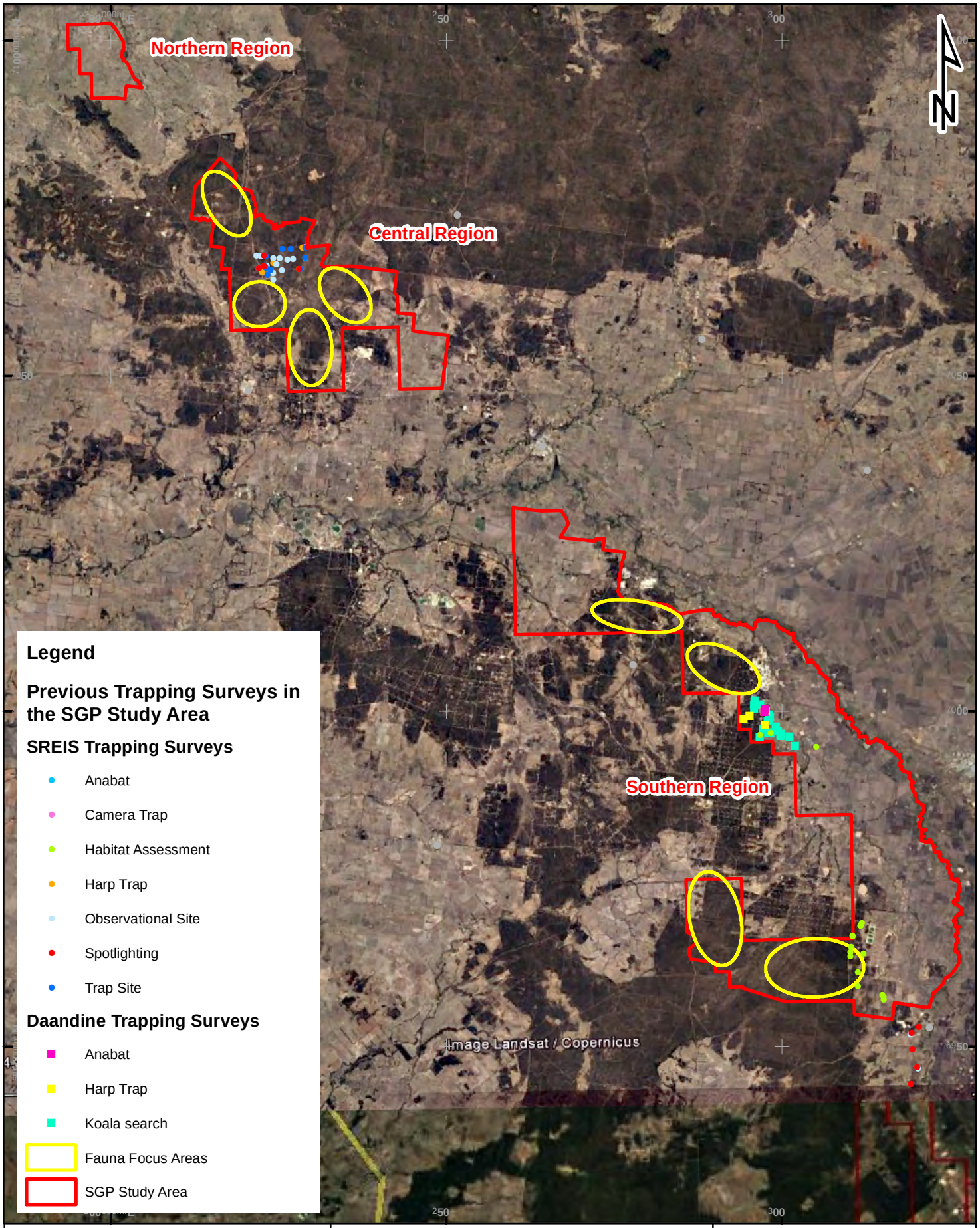

FIGURE 3.2 Previous fauna survey locations within the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

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While Lake Broadwater National Park lies within the SGP study area, it was not the focus of detailed works. Frequent surveys are conducted in the National Park by Griffith University, and the area has been frequently visited by EcoSmart Ecology staff over many years. The fauna communities and values within the National Park are well documented and understood. All observations within the Park during this survey were taken ad-hoc.

3.3.1.2 Habitat Stratification

To stratify the trapping program and encapsulate habitat variety, Broad Vegetation Group (BVG) mapping by the Queensland Herbarium (version 3.0) was used to identify the location and extent of BVGs[1] at the 2 million (2M) scale. The contribution of each BVG to the extent of remnant vegetation was calculated and theoretical trap effort distributed accordingly.

3.3.1.3 Survey Design

Having completed the above spatial and habitat analyses, a survey program was developed to fill the identified gaps and included:

- A five-day pilot study (August 2016) to visually inspect the SGP study area, identify survey constraints, and locate possible detailed fauna trap sites,
- Two, 12-day detailed surveys were completed, one during the 'dry' (September 2016) and one during the 'wet' (February/March 2016) season, by four teams (eight ecologists/survey). Each team serviced 10 detailed trap sites over the 12 days, with each trap site operational for four consecutive nights, and
- A three-day follow-up survey (March 2016) to sample fragmented habitats (including habitats for Squatter Pigeon, Painted Honeyeater and Yakka Skink), habitats not subject to effort during the detailed surveys (e.g., wetlands), or areas which may not have been otherwise inspected.

3.3.1.4 Survey Site Selection

Detailed Survey Sites

The location of detailed survey sites (which included Elliot, Pitfall, Funnel, white-flash camera, detailed bird survey, spotlight, active searches, Spot Assessment Technique (SAT) searches) were determined during the pilot study, which used the above spatial and BVG stratification, as well as considering:

- Landholder access constraints - access was not granted to some parcels of land, while others had stringent conditions preventing ease of movement on or off the property,
- Travel logistics and limitations, trap sites must be located so they could be cleared before 9.00 am each morning,
- Any notable geomorphological features such as rock outcrops, caves etc,
- Habitats likely to support specially protected species, and

[1] as described in Nelder *et al* 2015.

- Vegetation condition and in particular fire scaring (see Section 2.4).

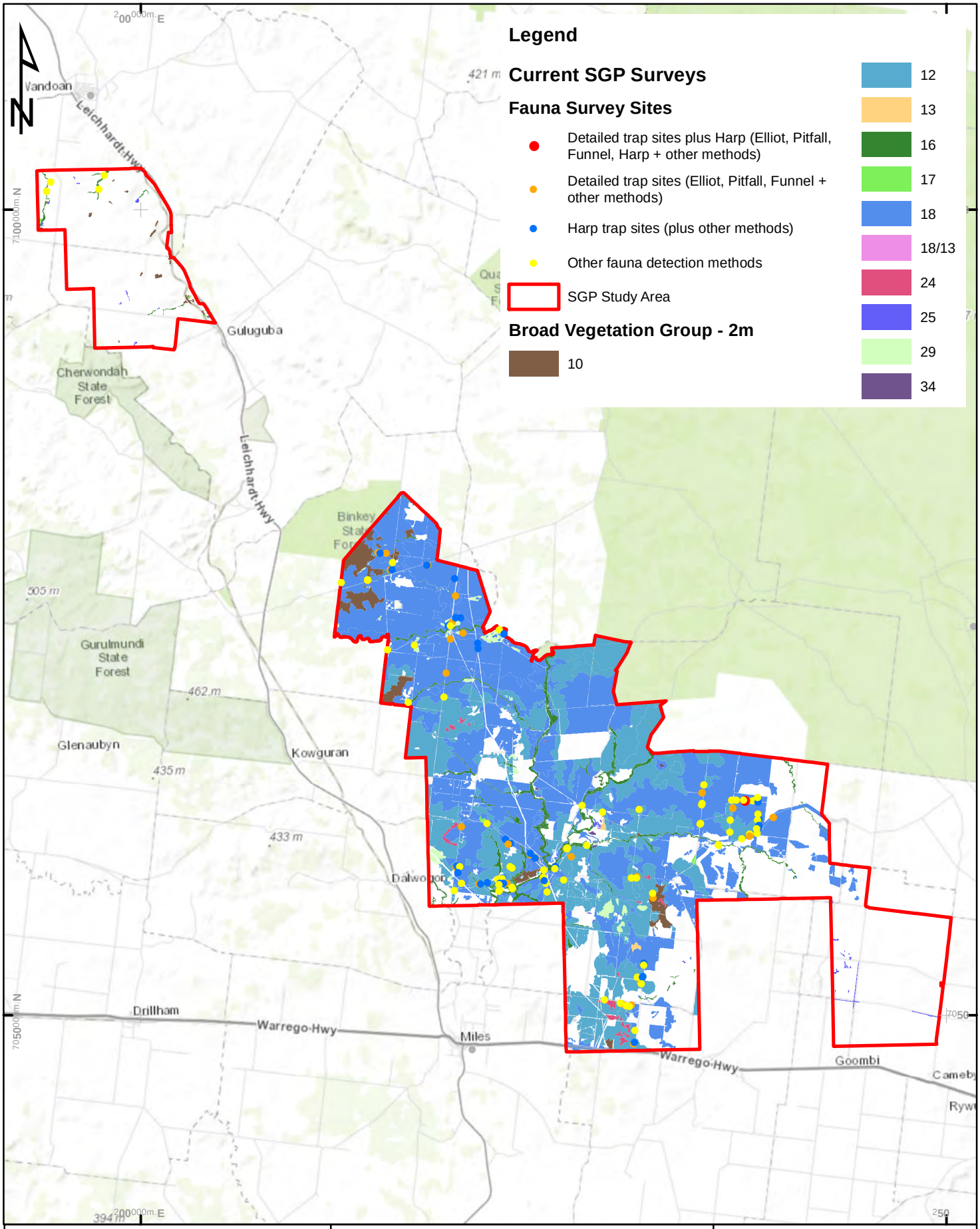
Once selected, each site was inspected and approved by traditional owners to ensure trapping activities would not impact upon indigenous cultural values. As no pitfall trapping could occur without prior cultural heritage assessment, trap site locations could not be relocated after the pilot study. The pilot study occurred prior to the flora investigations and did not account for any subsequent vegetation mapping changes.

Where possible trap sites were surveyed during both the 'dry' and 'wet' season, though in some cases this was not possible without compromising spatial or BVG representation. Trap site effort within each BVG is documented in Table 3.4 and trap locations are shown in Figure 3.3a and b.

Table 3.4. Number of trap sites by BVG based on ground-truthed vegetation mapping

BVG[#]	Description	Mapped Extent (ha)[+]	No. Detailed sites*	No. Target Sites
10	*Corymbia citriodora* dominated open forests to woodlands on undulating to hilly terrain	1,040 (1.3%)	2	2
12	Dry eucalypt woodlands to open woodlands, mostly on shallow soils in hilly terrain (mainly on sandstone and weathered rocks)	22,186 (28.6%)	23	49
13	Dry to moist eucalypt woodlands and open forests, mainly on undulating to hilly terrain of mainly metamorphic and acid igneous rocks	5,448 (7.0%)	4	17
16	*Eucalyptus* spp. dominated open forest and woodlands drainage lines and alluvial plains	3,211 (4.1%)	4	27
17	*Eucalyptus populnea* or *E. melanophloia* (or *E. whitei*) dry woodlands to open woodlands on sandplains or depositional plains	1,189 (1.5%)	0	5
18	Dry eucalypt woodlands to open woodlands primarily on sandplains or depositional plains	41,158 (53.0%)	43**	90**
24	*Acacia* spp. on residuals. Species include *A. clivicola*, *A. sibirica*, *A. shirleyi*, *A. microsperma*, *A. catenulata*, *Acacia rhodoxylon*	176 (0.2%)	0	0
25	*Acacia harpophylla* sometimes with *Casuarina cristata* open forests to woodlands on heavy clay soils	886 (1.1%)	0	3
29	Heathlands and associated scrubs and shrublands on coastal dunefields and inland rocky substrates	467 (0.6%)	1	2
30	*Astrebla* spp. (mitchell grass), *Dichanthium* spp. (bluegrass) tussock grasslands	0 (0%)	0	1***
34	Wetlands. Swamps (wooded or otherwise) and lakes (permanent or ephemeral), claypans. Includes fringing woodlands and shrublands	630 (0.8%)	0	3
18/13	Mixed community of BVGs 18 and 13.	1,233 (1.6%)	3	1
N/A	Non-remnant regrowth	N/A		3
	Total	77,624	80	203

[+]BVG extent and trap position with relation to BVG based on 3DE ground-truthed mapping.
*Replicated sites are counted twice, once for each survey.
**Includes one detailed site and two target sites placed in advanced regrowth.
***An area of derived grassland previously mapped as remnant by the Queensland Herbarium.



NOTES:
Other methods includes one or more of the following techniques; opportunistic bird survey, spotlight, active search, Anabat, remote sensor camera, and/or Glossy Black Cockatoo and Koala signs/scat searches.

FIGURE 3.3A Detailed fauna trapping sites within the SGP Study Area - Northern and Central Regions

Client ARROW ENERGY

0 5 10 15 20
Kilometers

Scale	1:312,525	Drawn By	DG	Date	23-Jun-17	A4

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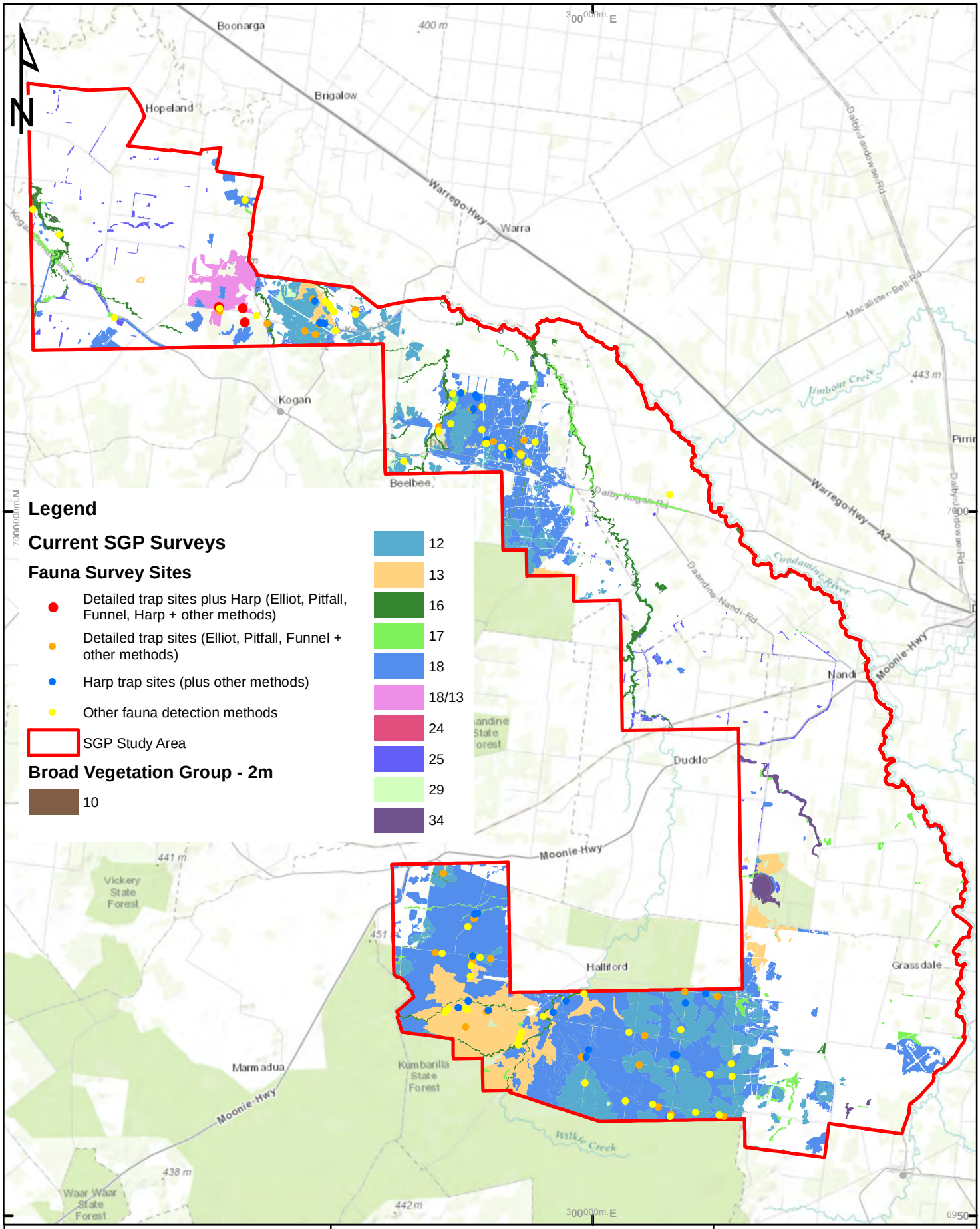

N O T E S:
Other methods includes one or more of the following techniques; opportunistic bird survey, spotlight, active search, Anabat, remote sensor camera, and/or Glossy Black Cockatoo and Koala signs/scat searches.

FIGURE 3.3B Detailed fauna trapping sites within the SGP Study Area - Southern Region

Client ARROW ENERGY

0 5 10 15 20
Kilometers

Scale 1:357,316 **Drawn By** DG **Date** 23-Jun-17 A4

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The allocation of actual detailed fauna survey sites across the BVG's varied slightly from 'theoretical' due to survey constraints (e.g., travel times, access conditions, and recent fire damage) and changes to RE mapping following the flora investigations. No detailed trap sites were located in five BVG's (17, 24, 25, 30 or 34):

- Detailed trap sites where positioned in areas mapped as BVG 17 during the pilot study (based on Queensland Herbarium mapping). Mapping inaccuracies were corrected by ground-truthed assessment and resulted in no detailed trap sites remaining in BVG 17. Due to cultural heritage restrictions, the pre-survey selected trap locations could not be altered to account for these changes (see discussion above),
- It was not until vegetation mapping and fauna surveys had been completed that BVG 24 was identified within the SGP study area,
- While the existing RE mapping showed patches of accessible Brigalow (BVG 25), field inspection found these areas to be incorrect. Rather, Brigalow was restricted to small, usually linear, fragments which were often separated from other vegetation by considerable distance. Travel logistics prevented trapping these habitats in detail, though sampling using rapid survey methods (e.g., bird survey, habitat search) was undertaken during a three-day follow-up survey,
- Queensland Herbarium mapping showed a small are of BVG 30 which was separated from other vegetation by considerable distance. Travel logistics prevented trapping of this habitat. The vegetation was altered following the completion of the flora surveys to 'derived grassland' and does not therefore represent a remnant community, and
- Surface water and the risk of possible flooding prevents trapping (particularly pitfall) in wetlands (BVG 34), though wetland locations were sampled using other survey methods (e.g., bird survey and active search).

Those BVG not subject to detailed trapping represent only a very small portion of remnant vegetation within the SGP study area (representing only 3.6% of total remnant vegetation).

Targeted Survey Sites

Targeted survey sites were used throughout the survey to supplement data collected at the detailed survey sites. Methods used at targeted sites varied from site to site and could include one or more of the following: opportunistic bird survey, spotlight, white- or black-flash camera, Harp trap, active search, SAT search, Glossy Black Cockatoo search, and Anabat. Two target sites included tripline over waterbodies to target michrochiropteran bats and artificial shelter to detect grassland reptiles.

Targeted sites are used to sample BVG that cannot be sampled by trapping (see above), or to increase spatial representation.

3.3.1.5 Contingency Survey

In December 2016 a wildfire roared through the eastern portion of the SGP study area in the Kumbarilla State Forest, significantly damaging the vegetation and habitat (Photo 1). The affected area included the five detailed fauna sites that were to be surveyed in March

2017 (i.e., the 'wet' season survey). A one-day contingency survey was undertaken in February 2017 to select new survey locations in the eastern area of the study area and gain the necessary cultural clearance. The locations of new trap sites were constrained by the extent and damage of both the December 2016 and 2012 wildfires (see Section 2.4 for fire extent).

Photo 1. Fire scaring following the December 2016 wildfire in the south-east portion of the SGP study area (i.e., Kumbarilla State Forest) (photo taken during the February contingency survey)

3.3.2 Survey Techniques

The terrestrial fauna surveys used a variety of recognised survey methods consistent with relevant federal and state survey guidelines. These included trapping (Elliot, pitfall, funnel and Harp), observation (spotlighting, bird survey, and active search), remote sensing (Anabat ultrasonic bat detection and camera trapping), and targeted methods (Koala [SAT] and Glossy Black Cockatoo ort searches, tripline, artificial shelter). These methods, detailed below, were replicated in both the dry and wet season survey unless otherwise indicated.

3.3.2.1 Fauna Trapping

Fauna trapping includes Elliot, pitfall, funnel and harp trapping. With the exception of Harp trapping, all trap methods remain at a designated location for the duration of the survey. These locations are the detailed fauna survey sites discussed in Section 3.3.1. Twenty detailed fauna sites (designated with a prefix of 'Det' in the associated GIS package) were operational within both the central and southern regions four consecutive nights during both the 'dry' (October) and 'wet' (March) season survey. The location of detailed trap sites is shown in Figure 3.3a and b. A summary of trap effort is provided in Section 3.3.3.

Elliot, Pitfall and Funnel Trapping

Pitfall trapping consisted of four 20L buckets and two drift fences set in a T configuration. Six funnel traps, positioned in pairs at the end of each fence, augmented the pitfall traps. This configuration is consistent with Eyre *et al* (2012) and resulted in a survey effort of 1276 bucket nights[2] and 1,914 funnel nights.

Ten Elliot traps, positioned approximately five to ten meters apart, were located in the vegetation immediately surrounding each pitfall/funnel array. Each Elliot trap was baited with a combination of peanut butter, rolled oats, and vanilla essence. Elliot survey effort was 3,190 nights[2].

All trapping sites were visited twice daily, once in the morning and once in the late afternoon. Animals were identified and released at the site of capture.

Harp Trapping

Insectivorous (microchiropteran) bat capture using harp traps was undertaken along flyways, which are linear clearings through vegetation such as tracks and creeks. Flyways are not necessarily located in areas suitable for other trapping methods, and as such, harp trapping did not coincide with pitfall, funnel or Elliot techniques. Unlike other trapping methods, harp traps are not used in a single location over consecutive nights but rather moved to a new location each night. Due to flyway width, two harp traps were placed at each harp trap location, side-by-side.

While each 'dry' and 'wet' season survey aimed to have 16 harp traps operational for three nights within both the central and southern areas, the lack of flyways and adverse weather reduced trap effort. Total harp survey effort was 86 harp nights (43 locations) in the 'dry' season survey and 78 harp nights (39 locations) during the 'wet' season survey.

3.3.2.2 Observation Based Detection

Observation based detection methods included bird survey (detailed bird survey and opportunistic bird survey), nocturnal spotlighting, and active searches. These methods are used at each trap site in both the 'dry' and 'wet' season survey, as well as additional locations as indicated in Figure 3.3a and b. Opportunistic bird surveys and active searching was also undertaken during the follow-up survey.

Bird Surveys

Detailed bird surveys were undertaken on two separate mornings at each detailed trap site, typically before 9am. Each survey took 30 minutes, but less time may have been spent if bird activity was poor, with the balance of time spent at the site whenever bird activity was high. Thus, a minimum of one hour birding over a minimum of two mornings was dedicated to detailed bird survey at each trap site. During each survey the maximum number of

[2] One trap site (4 buckets, 6 funnels and 10 Elliots) was closed for one night during the 'wet' season survey at the central region (see Section 3.5.1).

individuals for each species was recorded, though no abundance was noted if heard calling in the far distance or seen as flying-over. Total detailed bird survey effort was 80hrs.

Opportunistic bird surveys of an indeterminate period, but usually approximating 20 minutes, were undertaken at additional survey locations (Figure 3.3a and b). These surveys were not replicated and typically occurred between the hours of 9 and 11 am. Unlike detailed bird surveys, opportunistic bird surveys did not attempt to record the number of individuals, but rather only recorded species as 'present'. Opportunistic bird survey effort was approximately 8hrs during the 'dry' season, 13hrs during the 'wet season' and 5hrs during the follow-up survey (26hrs total).

Nocturnal (spotlighting) Surveys

Nocturnal foot-based surveys included two observers walking through habitats spotlighting for arboreal mammals, including small and medium sized terrestrial mammals, frogs, geckoes, nocturnal snakes and birds. Animals were detected by eye shine, call, or direct observation. Surveys typically lasted between 30-60 min per site, and were conducted by between two and three observers. Nocturnal foot surveys were undertaken at each trap site, as well as other locations. Nocturnal spotlight effort was approximately 72hrs during the 'dry' season and 68hrs during the 'wet' season.

Active Search

Active searches of habitats were undertaken at each trap site as well as additional locations. Active habitat searches involved two observers spending 30 minutes rolling rocks and logs, searching debris, inspecting trees for scratches and searching for scats or feeding remains. Greater Glider and Koala scats (or signs), and Glossy Black Cockatoo feeding remains (orts) were noted during the search.

Active searching was undertaken for approximately 56hrs/region during the 'dry' season and 64hrs/region during the 'wet season' (excluding the north region). Five hours of active search was also conducted during the follow-up survey.

Opportunistic Observations

Opportunistic observations of fauna not previously noted or infrequently observed were recorded throughout the surveys. Sightings were recorded from direct observation, or from indirect signs such as scats, tracks, scratch marks, nests, feeding indicators, or remains. Opportunistic observations were also used while traversing the SGP study area in a vehicle, a method recognised as suitable for detecting Squatter Pigeon. Traverses made by the flora teams, who are familiar with Squatter Pigeons, have been included within the traverse survey effort. It is estimated that 160hrs of traversing was undertaken in both the 'dry' and 'wet' season surveys (320hrs total) and 18hrs in the follow-up survey. An additional 700hrs of traverse through the SGP study area was undertaken during the pilot study, two flora surveys and the contingency survey.

3.3.2.3 Automatic Detection Methods

Ultrasonic bat call detectors and remote sensors cameras were used in both the 'dry' and 'wet' season surveys.

Ultrasonic Bat Call Detection

Ultrasonic calls of microchiropteran bats were recorded using ANABAT devices selectively positioned across the central and southern regions of the SGP study area. The ANABAT devices were set to record from dusk till dawn and sampled a new location each night. Locations were selected based on the likelihood of high bat activity, such as along flyways or over water bodies. Total Anabat survey effort was 33 Anabat nights in the 'dry' season (17 in the central region and 16 in the southern) and 35 Anabat nights in the 'wet' season (17 Anabat nights in the central region and 18 in the southern region). Recordings were analysed by Greg Ford.

Remote Sensor Cameras

Remote sensor cameras were used to survey small to large terrestrial vertebrates and is preferred over cage or hair-tube trapping as it is non-invasive, allows for greater detection rates, whilst minimising stress on animals (de Bondi *et al*. 2010; Claridge *et al*. 2010; Meek *et al*. 2012). Further, camera traps are effective for many species which are difficult to capture using cage or hair tubes (Vine *et al*. 2009; Robley *et al*. 2010).

Twenty-four white-flash cameras (Reconyx HC550) were in operation over four consecutive nights in both the central and southern regions during the 'dry' and 'wet' season surveys. One of these white-flash cameras was positioned in proximity to each detailed trap site (n=20), while another four were located at random positions. An additional 12 cameras were operational at one site (A7_Det06) for two consecutive nights during the follow-up survey. Each camera was baited by smearing quantities of peanut butter and Macadamia oil on the ground within the detection zone. Total white-flash camera effort was 396 camera nights.

In addition to the white-flash cameras, four black-flash (infra-red) cameras were located within the central and southern regions and baited with peanut butter, Macadamia oil and chicken wings. These cameras, which are intended to target exotic pests, were located near a track or road and were operational for four consecutive nights. Total black-flash camera effort was 64 camera nights.

3.3.2.4 Targeted Detection

Targeted detection methods included targeted searches for Koala evidence (scratches and scats) and Glossy Black Cockatoo feeding remains (called orts) as well as the use of artificial shelter.

Targeted Searches

Targeted searches were used for detecting Greater Glider, Koala and Glossy Black Cockatoo in areas of suitable habitat. Koala detection was based on the SAT method (Phillips and Callaghan 2011), but due to high densities of non-koala feed trees and only requiring confirmation of Koala presence, the method was modified to include twenty eucalypt trees

(rather than 30 trees of any species) or Koala evidence, whichever occurred first. Greater Glider scats were also noted during SAT searches. In total two SAT searches were undertaken in the northern region, 50 in the central region and 57 in the southern region during the surveys.

Searches were also conducted under stands of Allocasuarina for Glossy Black Cockatoo feeding remains (orts). *Allocasuarina inophloia, A. cristata* and *A. litoralis* are the primary food tree of this species in the Southern Brigalow Belt. Ort searches were conducted until 20 feed trees had been searched or feeding remains located. Searches were only conducted in suitable habitat, which was greatly reduced following a wildfire in the best areas of habitat prior to the 'wet' season survey. In total, nine dedicated ort searches were undertaken during the surveys.

Artificial Shelter

Nine hardwood tiles, approximately 40x40x4 cm in size, were scattered throughout the only area of mapped native grassland within the SGP study area[3]. These artificial shelters were positioned during the 'dry' season survey and later collected during the 'wet' season survey, allowing them to remain in-situ for approximately 20 weeks. The tiles were collected in the early morning, when ambient temperatures were low, to increase the likelihood of reptile capture. This method is frequently used to detect grassland reptiles (Sadlier *et al.* 2011).

3.3.3 Summary of Fauna Survey Effort

Table 3.5 provides a summary of 2016-2017 fauna survey effort within the SGP study area. Appendix B compares the survey effort with EPBC survey guidelines, which are intended to be applied to small areas of interest. The application of these guidelines across large areas (as required in this project) will result in an unachievable survey effort.

3.4 Assessing Likely occurrence of Threatened Taxa

While an assessment of the likely occurrence of threatened taxa was completed for the approved EIS (3d Environmental and EcoSmart Ecology 2011), this assessment was based on data available in 2011. Since this assessment was completed the conservation status of several species has changed, and it is possible that new populations have been discovered or previously known populations are no longer present. A new assessment has therefore been undertaken.

The likelihood that individual threatened species could occur within the study area over the life of operation is based on habitat (existence and quality as assessed during field investigations) and existing record relevance (the number of records, record date, and proximity to the SGP study area). Each species is ranked as present, likely, possible, unlikely, or transient base on criteria outlined in Table 3.6.

[3] Mapped as remnant by Queensland Herbarium but re-classed as non-remnant vegetation during this work.

Table 3.5. Terrestrial Fauna Survey Effort.

Method	Unit	'Dry' season (Oct)	'Wet' Season (Mar)	Follow-up (Mar)	TOTAL
Pitfall	Trap nights	640	636		1276
Funnel		960	954		1914
Elliot		1600	1590		3190
Harp		86	78		164
Anabat		36	33		69
Camera trap (white-flash)		186	186	24	396
Camera trap (black-flash)					64
Active Search	Person hrs	56.25	64	5	125.25
Detailed Bird		40	40		80
Opportunistic Bird		8	13	5	26
Foot Spotlight		71.75	68		139.75
Vehicle Spotlight		9.58	17.5		27.08
Traverse (fauna surveys)		160	160	18	338
Traverse (flora surveys & other)		Includes traverses during the pilot study, dry (Sept) and wet (Feb) season flora surveys and the contingency survey			700
SAT	Sites	60	43	8	111
GBC ort search		8	3		11

Table 3.6. Assessment guidelines for determining species likelihood

Likelihood	Criteria	Probability
Present	Recorded within and/or immediately adjacent study area during this work. Likely resident populations of these species are known from within the SGP study area within the last 10 years.	100%
Likely	Suitable habitat within or adjacent the study area; numerous relevant records (less than 20 years old and within 10 km) from desktop assessment.	>80%
Possible	Suitable habitat within or adjacent the study area; numerous records from desktop assessment study area but records > 10 km away or 20-50 years old. OR Marginal habitat within or adjacent the study area; few, but recent (<20 yrs), records within 10 km of study area.	10-80%
Unlikely	Little suitable habitat or habitat marginal; few records from desktop assessment, usually >50years old, and records > 10 km from study area.	<10%
Transient	Species highly mobile and known to occasionally appear in areas away from known population centres (usually birds). These species could occur sporadically over time (i.e., >10% likelihood), but records and observations are unlikely to represent an established population worthy of special protection. This category does not include species which might occur seasonally or frequently.	N/A

3.5 SURVEY CONDITIONS AND LIMITATIONS

3.5.1 Survey Conditions

August Pilot Survey

The pilot survey was conducted between the 29th August and 2nd September 2016. Chinchilla received a total of 117 mm of rain between the 15th and 20th of September resulting in the presence of some surface water during the pilot survey. Maximum daily temperatures during the survey ranged from 23°C (31st Aug) to 27°C (2nd Sept), while minimum overnight temperatures ranged between 3.2°C (29th Sept) and 14.9°C.

'Dry' Season Surveys

The 'dry' season flora surveys were conducted between the 12th and 23rd September 2016 working progressively north from Kumbarilla State Forest toward Wandoan over the 12 day period. Significant rainfall occurred during the survey with 152.4mm of rainfall recorded in Miles between September 15th to September 22nd and 63.5mm recorded at Dalby (Bureau of Meteorology data) for the same period. This caused localised flooding, limiting access to foot traverses on a large number of properties.

The 'dry' season fauna surveys were conducted between the 18th and 28th October 2016, with works concentrating on the central region (Miles) on the 18th and 22nd October, and the southern region (Dalby) between the 23rd and 27th October. Accumulative rainfall at Miles in the months (Jun – Oct) prior to the work was 260mm, while 259mm of rain fell at Dalby over the same period.

During the fauna 'dry' season survey Miles received 10.8mm, 0.8mm and 6.0mm of rainfall on the 18th, 21st and 23rd of October. However this rainfall was patchy and affected only some areas within the SGP study area. The storm front which moved through on the 21st of October coincided with nocturnal spotlighting, and while the SGP study area did not receive rain, lighting, thunder and high humidity was widespread. These conditions promote nocturnal fauna activity and ideal conditions for nocturnal fauna searches.

Minimum overnight temperatures during the fauna survey ranged between 5.0°C (24th) and 17.7°C 22nd). Spotlighting coincided with minimum overnight temperatures of between 12.9°C and 17.7°C while working in the central region, but due to a wide-spread cold front, dropped to ~ 5.0°C before recovering to 11.2°C while surveying the southern region.

'Wet' Season Surveys

Wet season flora surveys were completed between February 6th and 18th 2017. This period coincided with extremely hot weather where the initial 9 days of survey had maximum temperatures exceeding 43°. The conditions both slowed the rate of field surveys as well as wilted some groundcover forb species and caused general scorching of groundcovers in some habitats. This may have resulted in an under-sampling of total floristic diversity in some habitats, particularly grassy woodlands.

'Wet' season fauna surveys were undertaken between the 7th and 16th March 2017 (inclusive) with works commencing on the southern (Dalby) region (7th-11th) and finishing

in the central (Miles) region (12th-16th). A total of 213mm of rainfall was recorded at Miles, and 273mm at Dalby, in the months preceding the work (Nov 16-Mar 17).

Temperatures at Miles during the fauna survey ranged from a minimum of 14.2°C on one night and a minimum of 18.8 °C thereafter, to a maximum of 35 °C. Rainfall fell over three nights at Miles totalling 18.8mm, however rainfall was patchy with some areas receiving much greater rainfall events causing localised flooding. This flooding caused the closure of some traps (i.e., A02_Det05 was abandoned after three nights) due to access concerns.

Temperatures at Dalby during the fauna survey ranged from a minimum of 14.8 °C to a maximum of 33.2 °C. No rain fell while surveying the southern region.

3.5.2 Survey Limitations

While unlikely to have significantly affected the results of this work, the following limitations are recognised:

- Floristic surveys were hampered by extremely wet weather during the 'dry' (September) season survey meaning access was restricted in some localities and nearly all unsealed roads were impassable for a period of several days. This reduced site coverage in the first stage of the survey.
- Access was not possible to a small subset of properties. Generally this is unlikely to have affected survey results as surveys on adjacent land allowed assessment of a similar vegetation/habitat unit. However it is possible that some smaller features, such as wetlands or waterbodies, may have been overlooked.
- 'Dry' season fauna surveys conducted in the southern (Dalby) region coincided with unseasonably cold night temperatures. Temperatures quickly dropped to near 12-13°C within the first hour after sunset. These conditions, which affected only two nights of survey effort in the southern region, are largely unsuitable for the detection of a variety of fauna species, particularly nocturnal reptiles and bats.
- The coincidence of extremely hot weather with the 'wet' season flora survey effort may have resulted in the under-sampling of some of the more sensitive grass and forb species in woodland habitats. Of the EVNT species, this may have reduced the effectiveness of searches for the grass species *Digitaria porrecta*. The 'Endangered' forb species *Solanum papaverifolium* was observed flowering in populations observed outside the assessment area during the wet season survey and the effectiveness of searches for this species are not expected to have been affected.
- Rainfall was experienced during both the 'dry' season and 'wet' season fauna surveys in the central (Miles) region. However no rain fell while undertaking fauna surveys in the southern region (Dalby) and this is likely to have affected frog activity and detectability in the region.
- An extreme wildfire impacted the eastern portion of the southern region (Kumbarilla SF) prior to the 'wet' season survey. This affected the spatial distribution of trap effort within Kumbarilla State forest, but did not affect BVG representation. The fire inhibited surveys over the impacted area during the 'wet' season.

4.0 RESULTS

4.1 DESKTOP RESULTS

4.1.1 Wetlands of High Ecological Significance

The SGP study area contains an extensive mosaic of palustrine wetland habitats, many of which are associated with the Condamine River floodplain. Across Queensland, comprehensive mapping has been undertaken to identify Wetland Management Areas (WMAs) which categorise wetlands as either General Ecological Significance (GES) or High Ecological Significance (HES). These units include habitats associated with RE 11.3.27, 11.3.25 and RE 11.4.3a.

Wetland Management Areas are of specific relevance to the project, requiring adherence to appropriate management buffers and specific mitigation measures. The location of Wetland Management Areas in the SGP study area is shown in Figure 4.1. Two major wetlands of HES occur within the SGP study area; i) Lake Broadwater, a major lacustrine Wetland of National Significance and ii) Long Swamp, a palustrine wetland which follows a shallow sinuous path to the north of Lake Broadwater. Further characterisation of these habitats based on field assessment is provided in Section 4.1.1.

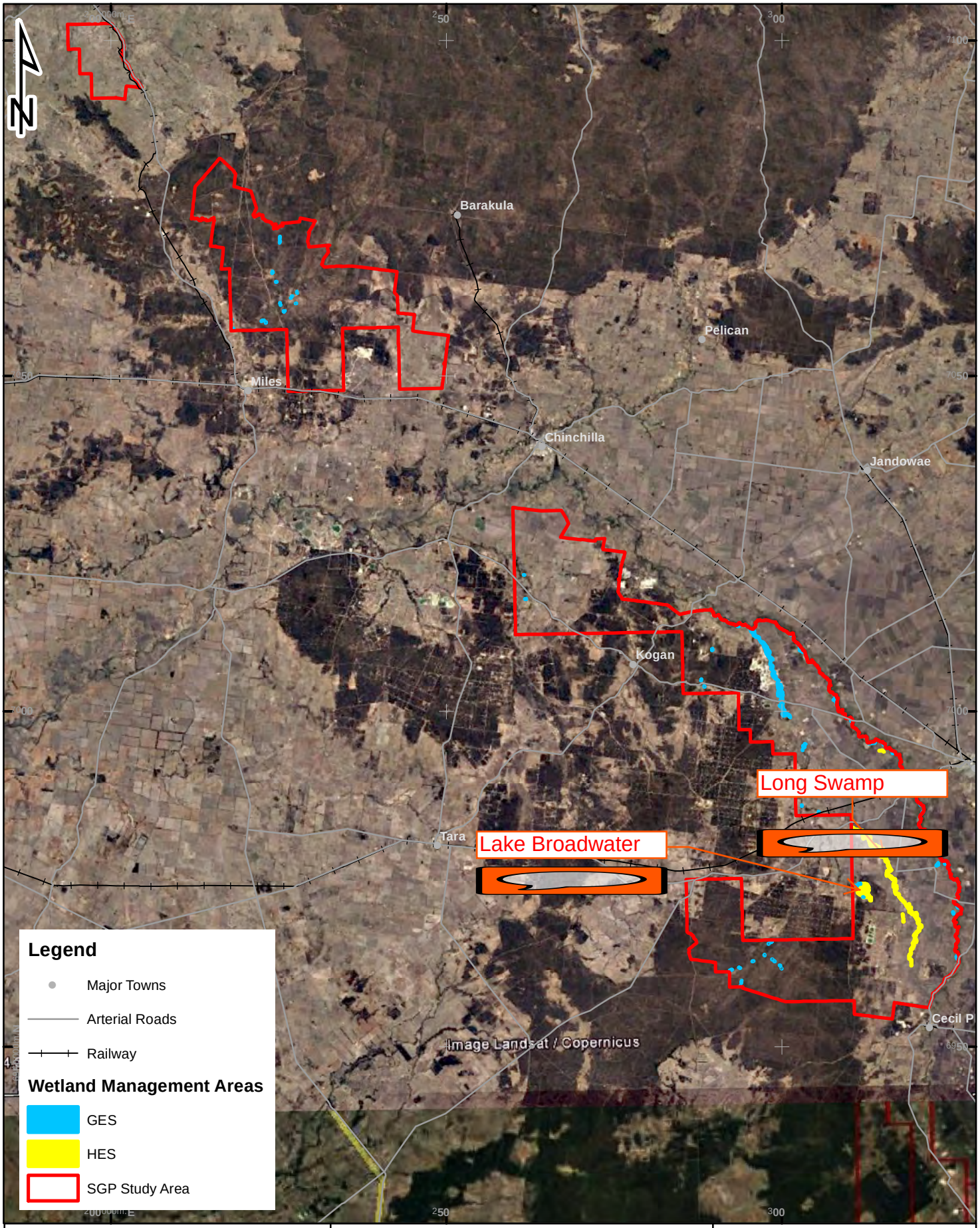
4.1.2 Essential Habitat

The essential habitat layer (Version 4.41; available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=essential+habitat) represents the most up-to-date essential habitat available. This layer however, is updated infrequently by the Queensland Government and at the time of preparing this report included essential habitat for species no longer specially protected under Queensland legislation (and therefore includes areas that should no longer constitute essential habitat). Unfortunately, recent government changes require property by property examination of Essential Habitat, which limits its use for assessments over large areas encompassing many properties and areas of essential habitat. Closer examination will be required in the future to assess essential habitat values.

4.1.3 Protected Plant 'High Risk' Buffers

A 'High Risk' plant buffer protects plants listed as Endangered, Vulnerable and Near Threatened under the NC Act. These protected areas are generated by placing a 2km wide buffer around confirmed locations of individuals to show where protected plant species are considered likely to be present.

The locations of High Risk buffers for protected plants that were assessed in accordance with Flora Survey Guidelines – Protected Plants (DEHP 2016) during SGP Surveys are shown in Figure 4.2.



NOTES:
Queensland wetland data version 4 (2016)

FIGURE 4.1 Wetland Management Areas within the SGP Study Area

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0 5 10 15 20
Kilometers

Scale	1:750,000	Drawn By	DG	Date	23-Jun-17	A4

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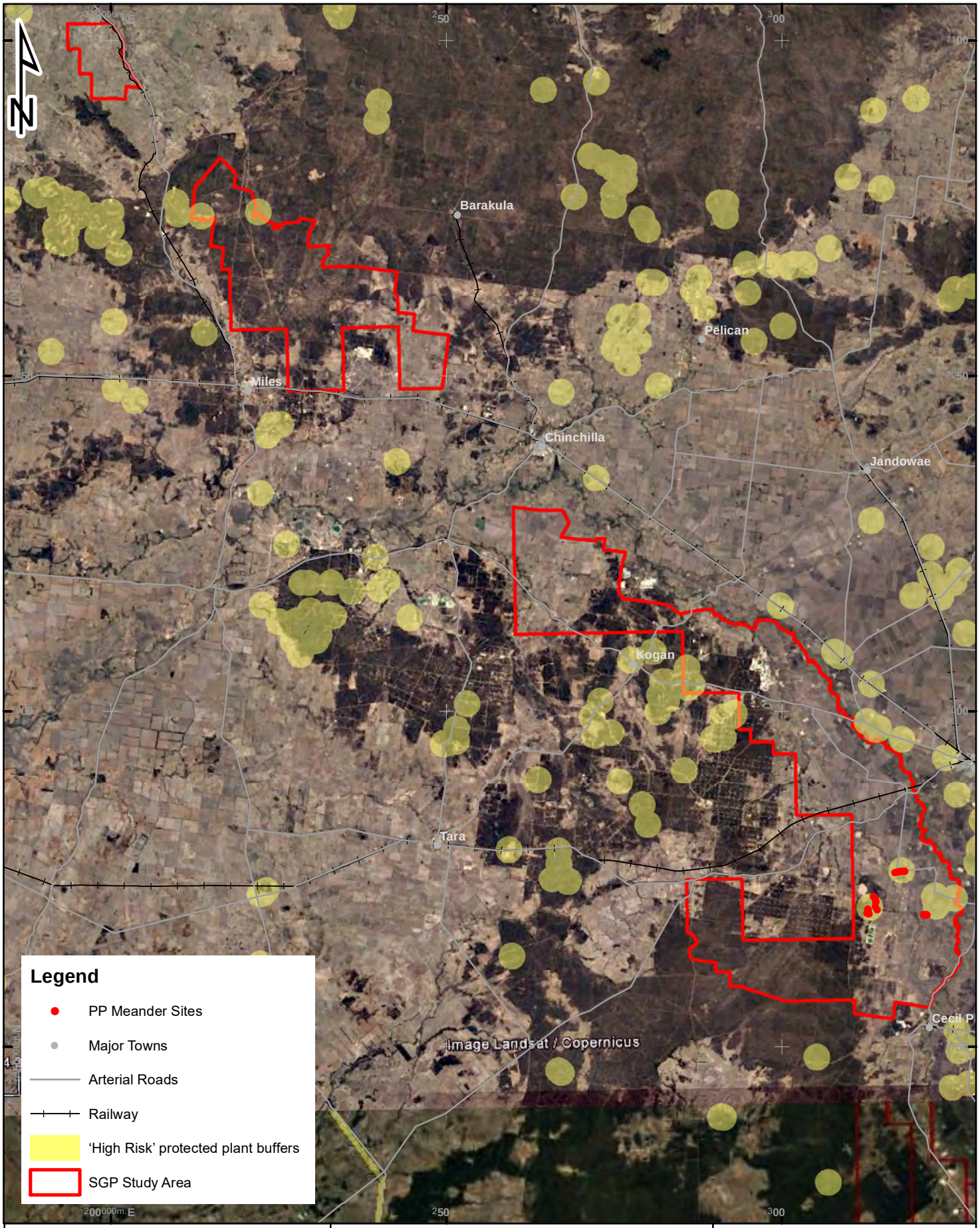

FIGURE 4.2 'High Risk' protected plant buffers assessed during SGP Study

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 24-Jun-17 A4

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4.1.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas relevant to the SGP study area include:

- Category A - National Parks and Conservation Parks, specifically Lake Broadwater Conservation Park (Lot 68/SP139357),
- Category B - REs scheduled as Endangered (Biodiversity Status) by Queensland Department of Environment and Heritage Protection (DEHP), and
- Category C – which includes the following:
    - Lake Broadwater Resources Reserve (Lot69/DY6009),
    - Regional Ecosystems with 'Of Concern' Biodiversity Status,
    - State Forest areas as previously detailed in Section 2.3, and
    - Essential Habitat as described in Section 4.1.2.

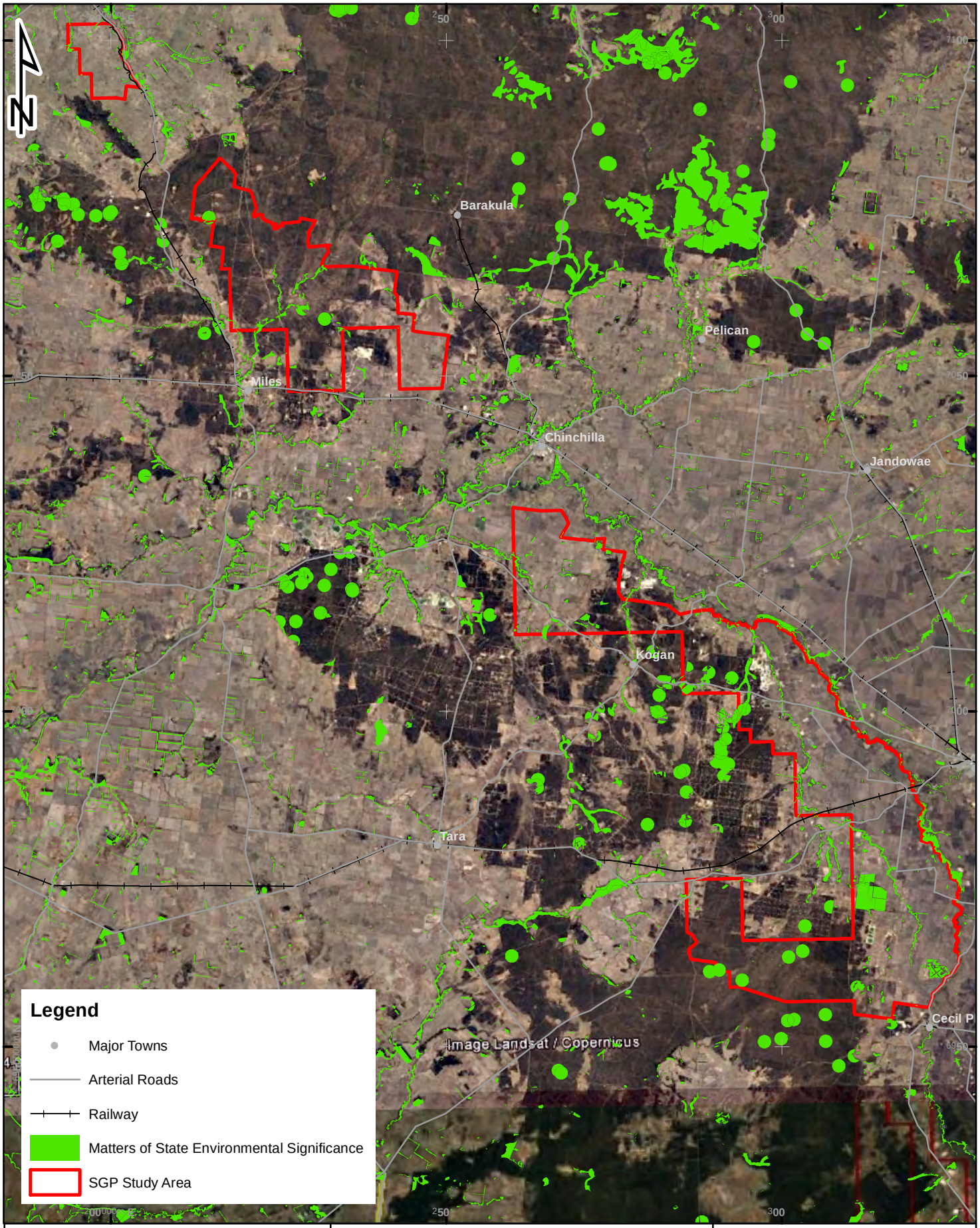
It should be noted that a property designated as a Category A ESA based on tenure overrides any attribution of ESA status based on vegetation composition (i.e. Of Concern and Endangered Biodiversity Status).

4.1.5 Matters of State Environmental Significance

Impacts to Matters of State Environmental Significance (MSES) may trigger a requirement for offsets under the Queensland Environmental Offsets Policy (Version 1.1). Within the SGP assessment area, the following features may be considered MSES:

- Areas or habitats that contains plants that are Endangered or Vulnerable wildlife (including those within protected plant High Risk buffers,
- Habitat (e.g. foraging, roosting, nesting or breeding habitat) for an animal that is Endangered, Vulnerable or a Special Least Concern animal,
- Remnant Endangered REs,
- Remnant Of Concern REs,
- Least Concern REs intersecting a watercourse or associated with a wetland,
- VM Act wetland habitats,
- National Parks and Nature Refuges, and
- Connectivity (as calculated using the Landscape Fragmentation and Connectivity (LFC) tool)

The Queensland Government has mapped MSES throughout the SGP study area and more broadly throughout Queensland with a comprehensive MSES dataset (DEHP 2014). MSES in the assessment area, as per DEHP (2014) is shown in Figure 4.3. It should be noted that this data excludes those areas identified in the current survey as habitat for protected animals or plants.



Legend

- Major Towns
- Arterial Roads
- Railway
- Matters of State Environmental Significance
- SGP Study Area

NOTES:
Matters of State environmental significance (version 4.1), Queensland Government

FIGURE 4.3 MSES in the SGP Study Area based on DEHP 2014.

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale	Drawn By	Date	
1:750,000	DG	24-Jun-17	A4

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4.1.6 Threatened Flora and Fauna

Examination of relevant databases and literature (see Section 3.1) identified threatened flora and fauna species recorded within 50km of the SGP study area, or having some possibility of occurring. While a long list of threatened species are known to occur within the SGP study area, not all are likely to occur with frequency, but rather, records may represent species which have become locally extinct or individuals which periodically appear but do not represent a permanent or seasonal population (i.e., particularly mobile fauna species). Closer analysis (see Appendix C) recognises a subset as being resident (i.e., present), or considered likely/possible. Present, or taxa likely to occur, are assessed further in Sections 4.2.3 (flora) and 4.3.1 (fauna) and have been provided detailed habitat maps in the attached GIS package.

4.2 TERRESTRIAL FLORA RESULTS

4.2.1 Threatened Ecological Communities and Regional Ecosystems

4.2.1.1 Threatened Ecological Communities

Past and present flora surveys have identified three TECs listed under the EPBC Act within the SGP study area. These communities are:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) (Endangered),
- Weeping Myall Woodlands (Endangered), and
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (Endangered).

The spatial extent of these TECs within each of the three regions of the SGP study area are provided in Table 4.1 and their locations show in Figure 4.4.

Table 4.1. Spatial extent of TECs within the SGP study area

TEC	Area (ha) / SGP study area region			Total Area (ha)
	North	Central	South	
Brigalow (*Acacia harpophylla* dominant and co-dominant)	16.6	66.8	870.9	954.3
Weeping Myall Woodlands	0	0	0.9	0.9
Coolibah – Black Box Woodlands	0	0	22.6	22.6

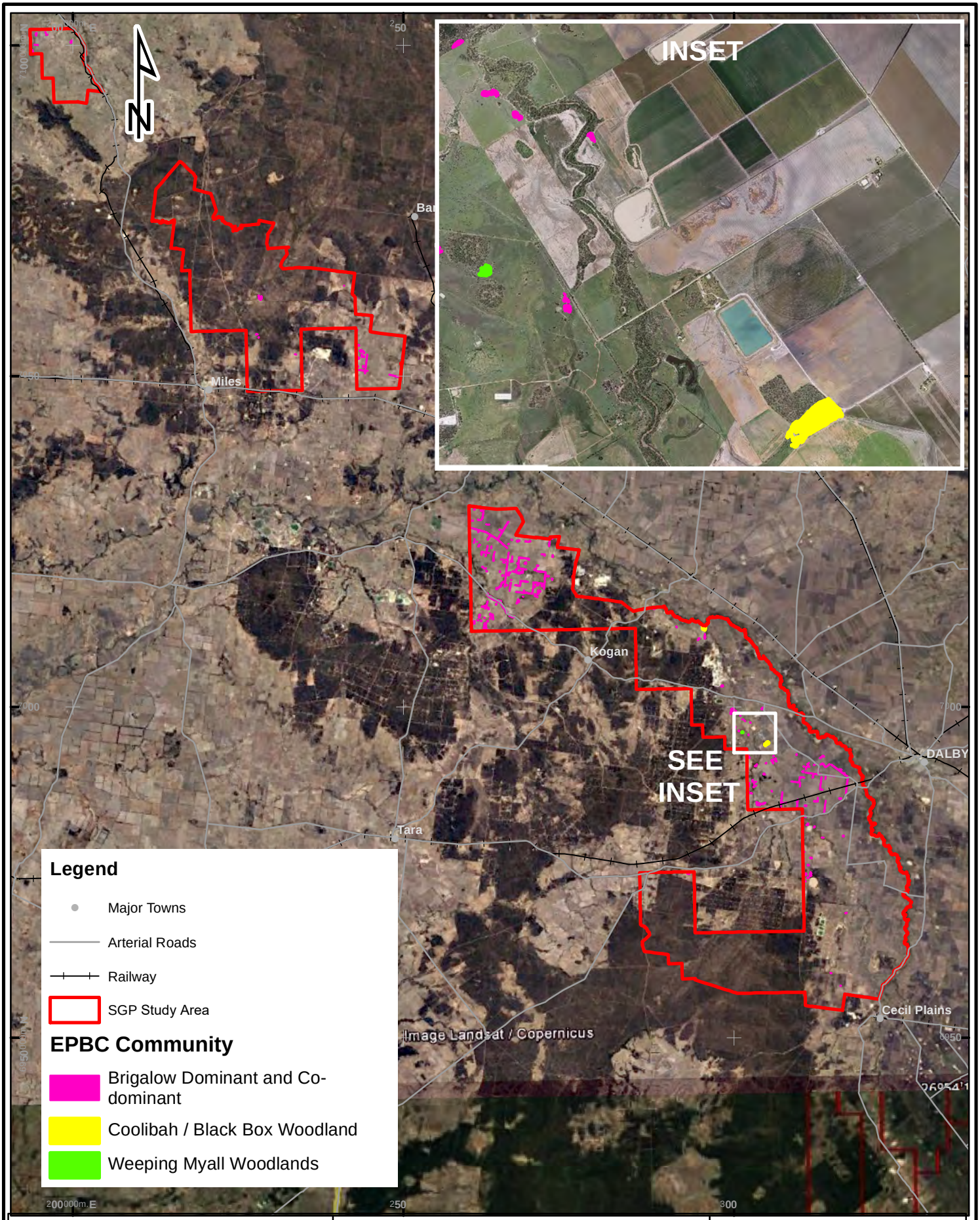

FIGURE 4.4 Threatened Ecological Communities within the SGP Study Area.

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 14-May-17 A4

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4.2.1.2 Regional Ecosystems:

Of the 20 REs recorded within the SGP study area, three are listed as Endangered and six as Of Concern, with the remainder being Least Concern under the VM Act. The extent of each RE within the three regions of the SGP study area is provided in Table 4.2 and their spatial distribution based on VM Act is shown in Figure 4.5 to Figure 4.7 and biodiversity status (as surrogate for ESA status) shown in Figure 4.8 to Figure 4.10. A detailed description for each RE listed as occurring within the SGP study area is provided within Appendix D.

It should be noted that heterogeneous polygons of RE11.3.25 and 11.3.4 are often mapped along riparian corridors, represented as either 'Of Concern Dominant' or 'Of Concern Sub-dominant' (under the VM Act) dependent on relative proportion. This is the result of scale limitations where large numbers of contiguous riparian polygons fall below the 0.5ha mapping threshold.

Table 4.2. Regional Ecosystem extent within the three regions of the SGP study area.

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	E	E	7.7	14.8	195.0
11.3.14	*Eucalyptus* spp., *Angophora* spp., *Callitris* spp. woodland on alluvial plains.	LC	NCAP	0	127.1	205.23
11.3.17	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.	OC	E	12.3	0	201.2
11.3.18	*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium.	LC	NCAP	0	0	418.4
11.3.2	*Eucalyptus populnea* woodland on alluvial plains.	OC	OC	9.9	3.0	580.7
11.3.25	*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines.	LC	OC	61.6	804.23	778.7
	11.3.25g: Seasonal vegetation associated with larger waterholes and areas of open water.			3.8	-	-
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains.	LC	NCAP	0	18.3	7.1
11.3.27	11.3.27a: Palustrine wetland (e.g. vegetated swamp). Mixed grassland or sedgeland with areas of open water +/- aquatic species.	LC	OC	0	36.1	256.5
	11.3.27d: Palustrine wetland *Eucalyptus camaldulensis* and/or *Eucalyptus tereticornis* woodland			1.5	0	15.15

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
	11.3.27f: *Eucalyptus coolabah* and/or *E. tereticornis* open woodland to woodland fringing swamps.			0	0	320.8
11.3.3	11.3.3c: Palustrine wetland (e.g. vegetated swamp). Eucalyptus coolabah woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels.	OC	OC	0	0	26.82
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	OC	OC	5.8	476.3	898.61
11.4.3	*Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains	E	E	0	0	388.7
	11.4.3a: Palustrine wetland (e.g. vegetated swamp). *Melaleuca bracteata* woodland associated with *Acacia harpophylla* communities.			0	0	56.64
11.5.1	11.5.1: *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces	LC	NCAP	0	17,972.06	18,607.9
	11.5.1a: *Eucalyptus populnea* woodland with *Allocasuarina luehmannii* low tree layer.			0	23.2	327.7
11.5.20	*Eucalyptus moluccana* and/or *E. microcarpa/E. pilligaensis*[4] ± *E. crebra* woodland on Cainozoic sand plains.	LC	NCAP	0	20.9	6635.7
11.5.21	*Corymbia bloxsomei* ± *Callitris glaucophylla* ± *Eucalyptus crebra* ± *Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces.	LC	NCAP	0	2,238.9	0
11.5.4	*Eucalyptus chloroclada, Callitris glaucophylla, C. endlicheri, Angophora leiocarpa* woodland on Cainozoic sand plains and/or remnant surfaces	LC	NCAP	0	287.4	2941
11.7.4	*Eucalyptus decorticans* and/or *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust.	LC	NCAP	0	176.4	0
11.7.5	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.	LC	NCAP	0	5,669.9	7243.6
	11.7.5b: *Acacia aprepta* shrubland.			0	371.2	95.4

[4] *E. pilligaensis* has been recently consumed within the broader reclassification of *E. woollsiana.*

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
11.7.6	*Corymbia citriodora* or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust.	LC	NCAP	0	950.8	5.3
11.7.7	*Eucalyptus fibrosa* subsp. *nubila* ± *Corymbia* spp. ± *Eucalyptus* spp. on Cainozoic lateritic duricrust.	LC	NCAP	0	6,297.2	2,988.5
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	LC	NCAP	48.27	0	0
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.	E	E	4.3	0	0
11.9.7	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	OC	OC	1.5	0	0
11.9.10	*Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks	OC	E	15	0	0

E = Endangered, OC = Of Concern, LC = Least Concern, NCAP = No Concern at Present

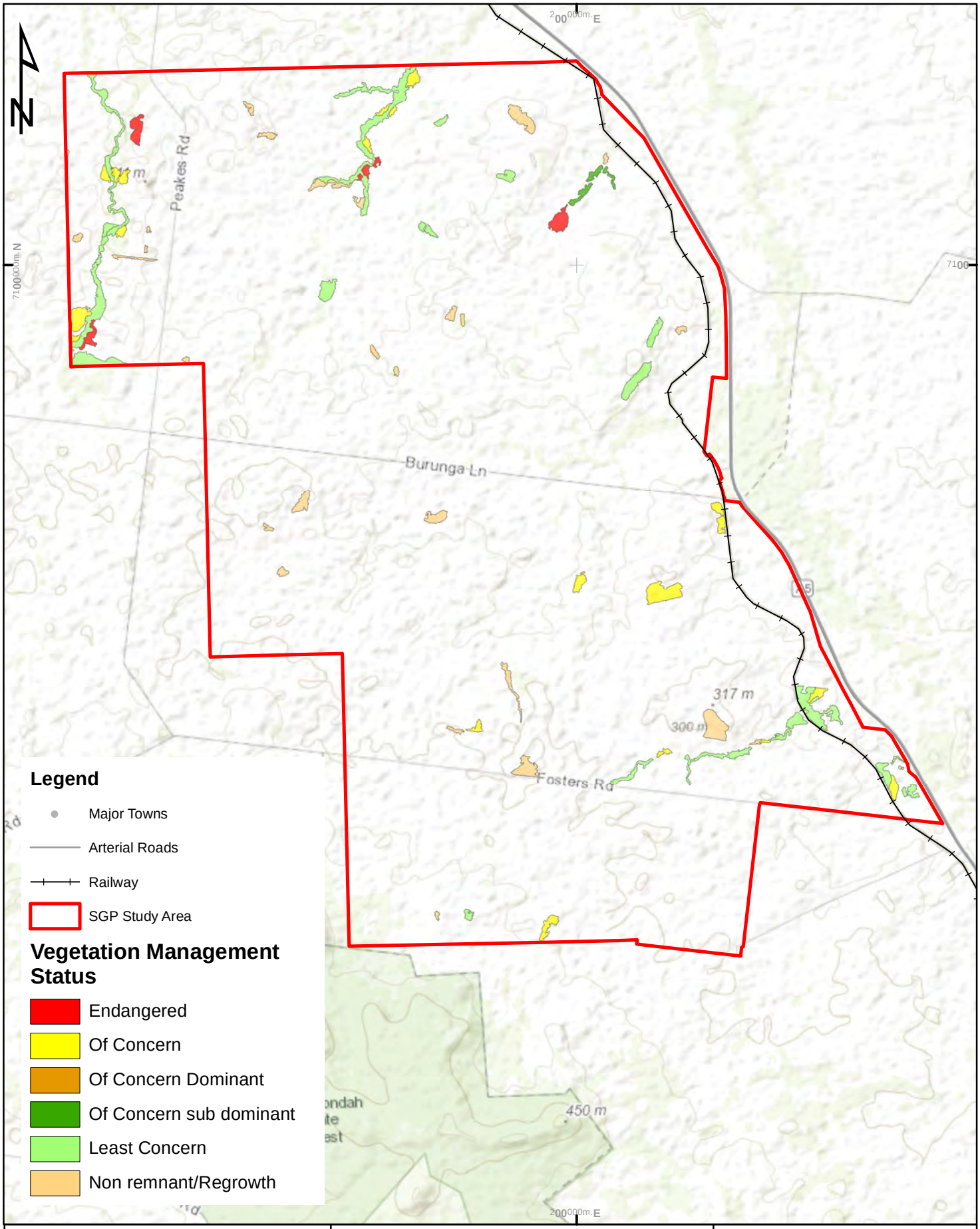

FIGURE 4.5 Endangered, Of Concern, and Least Concern REs within the northern region of the SGP Study Area

Client ARROW ENERGY

0 1 2 3 4
Kilometers

Scale	1:63,440	Drawn By	DG	Date	25-Jun-17	A4

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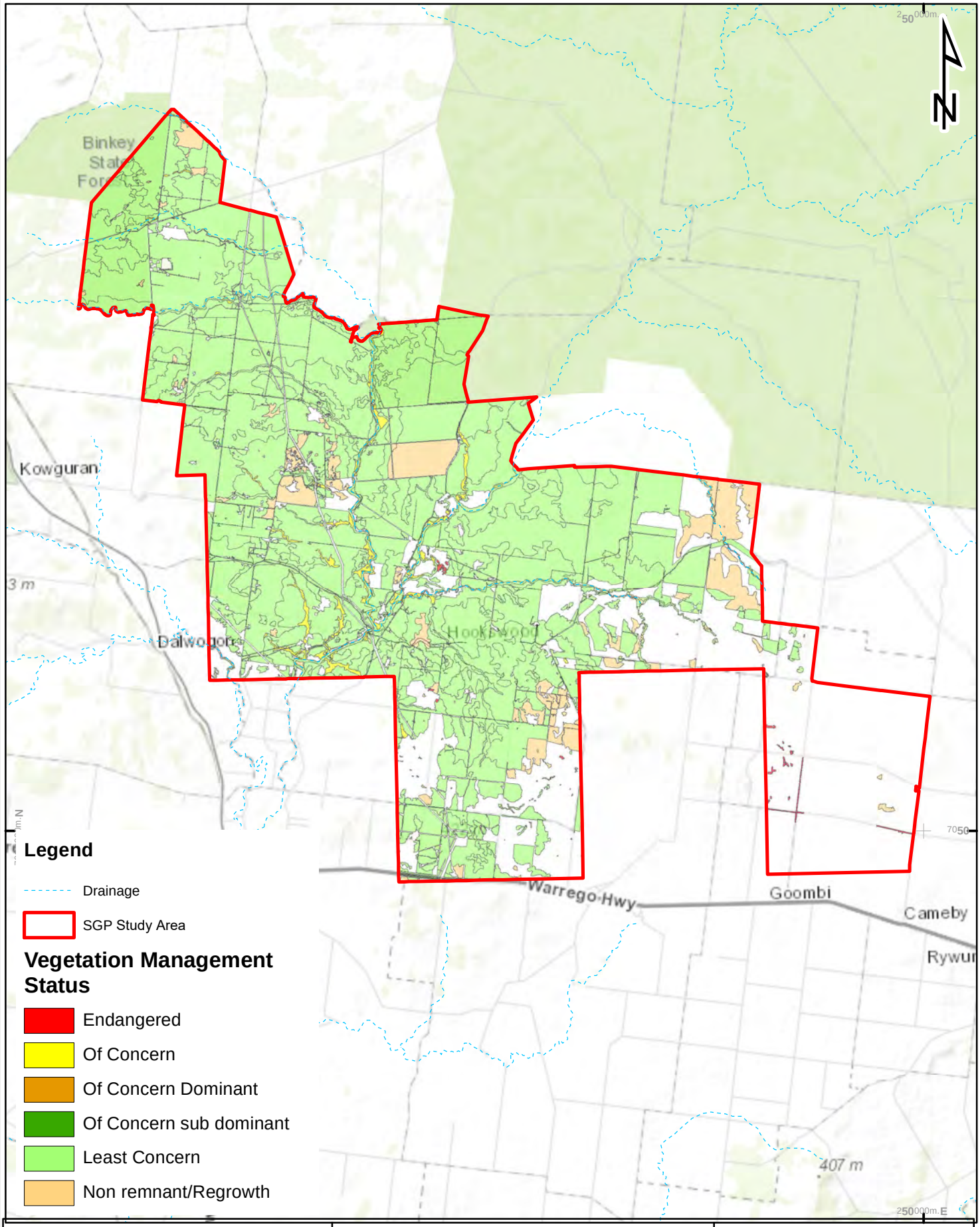

FIGURE 4.6 Endangered, Of Concern, and Least Concern REs within the central region of the SGP Study Area

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0 4 8 12 16
Kilometers

Scale 1:226,000 | **Drawn By** DG | **Date** 21-May-17 | A4

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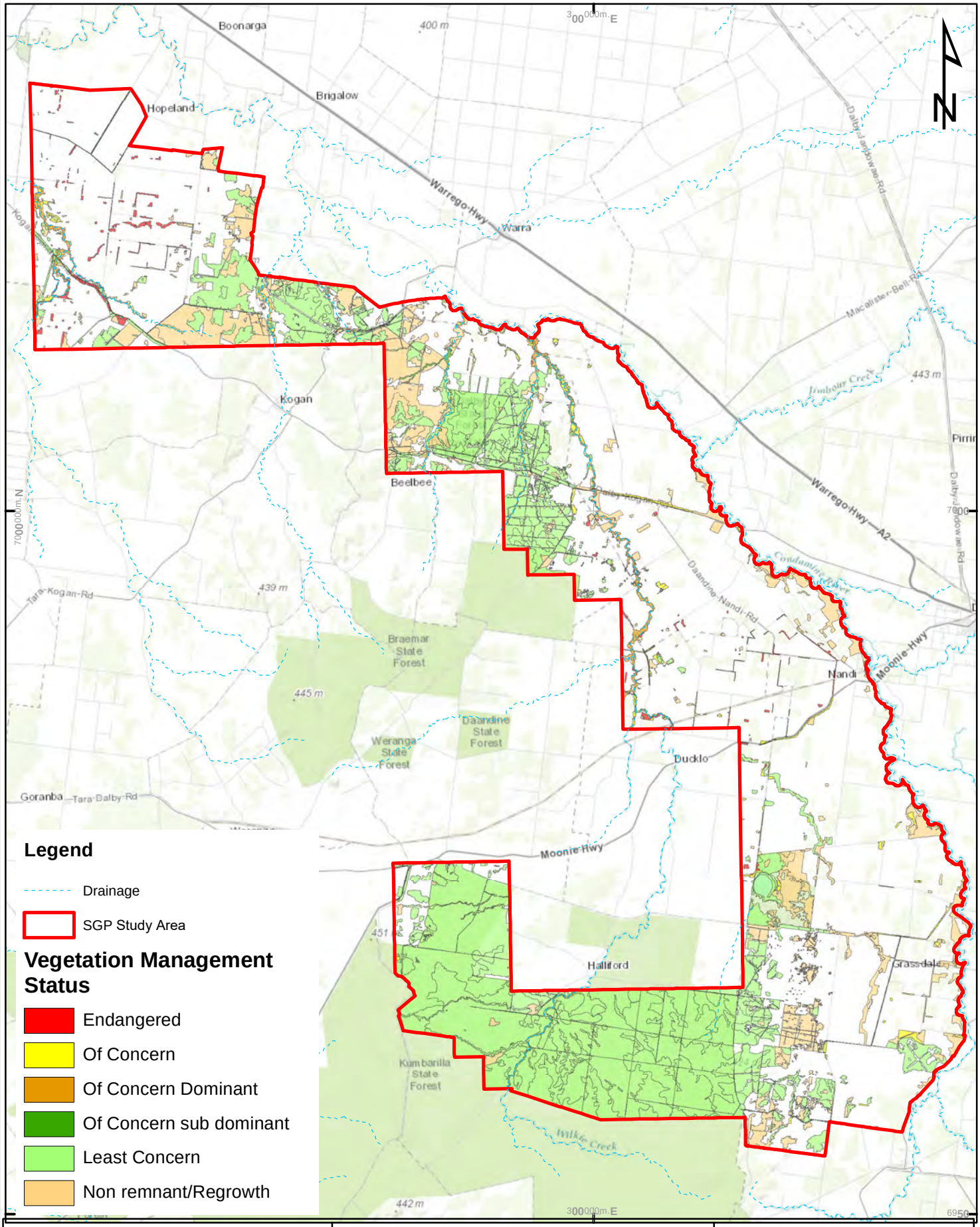

FIGURE 4.7 Endangered, Of Concern, and Least Concern REs within the southern region of the SGP Study Area

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0 4 8 12 16
Kilometers

Scale 1:357,316 | **Drawn By** DG | **Date** 21-May-17 | A4

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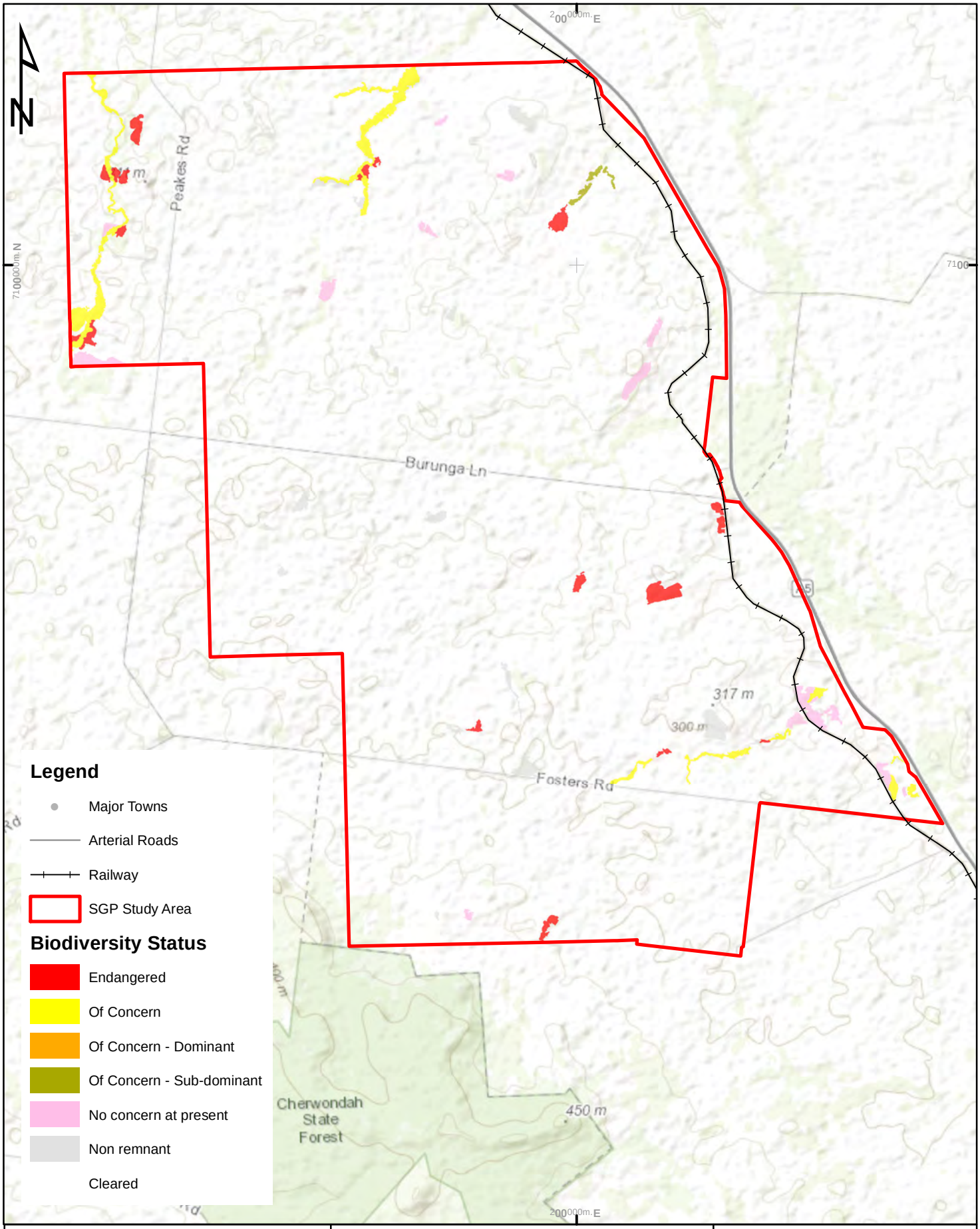

FIGURE 4.8 Biodiversity Status of Regional Ecosystems in the northern region of the SGP Study Area.

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0 1 2 3 4
Kilometers

Scale 1:63,440 | **Drawn By** DG | **Date** 25-Jun-17 | A4

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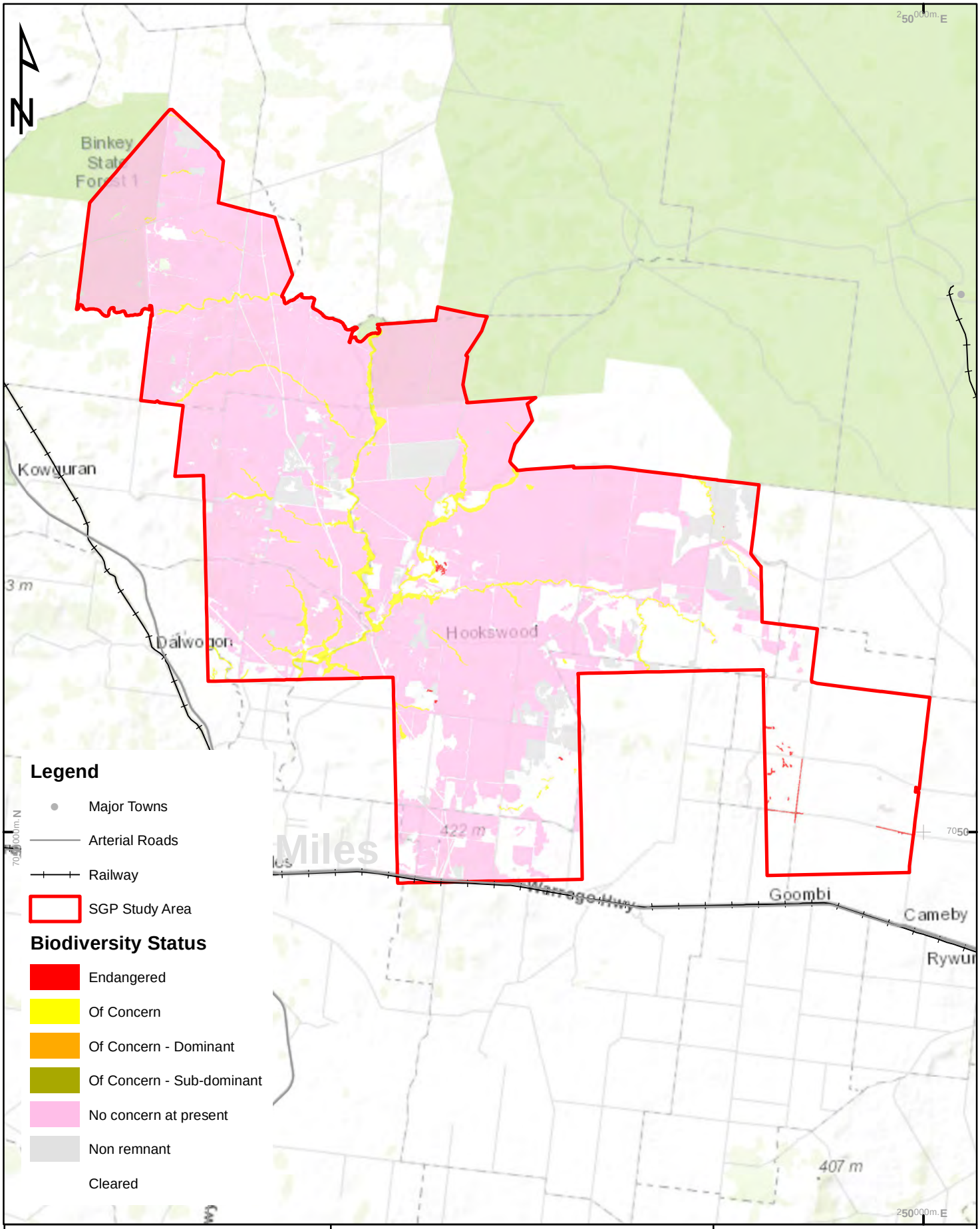

FIGURE 4.9 Biodiversity Status of Regional Ecosystems in the central region of the SGP Study Area.

Client ARROW ENERGY

0 4 8 12 16
Kilometers

Scale 1:226,000 | **Drawn By** DG | **Date** 25-Jun-17 | A4

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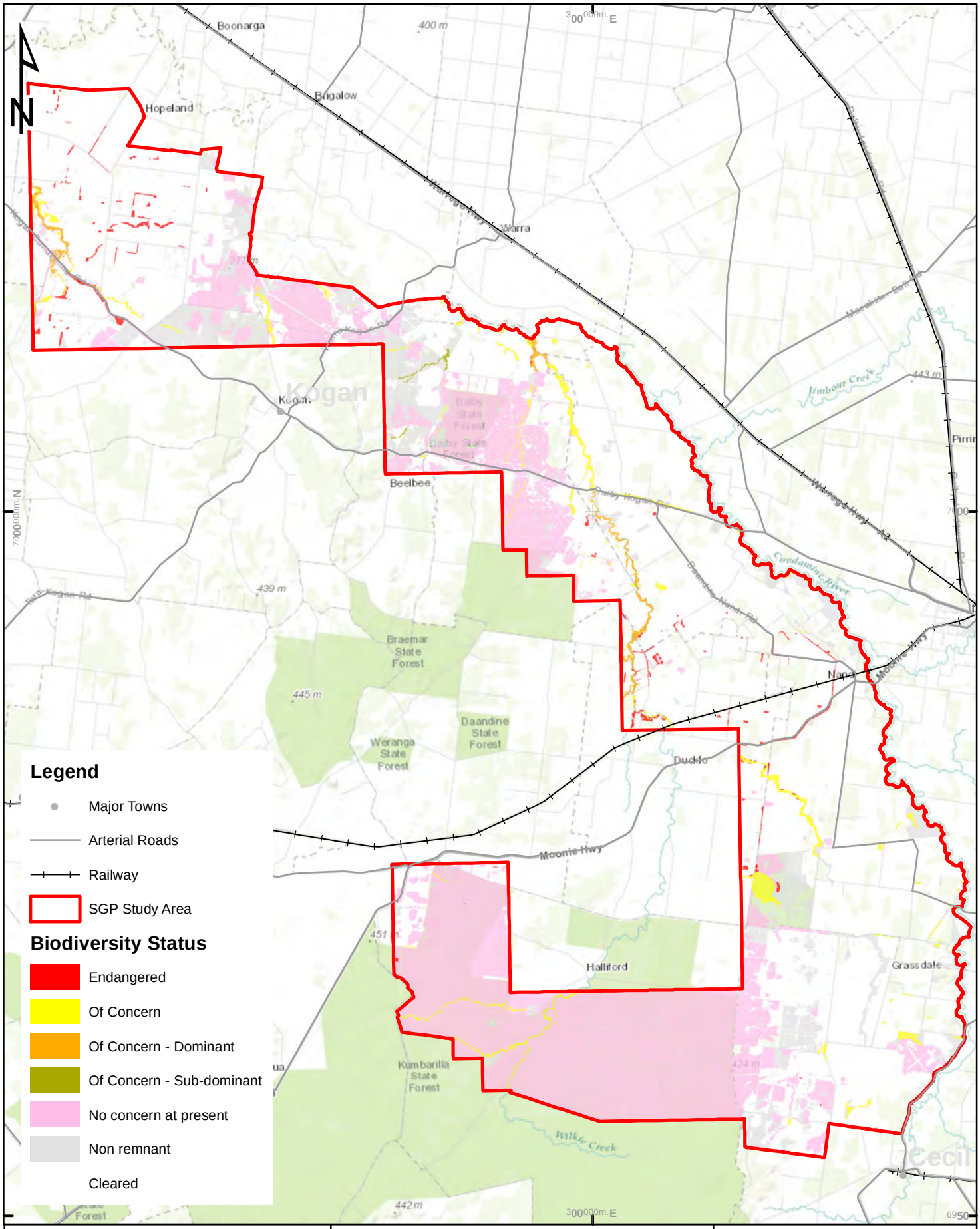

FIGURE 4.10 Biodiversity Status of Regional Ecosystems in the southern region of the SGP Study Area.

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4.2.2 Flora Diversity

A total of 438 flora species were recorded during the SGP study area flora surveys including:

- 38 exotic species
- 2 Conifers
- 2 ferns
- 90 grasses
- 2 species of grasstree
- A balance of trees, shrubs and forbs across 65 plant families.

The highest floristic diversity was associated with RE 11.5.1 where 100 species were recorded across all survey sites. The high diversity would be in part due to the REs considerable extent and variation in floristic structure.

4.2.3 Threatened Flora Species Likelihood Assessments

Only one threatened flora species, *Philotheca sporadica* (Near Threatened NC Act; Vulnerable EPBC Act) has been recorded during assessments completed by Arrow Energy, including the current 2016 – 2017 survey event. However database records (Herbrecs and Australia's Virtual Herbarium) indicate a number of additional EVNT species have been previously recorded either in or adjacent to the SGP study area. These species include *Crytandra ciliata* (Near Threatened NC Act); *Solanum papaverifolium* (Endangered NC Act), *Fimbristylis vagans* (Endangered NC Act) and *Digitaria porrecta* (Near Threatened NC Act). Some of these records are relatively old and there are no contemporary records despite extensive searches in suitable habitat. *Digitaria porrecta*, for example has not been recorded from within the SGP study area since 1995, and *Fimbristylis vagans* was last recorded from the Lake Broadwater area in 1984.

Figure 4.11 identifies the locations of all EVNT species records contained within 1km of the SGP study area boundary based on Herbarium records and a range of surveys undertaken on behalf of Arrow Energy.

Whilst only five EVNT flora species are considered known or likely to be present within the SGP study area, an additional 31 species are known from the regional area (i.e. within a 50km buffer of the SGP study area boundary). An analysis of the likelihood of these species occurring is provided in Appendix C which identifies an additional 14 species that may possibly occur within the SGP study area (Table 4.3). In general, species with records greater than 25km from the SGP study area were considered unlikely unless large tracts of sparsely surveyed habitat was present.

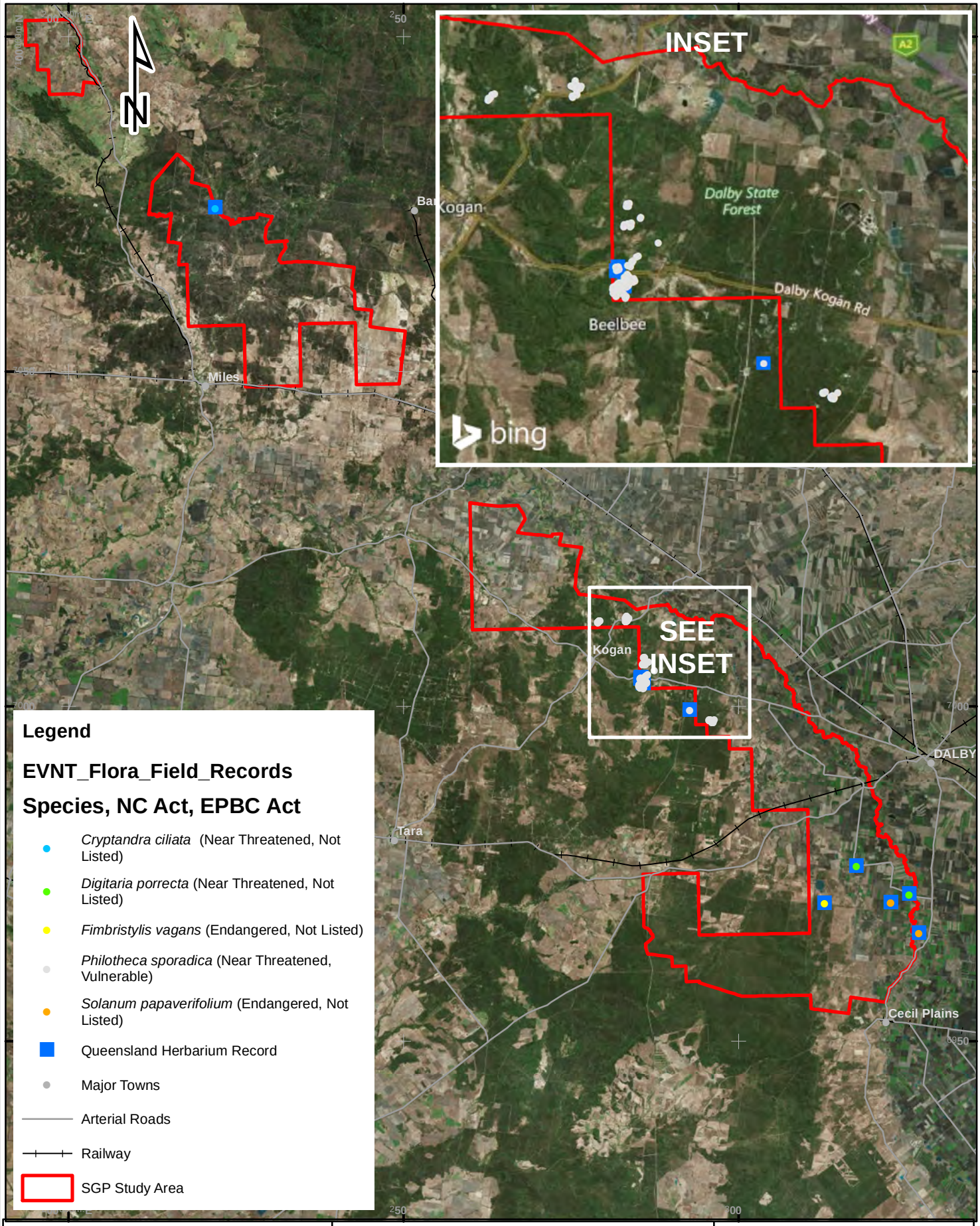

FIGURE 4.11 Survey records of EVNT flora species from within the SGP Study Area.

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Kilometers

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Table 4.3. Likelihood assessment for Threatened flora species in the SGP study area.

Scientific Name	Common Name	EPBC Status	NC Status	Likelihood
Shrubs and Trees				
Philotheca sporadica	Kogan waxflower	V	NT	Present
Acacia barakulensis	Waaje wattle	-	V	Possible
Acacia curranii	Curly-bark wattle	V	V	Possible
Acacia handonis	Hando's wattle	V	V	Possible
Callitris baileyi	Bailey's cypress	-	NT	Possible
Calytrix gurulmundensis	Gurulmundi fringe myrtle	V	V	Possible
Micromyrtus carinata	Gurulmundi heath myrtle	-	E	Possible
Eucalyptus curtisii	Plunkett mallee	-	NT	Possible
Acacia lauta	Tara wattle	V	V	Unlikely
Acacia wardellii	Wardell's wattle	-	NT	Unlikely
Cadellia pentastylis	Ooline	V	V	Unlikely
Denhamia parviflora	Small-leaved denhamia	V	V	Unlikely
Eucalyptus argophloia	Chinchilla white gum	V	V	Unlikely
Eucalyptus virens	Shiny-leaved ironbark	V	V	Unlikely
Grasses and Sedges				
Digitaria porrecta	Finger panic grass	-	NT	Present
Fimbristylis vagans	NA	-	E	Present
Homopholis belsonii	Belson's panic	V	E	Possible
Cyperus clarus	-	-	V	Unlikely
Herbs and Orchids				
Solanum papaverifolium	-	-	E	Present
Cymbonotus maidenii	-	-	E	Possible
Picris barbarorum	-	-	V	Possible
Rutidosis lanata	-	-	NT	Possible
Solanum stenopterum	-	-	V	Possible
Xerothamnella herbacea	Xerothamnella	E	E	Possible
Cryptandra ciliata	-	-	NT	Likely
Thesium australe	Austral toadflax	V	V	Possible
Pomaderris coomingalensis	-	-	E	Unlikely

E = Endangered; V = Vulnerable; NT = Near Threatened

Further discussion regarding threatened flora taxa considered possible, likely or present from the SGP study area is provided in Appendix E. The appendix includes the criteria used to develop individual species habitat maps in the associated GIS product, and an assessment of the mapping accuracy for predicting the species habitat/extent. Table 4.4 shows the extent of habitat available to each species based on the GIS mapping product.

Table 4.4. The extent of mapped habitat for Threatened flora species present or possibly occurring within the SGP study area.

Scientific Name	Common Name	Status		Habitat extent in SGP (ha)*		
		EPBC	NCA	CHK	CHP	GH
Acacia barakulensis	Waaje wattle	V	-	0	0	33,811.2
Acacia curranii	Curly-bark wattle	V	V	0	0	33,811.2
Acacia handonis	Hando's wattle	V	V	0	0	33,811.2
Callitris baileyi	Bailey's cypress	NT	-	0	0	33,811.2
Cryptandra ciliata	NA	.	-	103.4	-	33,707.8
Calytrix gurulmundensis	Gurulmundi fringe myrtle	V	V	0	0	13,096.5
Cymbonotus maidenii	NA	E	-	0	0	3,677.6
Digitaria porrecta	Finger panic grass	NT	-	99.8	0	3,675.5
Eucalyptus curtisii	Plunkett mallee	NT	-	0	0	24,167.5
Fimbristylis vagans	NA	V	-	5.3	499.1	3,181.7
Homopholis belsonii	Belson's panic	V	V	0	19.3	1,206.9
Micromyrtus carinata	Gurulmundi heath myrtle	E	-	0	0	6,217.0
Philotheca sporadica	Kogan waxflower	NT	V	1,574.5	2,213.0	20,308.0
Picris barbarorum	NA	V	-	0	0	3,788.9
Rutidosis lanata	NA	-	NT	0	0	3,393.9
Solanum papaverifolium	NA	E	-	2.9	0	3,672.2
Solanum stenopterum	NA	E	-	0	0	2,764.5
Thesium australe	Austral Toadflax	V	V	0	0	526.7

*CHN = Core Habitat Known, CHP = Core Habitat Possible and GH = General Habitat

4.2.4 Exotic Flora Species

Of the 38 exotic species recorded during the assessment, five are listed as Restricted Invasive Plants under Queensland's Biosecurity Act 2014 meaning that they cannot be given away, sold, or released into the environment without a permit. The majority of these plants are from the Cactus (Cactaceae) family which includes the genera of Opuntia and Harissia. African lovegrass (Eragrostis curvula), whilst not listed as a restricted plant in Queensland is considered a 'High Priority Weed' under the Western Downs Regional Council Pest Management Plan (2011 to 2015). The species was also abundant in the study area, particularly in southern portions in the vicinity of Dalby. A summary of significant pest plants recorded during the survey is provided in Table 4.5.

Table 4.5. Summary of declared weeds and weeds of national significance (WONS) known to occur in the study area from database searches and field survey.

Scientific Name **Common Name**	**Category***	**Significantly Infested Res**	**Comments**
Opuntia tomentosa Velvet tree pear	3/WONS	11.3.1, 11.3.4, 11.4.3, 11.3.17, 11.9.5.	Dense infestations of velvet tree pear were universally associated with brigalow habitats wihere it formed up to 15% cover in the taller shrub layers. The plant was also scattered throughout the majority of habitats although infestations considerably less vigorous on soils of lower fertility.
Opuntia stricta Prickly pear	3/WONS	Occurs at low to moderate levels throughout all ecosystems	Scattered individuals occur throughout all habitats although the species in more abundant in regional ecosystems with fertile alluvial soils.
Opuntia aurantiaca Tiger pear	3/WONS	11.3.1, 11.3.2, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.25, 11.4.3, 11.9.5 and non-remnant habitats	Dense infestations typically recorded adjacent to or within brigalow habitats where it formed up to 10% ground cover in patches. Particularly heavy infestations associated with the riparian margins of Wilkie Creek.
Harrisia martiniii Harrisia cactus	3	Mostly Brigalow habitats including REs 11.3.1 11.3.17, 11.4.3 and 11.9.5.	Most commonly associated with brigalow habitats where it typically formed cover of < 5%. Tends to be less common and in lower abundance than tiger pear in infested habitats.
Bryophyllum delagoensis Mother of millions	3	Generally in riparian ecosystems including REs 11.3.2, 11.3.4, 11.3.25.	Dense infestations of >50% groundcover recorded in REs 11.3.25 and 11.3.17 adjacent to Wilkie Creek and Braemar Creeks. Scattered infestations recorded on drainage lines throughout the SGP study area.
Eragrostis curvula African love grass**	N/A	Mostly non-remnant habitats, particularly roadside margins with sandy soils.	An aggressive coloniser that is most typically associated with roadside margins although extends into remnant woodland habitats in the vicinity of Dalby.

*As per Queensland's Biosecurity Act 2014 / Weed of National Significance; ** Priority plant in the Western Downs Regional Council Pest Management Plan 2011 – 2015.

4.3 TERRESTRIAL FAUNA RESULTS

Terrestrial fauna surveys for this work identified a total of 266 vertebrate species[5] within the SGP study area including 20 amphibians, 55 reptiles, 151 birds and 40 mammals (Appendix F). Based on available database sources and previous works, one species was recorded for the first time within the region of the SGP study area (i.e., the SGP and ~50km buffer), the Pink-tongue Lizard (*Cyclodomorphus gerrardii*). An investigation of previous records (WildNet) revealed three records east of Toowoomba, one due south of the SGP study area (located on the southern side of the Gore Highway) and two within Southwood National Park (approximately 85km west of the SGP study area).

A number of species recorded during the surveys are at, or near, their distributional limit including Green Tree Snake (*Dendrelaphis punctulata*), Cotton Pygmy-goose (*Nettapus coromandelianus*), Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*), Azure Kingfisher (*Ceyx azureus*), White-naped Honeyeater (*Melithreptus lunatus*), Scarlet Honeyeater (*Myzomela sanguinolenta*), Rufous Fantail (*Rhipidura rufifrons*), Broad-toed Feathertail Glider (*Acrobates frontalis*) and Yellow-footed Antechinus (*Antechinus flavipes*).

Other notable observations include two Amalosia geckos, which while most closely resembling *A. jacovae*, lacked the distinctive toe webbing diagnostic to the species. According to current knowledge, neither *A. rhombifera* or *A. jacovae* occur in the Miles region (Wilson 2015), and the captured individuals had a mix of both characteristics. Subject to further study, these individuals may be assigned to one of these two taxa, extending their current range, or prove to be a new undescribed taxon. One individual was submitted to the Queensland Museum.

Recent taxonomic work on *Carlia pectoralis* (Open-litter Rainbow Skink) found the species to be a composite of three distinct taxa (Hoskin and Couper 2012). Two of these newly described species, *C. rubigo* and *C. pectoralis*, have the potential to occur within the SGP study area. Our field studies assigned most individuals to *C. rubigo*, though several individuals matched the description of *C. pectoralis*. However numerous captured animals had a mix of characters and could not be assigned to either species.

Eleven of the 266 identified species (4%) are non-native introduced species (Table 4.9, Appendix F).

4.3.1 Likely Threatened Terrestrial Fauna Species

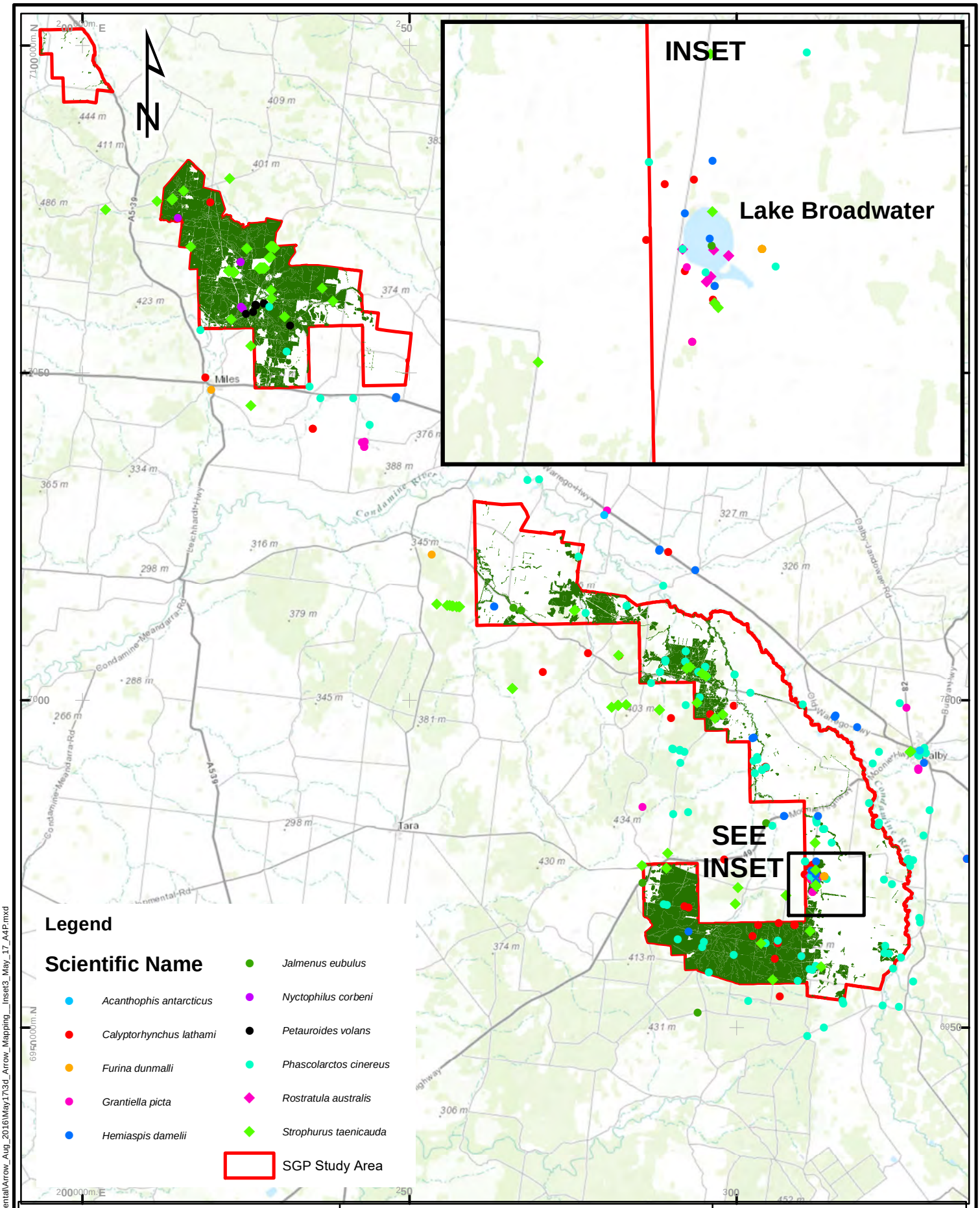
Database searches including the EPBC Act Online Protected Matters Search Tool have identified 39 threatened species as occurring, or potentially having habitat, within the SGP study area (Table 4.6). An assessment of these species based on record relevance and habitat suitability (see Appendix C) suggests 11 are present, or have potential to occur.

[5] Species totals discussed in this text do not include unidentified taxa (e.g., *Uperoleia* sp.), but do include recognisable taxa of taxonomic uncertainty (e.g., *Amalosia sp. cf. jacovae*).

Table 4.6. Likelihood assessment for Threatened fauna species in the SGP study area.

Scientific Name	Common Name	EPBC Status	NC Status	Likelihood
BUTTERFLIES				
Jalmenus eubulus	Pale Imperial Hairstreak	-	Vul	Likely
REPTILES				
Rheodytes leukops	Fitzroy River turtle	Vul	Vul	Unlikely
Elseya albagula	Southern snapping turtle	CEnd	End	Unlikely
Strophurus taenicauda	Golden-tailed Gecko	-	NT	Present
Delma torquata	Collared Delma	Vul	Vul	Unlikely
Anomalopus mackayi	Long-legged Worm-skink	Vul	End	Unlikely
Egernia rugosa	Yakka Skink	Vul	Vul	Unlikely
Tympanocryptis condaminensis	Condamine earless dragon	End	End	Unlikely
Aspidites ramsayi	Woma	-	NT	Unlikely
Acanthophis antarcticus	Common Death Adder	-	Vul	Possible
Furina dunmalli	Dunmall's Snake	Vul	Vul	Possible
Hemiaspis daemeli	Grey Snake	-	End	Present
Denisonia maculata	Ornamental Snake	Vul	Vul	Unlikely
BIRDS				
Botaurus poiciloptilus	Australasian Bittern	End	LC	Unlikely
Calidris ferruginea	Curlew Sandpiper	C End	End	Transient
Limosa lapponica baueri	Bar-tailed Godwit	Vul	Vul	Unlikely
Rostratula australis	Australian Painted Snipe	End	Vul	Possible
Pedionomus torquatus	Plains Wanderer	C End	Vul	Unlikely
Turnix melanogaster	Black-breasted Button-quail	Vul	Vul	Unlikely
Falco hypoleucos	Grey Falcon	-	Vul	Unlikely
Erythrotriorchis radiatus	Red Goshawk	Vul	End	Unlikely
Geophaps scripta scripta	Squatter Pigeon (southern)	Vul	Vul	Transient
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	Vul	Present
Lophochroa leadbeateri	Major Mitchell Cockatoo	-	Vul	Unlikely
Lathamus discolor	Swift Parrot	End	End	Unlikely
Ninox strenua	Powerful Owl	-	Vul	Unlikely
Grantiella picta	Painted Honeyeater	Vul	Vul	Possible
Anthochaera phrygia	Regent Honeyeater	C End	End	Unlikely
Poephila cincta cincta	Black-throated Finch	End	End	Unlikely
MAMMALS				
Dasyurus hallucatus	Northern Quoll	End	LC	Unlikely
Dasyurus maculata maculata	Spotted-tailed Quoll	End	Vul	Unlikely
Phascolarctos cinereus	Koala	Vul	Vul	Present
Petauroides volans	Greater Glider	Vul	Vul	Present
Petrogale penicillata	Brush-tailed Rock-wallaby	Vul	Vul	Unlikely
Pteropus poliocephalus	Grey-headed Flying-fox	Vul	LC	Unlikely
Macroderma gigas	Ghost Bat	Vul	End	Unlikely
Chalinolobus dwyeri	Large Pied Bat	Vul	Vul	Unlikely
Nyctophilus corbeni	South-eastern Long-eared Bat	Vul	Vul	Present
Pseudomys australis	Plains Rat	Vul	End	Unlikely

The of EVNT records detected during the current surveys are shown in Figure 4.12.



Vegetation_Management_Status

Remnant Vegetation

FIGURE 4.12 Survey records of EVNT fauna species from within the SGP Study Area Region

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Kilometers

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Many threatened species considered in the original SGP EIS (3d Environmental 2011) are no longer specially protected including Rough Collared Frog (*Cyclorana verrucosa*), Brigalow Scalyfoot (*Paradelma orientalis*), Grey Goshawk (*Accipiter novaehollandiae*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Square-tailed Kite (*Lophoictinia isura*), Black-chinned Honeyeater (*Melithreptus gularis*), Turquoise Parrot (*Neophema pulchella*), Cotton Pygmy-goose (*Nettapus coromandelianus*), and Little Pied Bat (*Chalinolobus picatus*).

Profiles for Threatened fauna considered to be possible, likely or present from the study area are provided in Appendix G. The profiles include the criteria used to develop individual species habitat maps in the associated GIS package, and an assessment of mapping accuracy. Table 4.7 shows the extent of habitat available to each species based on the GIS mapping product.

Table 4.7. The extent of mapped habitat for Threatened fauna species present or possibly occurring within the SGP study area.

Scientific Name **Common Name**	**Status**		**Habitat extent (ha) in SGP by region***			**Likelihood**
	EPBC	**NCA**	**CHK**	**CHP**	**GH**	
Jalmenus eubulus Pale Imperial Hairstreak	-	Vul	0	869.4	0	Likely
Strophurus taenicauda Golden-tailed Gecko	-	NT	7,160.3	74,649.4	1,341.5	Present
Acanthophis antarcticus Common Death Adder	-	Vul	69.81	72,052.9	1,550.6	Possible
Furina dunmalli Dumnall's Snake	Vul	Vul	297.9	71,463.1	6,504.8	Possible
Hemiaspis daemeli Grey Snake	-	End	939.6	9,280.7	44,189.4	Present
Rostratula australis Australian Painted Snipe	End	Vul	266.5	223.3	0	Possible
Calyptorhynchus lathami Glossy Black Cockatoo	-	Vul	5,165.3	1,852.8	35.1	Present
Grantiella picta Painted Honeyeater	Vul	Vul	696.5	863.6	359	Possible
Phascolarctos cinereus Koala	Vul	Vul	8,187.4	5,015.36	71,949.8	Present
Petauroides volans Greater Glider	Vul	Vul	324.7	3,413.8	1,914.1	Present
Nyctophilus corbeni South-eastern Long-eared Bat	Vul	Vul	3,531.4	55,836.2	26,146.0	Present

*CHN = Core Habitat Known, CHP = Core Habitat Possible and GH = General Habitat

4.3.2 Migratory Fauna Species

Three Migratory species, listed under the EPBC Act, were recorded during the 2016-17 SGP surveys (Table 4.8). Other species have been historically recorded within the SGP study area, predominantly from Lake Broadwater (Figure 4.13) which is likely to be significant habitat for Migratory taxa. A discussion on the likelihood of each species occurring in the SGP study area over Life of Operation (approximately 25 years) is also provided in Table 4.8.

Table 4.8. Migratory species recorded within the SGP study area

Scientific Name Common Name	ESE 2016-17	DB Recs	Discussion
Gallinago hardwickii Latham's Snipe		X	The Latham's Snipe frequents Lake Broadwater, with only on other record restricted to a small dam in the southern region of the SGP study area. While it has potential to occur throughout the SGP study area on suitable dams, swamps and flooded paddocks, best habitat is largely limited to Lake Broadwater and Long Swamp. These two locations should be considered 'Important Habitat' as defined in Department of Environment, Water, Heritage and Arts 2009).
Limosa lapponica Bar-tailed Godwit		X	The Bar-tailed Godwit has been recorded twice from Lake Broadwater in 1985 and 1987. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Limosa limosa Black-tailed Godwit		X	The Black-tailed Godwit has been recorded once from Lake Broadwater in 1995. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Numenius phaeopus Whimbrel		X	The Whimbrel has been recorded only once from Lake Broadwater in 1990. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Tringa nebularia Common Greenshank		X	Common Greenshank is only known at Lake Broadwater where the most recent observation occurred in 2007. It is a vagrant which has a very low probability of occurring within the SGP study area during Life of Operation. The only area of suitable habitat occurs at Lake Broadwater.
Calidris ferruginea Curlew Sandpiper		X	The Curlew Sandpiper has been recorded on seven occasions within the SGP study area, all but one at Lake Broadwater. The most recent record (2007) is from an artificial dam approximately 6.5km SSE of Lake Broadwater. All other records predate 1995. It is likely the species will appear at Lake Broadwater during SGP operations, but is unlikely elsewhere. These vagrant individuals will not represent a significant population.
Plegadis falcinellus Glossy Ibis		X	The Glossy Ibis has been frequently recorded at Lake Broadwater. Lake Broadwater and Long Swamp represent the best areas of habitat within the SGP study area, and at these locations the species is expected to occur over Life of Operation. Alternative habitat is scarce, but the species could possibly occur in other wetlands or flooded paddocks.
Tringa stagnatilis Marsh Sandpiper		X	Marsh Sandpipers have been recorded semi-frequently at Lake Broadwater where it was last observed in 2007. It is possible this species could occur within Lake Broadwater during Life of Operation, but is unlikely to occur elsewhere due to lack of suitable habitat.

Scientific Name Common Name	ESE 2016-17	DB Recs	Discussion
Myiagra cyanoleuca Satin Flycatcher		X	A single Satin Flycatcher has been recorded within the central region of the SGP study area in 1997. It is a vagrant species and is unlikely to occur over Life of Operation.
Calidris acuminata Sharp-tailed Sandpiper		X	Sharp-tailed Sandpipers are recorded semi-frequently at Lake Broadwater where it was last observed in 2009. This species could occur at Lake Broadwater or possible Long Swamp during Life of Operation. While habitat elsewhere is limited, there is some potential for the species to occur in smaller farm dams, wetlands and flooded paddocks.
Tringa glareola Wood Sandpiper		X	The Wood Sandpiper has been recorded once from Lake Broadwater in 1995. It is a vagrant species that is unlikely to occur during Life of Operation or away from the Lake.
Gelochelidon nilotica Gull-billed Tern		X	Gull-billed Terns have been recorded on only nine occasions within the SGP study area, most recently in 2013. In all but two occasions the species has been recorded at Lake Broadwater. There is some possibility the species could sporadically appear on isolated waterbodies, but on balance it is only likely to occur infrequently at Lake Broadwater.
Chlidonias leucopterus White-winged Black Tern		X	The White-winged Black Tern has been recorded once from Lake Broadwater in 1995. It is a vagrant species that is unlikely to occur during Life of Operation or away from either Lake Broadwater or Long Swamp. It typically only occurs around larger waterbodies, wetlands or swamps.
Hirundapus caudacutus White-throated Needletail	X	X	Recorded at seven separate locations during the 2016-17 ESE surveys, all within the central region. These records represent large foraging flocks moving across the region. Records are also present in databases. Being aerial in nature, this species can occur over both natural and modified landscapes (including urban cities), though large stands of forest may be important for roosting. The species is likely to frequently occur throughout the SGP study area.
Apus pacificus For-tailed Swift	X	X	Recorded at fourteen separate locations during the 2016-17 ESE surveys. Known from an additional 14 records in databases. Strictly aerial in nature, they can occur over modified landscapes (including tilled crops and urbanisation) though large tracts of woodland may be a key habitat requirement (Department of Environment 2015). They will occur throughout the SGP study area.
Rhipidura rufifrons Rufous Fantail	X	X	Recorded at four locations during the current surveys, all within or adjacent Dalby State Forest. The species has also been recorded at six other locations in databases, also only within the southern region of the SGP study area. Habitats within the SGP study area are marginal, the species prefers rainforest or wet sclerophyll forests. These records approximate the limit of the species western extent (only four records further west, all <100km of the SGP study area), and therefore their populations could be considered 'Important' as defined under the MNES impact assessment guidelines (Department of Environment 2013).

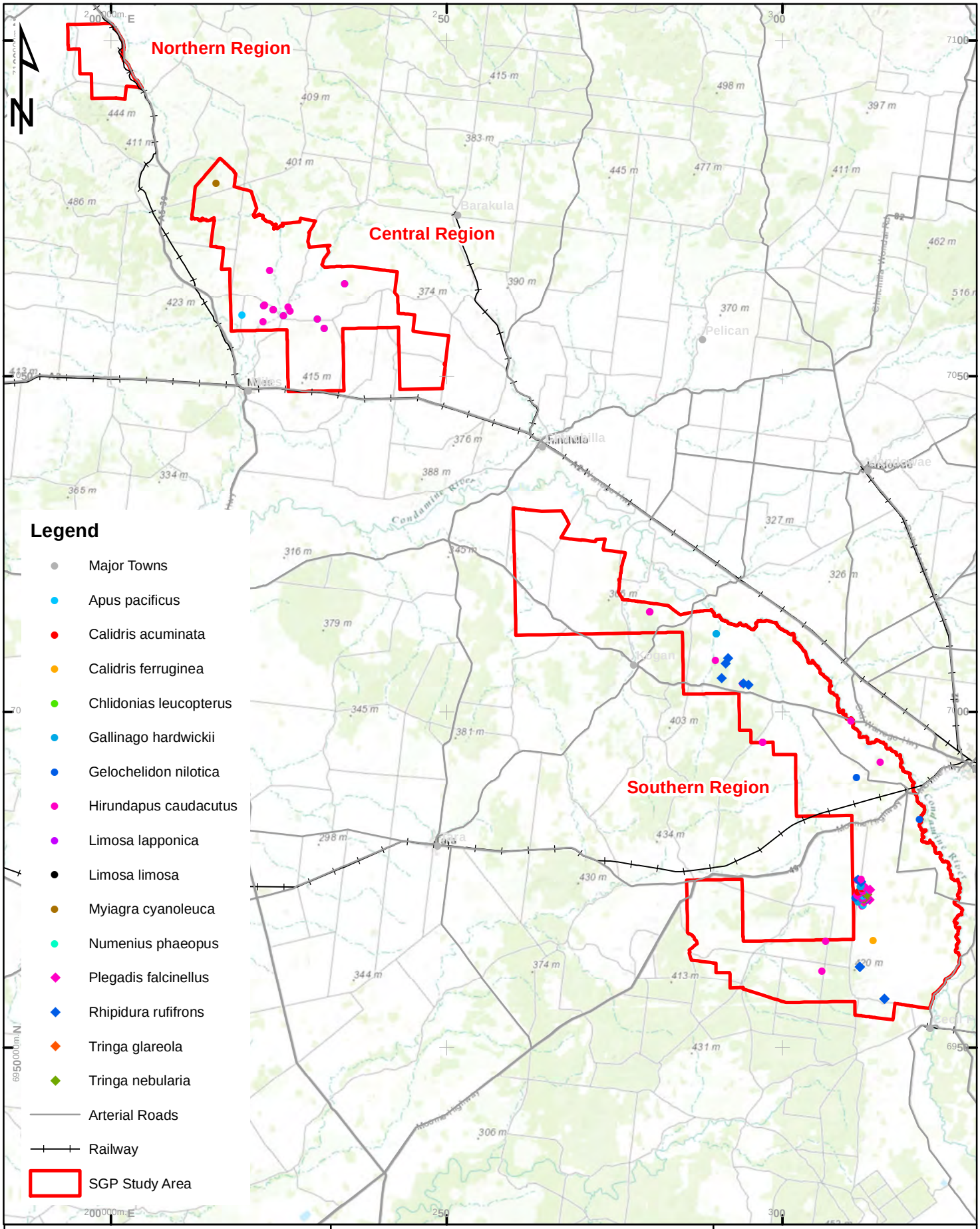

FIGURE 4.13 Migratory species records within the SGP Study Area

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0 12 24 36 48
Kilometers

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4.3.3 Exotic Pest Species

Feral pest species known to occur within the SGP study area are discussed in Table 4.9.

Table 4.9. Exotic pest species known from the SGP study area

Scientific Name Common Name	Recorded during ESE surveys	Discussion
Sus scrofa Feral Pig	Y	While only a handful of individuals were observed, feral pig evidence was commonly encountered. Evidence of pig activity was at its highest in locations with water or damp soils (e.g., creeklines and gullies), particularly in the larger tracks of forest. They are likely to be throughout the SGP study area. Predation, habitat destruction, competition and disease transmission by Feral Pigs is a Key Threatening Process under the EPBC Act.
Rhinella marina Cane Toad	Y	Cane Toads are common in the northern portion of the SGP study area, being frequently recorded north of the Dalby-Kogan Rd. South of this road they become increasingly less abundant, only one individual was recorded south of the Moonie Highway. A similar pattern is apparent in database records. The biological effects, including lethal toxic ingestion, caused by Cane Toads is a Key Threatening Process under the EPBC Act.
Canus lupus familiaris/dingo Dog/dingo	Y	Dogs/dingos and their signs were frequently observed during the survey and the species is likely to be widespread throughout the SGP study area. Highest densities may occur within larger tracts of vegetation away from grazing land where they are more likely to be actively hunted and controlled.
Felis catus Feral Cat	Y	Feral Cats were noted at 12 locations during the surveys and will be abundant and widespread within the SGP study area. Feral Cats pose a significant threat to biodiversity and predation by Feral Cats is a Key Threatening Process under the EPBC Act.
Oryctolagus cuniculus European Rabbit	Y	Rabbits are uncommon within the SGP study area. They were recorded four times during these surveys, and have only been recorded at two other locations within databases.
Lepus europeaus Brown Hare	N	Brown Hares are infrequently encountered within the SGP study area. Individuals were observed on only two occasions during these surveys, and the species has been recorded only eight times within the SGP study area in other databases.
Sturnus vulgaris Common Starling	N	Common Starlings are abundant in modified land along the Condamine River. They are largely absent from the heavily wooded areas covering most of the SGP study area.
Sturnus tristis Common Myna	Y	Within the SGP study area Common Mynas have a similar distribution to Common Starlings, being abundant in modified lands along the Condamine River and rare elsewhere.
Columba livia Rock Dove	Y	Rock Doves have not been frequently recorded within the SGP study area. They are usually more abundant around larger urban centres, but can be found in surrounding farmlands. They have only been noted from the southern region of the SGP study area, and in most cases in modified land along the Condamine River.

Scientific Name Common Name	Recorded during ESE surveys	Discussion
Mus musculus House Mouse	Y	House Mice have been recorded throughout the SGP study area. While they are likely to be most abundant in modified agricultural areas and adjacent remnant vegetation, they can occur from within large tracts of native vegetation.
Streptopelia chinensis Spotted Dove	N	Rare recorded from the SGP study area; all historic records (4) noted from Lake Broadwater between 2003 and 2009.
Rattus rattus Black Rat	N	Likely to be more abundant than suggested by the few database records. Likely to be largely restricted to around human dwellings and occupied centres.
Vulpes vulpes Red Fox	Y	Records of the Red Fox are restricted to the southern region of the SGP study area where grazing land is widespread. While they will have lower abundance in large continuous tracts of vegetation, they are likely to occur throughout the SGP study area. Red Foxes pose a significant threat to biodiversity and predation by European Red Fox is a listed Threatened Process under the EPBC Act.
Passer domesticus House Sparrow	N	House Sparrows will be largely restricted to urban towns. Currently they occur infrequently in the SGP study area, and are most likely to turn up in the southern region along the Condamine River where large-scale land clearing has occurred.
Unidentified Deer Species	Y	An unidentified species of deer was briefly observed during the March surveys north of Kogan. While unmistakably a deer, the species could not be identified. This is the first deer record within the region (i.e., SGP study area + 50km buffer).

5.0 HABITAT CONDITION

5.1 CONDITION OF WETLANDS INCLUDING LONG SWAMP

A relatively complex system of floodplain wetlands occurs in the southern region of the SGP study area, generally associated with sinuous overflows of the Condamine River and its larger tributaries. The southern region also contains Lake Broadwater, a seasonal water feature that is recognised nationally for its natural values, being significant at a national and state level. The lake is listed on the Directory of Important Wetlands and is recognised as being a rare example of a semi-permanent freshwater lake in the bioregional area (Blackman *et al*. 1999, EHP 2006) The Lake is fringed by an open forest of River Red Gum (*Eucalyptus camaldulensis*) (RE 11.3.27d) which is broadest (approx. 200m) around the north-eastern portion of the lake. Habitats surrounding the lake are generally in good condition.

The numerous flood plain wetlands are almost universally heavily infested with Lippia (*Phyla canescens*) during seasonal drying periods. This severely limits the ability of native aquatic species to re-colonise these areas during wetter, more favourable seasons.

Long Swamp is a sinuous hydrological feature (overland flow path) that flows across the Condamine Alluvium in a north-westerly direction to the east and north of Lake Broadwater, before joining with Wilkie Creek to the west. The feature occupies a broad depression on the alluvium with the central portion of the depression formed by heavy clay. Surface water is present seasonally and following dry spells the associated vertosol soils form deep hummocks and cracks. There was no flow, nor any significant pooled water within Long swamp during the field visits, despite heavy recent rains. These observations together with the observations of deep, open cracks in the central swamp channel soil surface confirmed that the feature is only active during significant flooding.

At Long Swamp the vegetation is predominantly native, although exotic groundcovers predominant in some localities. The canopy is formed by tall, broadly spaced River Red Gum (*Eucalyptus camaldulensis*) at approximately 15 - 30% cover with Poplar Box (*Eucalyptus populnea*) forming on the swampy margins. The canopy is significantly stressed in some areas with signs of senescence and foliage loss. The noted senescence is possibly due to historic groundwater drawdown for irrigation (Kath *et al.* 2014; 3d Environmental, 2017) although may have been further compounded by surface water extraction.

Four secondary vegetation survey sites were completed within Long Swamp during the dry season survey (DS21, DS22, DS26, DS31 completed when the swamp was dry). At these locations exotic vegetation cover contributed an average of 15% to the total groundcover, and formed 39% of the total living groundcover. Common native species included Nardoo (*Marsilea drummondii*), Water Chestnut (*Eleocharis dulcis*) and scattered native grasses including *Panicum decompositum*. Lippia (*Phylla canescens*) was the most abundant exotic forb blanketing the clay soils, particularly where grazing pressure is most intense. It should be noted that groundcover composition will vary seasonally with native aquatic sedges, particularly Water Chestnut, becoming dominant during periods of standing surface water.

Photo 2. Long Swamp with characteristic Red Gum showing moderates signs of stress as suggested by foliage loss.

5.2 General Habitat Condition

The SGP study area incorporates a number of landscapes, ranging from the broad river flood plains centred on the Condamine River and its associated tributaries, rolling hills on fine grained sedimentary rocks in the Wandoan (northern) area, rangeland woodlands formed on skeletal rocky soils, and ironstone jump ups and extensive tracts of ironbark dominant woodland associated with older Tertiary / Cainozoic plains. The impacts of land use vary across the landscape dependant largely on the fertility of the underlying substrate.

The productivity of the alluvial clay soils on the Condamine River floodplain, collectively referred to as the Condamine River Alluvium (CRA), has resulted in heavy utilisation of these areas for agricultural purposes, predominantly tilled cropping. Floodplain vegetation is generally restricted to the immediate river channel and associated flood pockets, with scattered areas on crown or council owned land and as isolated fragments adjacent to floodplain overflows and swamps. Long-term abstraction of groundwater associated with the CRA, has lowered groundwater levels by up to 25m in some localities (Kath *et. al.* 2014). It is understood that Arrow is currently investigating the presence and connectivity of perched aquifers and deeper aquifers in this area. The loss of water from the rooting zone of deeper rooted species such as River Red Gum (*Eucalyptus camaldulensis*) and Poplar Box (*Eucalyptus populnea*) has resulted in severe loss of canopy vigour and dieback in some localities. It is expected that based on

historic groundwater levels (take from Arrow well baseline assessments), maximum tree rooting depth would not have exceeded 15m across the dominant portion of the CRA. The reduction of canopy vigour has resulted in increased light penetration, coupled with the impact of grazing, which has resulted in pervasive displacement of native groundcovers by exotic species such as Green Panic (*Megathyrsus maximum var. trichoglume*) and Lippia (*Phylla canescens*).

Brigalow communities (RE 11.3.1, RE 11.4.3 and RE 11.9.5) and Brigalow/Eucalypt associations (RE 11.3.17) have been cleared to the margins of adjacent vegetation types and generally exist as small unviable remnants, slivers along the margins of riparian forest types, or as secondary forests with limited structural complexity or floristic diversity. Native ground covers, although naturally sparse in these communities are often displaced by exotic species including Prickly Pear (*Opuntia stricta*), Mother of Millions (*Bryophyllum delagoense*) and Harrisia Cactus (*Harrisia martinii*). Dense infestations of velvet tree pear are typical in brigalow habitats forming up to 20% cover in the taller shrub layer of many occurrences. Despite their extent, brigalow patches can still have significant value for several threatened fauna species including the Pale Imperial Hairstreak (*Jalmenus eubulus*) and Painted Honeyeater (*Grantiella picta*).

Although ecosystem types on soils of low fertility, typically those REs associated with land zones 5 and 7, form the largest and most continuous tracts of vegetation in the study area, these ecosystems have invariably been heavily utilised for their timber resources with varying degrees of impact. In particular, habitats dominated by the Narrow-leaf Ironbark species *Eucalyptus crebra, E. elegans* and *E. woollsiana* (RE 11.5.1, 11.5.4, 11.7.4 and 11.5.20) have been logged to a degree that all mature canopy trees have been removed. The remaining vegetation comprises of secondary growth with a thickened shrub layer forming the canopy. Examination of 1981 aerial photography for the SGP study area demonstrates closely spaced rip-lines through large areas of remnant vegetation indicating the intensity of historical timber extraction practices.

The impact of logging is also evident in the majority of state forests within the SGP study area including Braemar SF, Kumbarilla SF to the west of Dalby and Barakula SF to the north of Chinchilla. However from general observation these logging regimes have been less severe than those applied on freehold land.

A number of ecosystems appear more resilient to landscape-wide processes of degradation. In particular *Eucalyptus fibrosa subsp. nubila* forest communities (RE11.7.7) have, in general, a better-preserved canopy structure, a greater number of mature canopy trees, and fewer large canopy gaps. This preservation is likely to be due to the quality and usefulness of the timber resource rather than an inherent ability to recover from disturbance.

While, on balance, the State Forests have retained greater conservation value than vegetation on freehold land, the future of these areas may be affected by changes to fire regime. Within the last 10 years, three extremely hot fires have affected large expanses of State Forest within the SGP study area, and in the case of Kumbarilla State Forest on more than one occasion (see Section 2.4). These hot fires can cause significant damage to the canopy and vegetation composition (by removing fire-sensitive species). It is likely the vegetation will take many decades to fully recovery after a significant wildfire. The frequency and intensity of wildfires are predicted to increase due to climate change (Williams *et al.* 2001), possibly leading to possible broad-scale vegetation changes.

In the northern portion of the SGP study area surrounding Wandoan, the arable clay soils and favourable nature of the gently undulating landscape has promoted widespread land clearing for an intensive cattle grazing land use. Only scattered vestiges of remnant vegetation remain including degraded patches of brigalow and riparian remnants adjacent to drainage lines. These patches have invariably suffered from canopy disturbance and invasion of exotic groundcovers, most notably Buffel Grass (*Cenchrus ciliaris*) and Green Panic (*Megathyrsus maximus var. trichoglume*).

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Appendix A.
GIS Package Contents

Contents of the associated Geodatabase package are outlined in the below table.

Geodatabase Dataset	Contents	Notes
Vegetation		
Arrow_Vegetation	RE mapping, TEC mapping and Threatened species habitat mapping (Core Habitat Possible, General Habitat).	Primary vegetation mapping database which identifies vegetation type in terms of Regional Ecosystem, Threatened Ecological Community and Conservation Status under relevant state and federal legislation. Provides the basis for mapping of EVNT fauna habitats based on vegetation type.
Core Habitat		
Core_Habitat_Flora	Core Habitat Known for all possible, likely or Present flora species	Overlaps the Threatened species mapping in Arrow_Vegetation dataset but takes priority.
Core_Habitat_Fauna	Core Habitat Known for all possible, likely or Present fauna species	Overlaps the Threatened species mapping in Arrow_Vegetation dataset but takes priority.
Ecological Survey Sites		
Flora_Survey_Sites	Compilation of all Secondary, Tertiary, Quaternary and Observation sites collected in floristic ecology surveys commissioned by Arrow Energy since 2009.	Included records from Surat Gas Pipeline Assessments, EIS and Supplementary EIS assessments as well as survey points from the recent 2016 – 2017 surveys.
ESE_Survey_Sites	Location of fauna survey methods completed during current surveys (2016-17)	SGP advanced exploration project works
Daandine_Trapping_Surveys	Location of fauna survey methods completed during Daandine fauna assessments (2014)	Ecosmart Ecology 2014.
SREIS_Trapping _Surveys	Location of fauna survey methods completed during Surat Gas Project supplementary EIS (2013).	3D Environmental (2013)
EVNT_Flora_and_Fauna_Field_Records		
EVNT_Fauna_Field_Records	Terrestrial fauna survey results collected during the current work	Error vetted. Includes geo-referenced sightings and opportunistic records without coordinates. Where opportunistic records have been recorded without specific dates the first day of the survey has been attributed.

Geodatabase Dataset	Contents	Notes
EVNT_Flora_Field_Records	Terrestrial flora survey results for both recent and historical collections in the SGP study area.	Includes EVNT records for all Arrow commissioned survey works from 2009 onwards plus Queensland Herbarium records within the SGP study area.
Herbrecs_SGP_25km_Buffer	Queensland Herbarium database records for EVNT flora species recorded within a 25+km buffer surrounding the SGP assessment area	Queensland Herbarium records within both the SGP and adjacent areas.
Additional Datasets		
ESE+DB_Recs_SGP	All coordinate based fauna records from both database sources and this work within the SGP.	No error vetting and duplicate records likely. Includes only geo-references sightings
SGP_EVNT_Recs	All known Threatened fauna species records within the SGP + 10km buffer	

Appendix B.
Fauna Survey Effort Compared to EPBC Survey Guidelines

The table below details the recommended survey effort for EPBC threatened taxa compared to survey effort achieved during this work. Note that the recommended EPBC survey effort is based on small project sites.

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
Delma torquata Collared Delma	Late spring/ summer	Primarily hand searches.	primary	No documented species-specific survey effort. Large survey areas (> 50ha) must include sampling of distinct vegetation types and provide good spatial coverage. Documentation must include justification of survey effort.				10,12, 13,16, 25	32,771	N/A	122.75 hrs
		Pitfall traps	supp								1276 trap nights
Anomalopus mackayi	Late spring/ summer	Active search (when possible)	primary					30	0	N/A	125.25 hrs
		Pitfall traps	primary								1,276 trap nights
		Artificial shelter	primary								Nine shelters
Tympanocryptis condamiensis Condamine Earless Dragon	Late spring/ summer	Pitfall traps	primary					30	0	N/A	1,276 trap nights
Furina dunmalli Dunmall's Snake	Late spring/ summer	Active search	primary					10,12, 13,16, 17,18, 25,30, 34	76,351	N/A	122.75 hrs
	Late spring/ summer	Pitfall traps	primary								1276 trap nights
	Late spring/ summer	Road driving	supp								48 hrs
Anthochaera phrygia Regent Honeyeater	Breeding season	Area search	primary	20hrs	10 days	< 50ha		13,16, 17,18, 34	15,239	6,095hrs	106 hrs bird survey + 1038 hrs site traverse
	Peak flowering	Targeted searches	primary	20hrs	10 days	-				6,095hrs	NIL
Grantiella picta Painted Honeyeater	No survey guidelines							25	176	N/A	106 hrs bird survey + 1038 hrs site traverse
Rostrulata australis Australian Painted Snipe	-	Transect/ area search	primary	10 hrs	3 days	< 50ha		34	1,233	147hrs	106 hrs bird survey + 1038 hrs site traverse (NIL in suitable habitat)

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
	-	Targeted stationary watches	suppl	10 hrs	5 days	< 50ha				147hrs	NIL
Geophaps scripta scripta Squatter Pigeon	-	Transect/ area search	primary	15hrs	3 days	< 50ha		10,12, 13,16, 17,18, 25,29, 30,34	35,660	1,548hrs	106 hrs bird survey
	-	Flush survey	primary	10hrs	3 days	< 50ha				7,132hrs	1038 hrs site traverse
Petauroides volans Greater Glider	No survey guidelines							13,16, 17,18, 34	52,239	N/A	139.75 hrs foot-based + 27.08 hrs vehicle-based spotlight
Phascolarctos cinereus Koala	-	Indirect signs (scratch/ scat).	primary	No specific survey effort documented. Surveys must undertaken to 'maximise the chance of detection'				13,16, 17,18, 34	52,239	N/A	122.75 hrs active search + 111 SAT searches
	Aug-Jan	direct observation (search/ spotlight)	supp								139.75 hrs foot-based + 27.08 hrs vehicle-based spotlight
Nyctophilus corbeni South-eastern Long-eared Bat	Not cold nights	Harp nets	primary	20 nights	>=5 nights	< 50ha	Mutually exclusive (i.e., don't need both harp *and* mist nets)	10,12, 13,16, 17,18, 25	75,118	30,047 trap nights	164 trap nights
	Not cold nights	Mist nest	primary	20 nights	>=5 nights	< 50ha					NIL
Chalinolobus dwyeri Large Pied Bat	Not cold nights	Unattended Anabat	primary	16 nights	4 nights	< 50ha		10,12, 13,16, 17,18, 25	75,118	24,038 nights	69 Anabat nights
	Not cold nights	Attended Anabat	primary	6 hrs	3 nights	< 50ha				9,014hrs	NIL
	Not cold nights	harp	supplementary	16 nights	4 nights	< 50ha	Useful near possible roosts			24,038 trap nights	164 trap nights
Dasyurus maculata Spotted-tailed Quoll	-	Active searches	primary	2hrs	1 day	5ha	Recommendation for	10,12, 13,20	28,674	11,469hrs	122.75 hrs active search

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
	-	Hair-tubes	primary	40 tubes	14 nights	5ha	small sites. No guideline for larger sites			3,211,488 trap nights	NIL
	-	Camera trap	primary	10 nights	14 nights	1ha				4,014,360 trap nights	460 camera nights

Appendix C. Threatened Species Likelihood Assessments

The table below lists flora and fauna species that either known from within 50 km of the SGP or have been identified in the EPBC online Protected Matters search. The Likelihood assessment has been based on the SGP having a Life of Operation of approximately 25 years. Mobile fauna species which could occur within the SGP over this timeframe, but are unlikely to represent a permanent population or a population relying on the SGP for its long-term viability (vagrants) are assessed as 'Transient'.

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
FLORA						
Philotheca sporadica Kogan Waxflower	NT	Vul	Based on field survey observation, the species is universally restricted to open scalds and low *Eucalyptus exserta* dominant woodlands associated with RE11.7.4.	The extent of habitat including known, core habitat possible and general habitat has been provided within the attached GIS package	There are 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 extent of known populations and habitat has been expanded considerably as a result of the current assessment.	Present
Acacia barakulensis Waaje Wattle	Vul	-	HERBRECS specimen records indicate species is associated with woodland and shrubland habitats formed by *Eucalyptus tenuipes, Corymbia trachyphloia, Calytrix gurulmundensis, and Triodia mitchellii.* Habitat is consistent with RE 11.7.4, 11.7.5, 11.7.6, and 11.7.7.	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Herbrecs identifies 5 confirmed populations 28 km to the north-east of the SGP study area within Barakula State Forest.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Acacia curranii Curly Bark Wattle	Vul	Vul	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 (Pickard 1995c).	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Sixteen local populations are recorded in Herbrecs with the nearest population 11 km west of the SGP study area with Gurulmundi State Forest (excluding low precision records).	Possible
Acacia handonis Hando ‘s Wattle	Vul	Vul	Hando’s wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest. 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). This is consistent with RE11.7.7	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Seventeen local populations are recorded in Herbrecs with the nearest population 35 km east of the SGP study area within Barakula SF (54 km west-north-west of Miles)	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Callitris bayleyii Bailey's Callitris	NT	-	A 3D Environmental survey record associated with the Surat EIS (3D Environmental 2011) confirms its presence in low open forest (11-15m) of *Eucalyptus exserta, E. crebra* and *Callitris glaucophylla* with a mid-dense shrubby understorey dominated by *Micromyrtus sessilis with Acacia crassa, Alphitonia excelsa,* and *Petalostigma pubescens*. Habitat typical of RE11.7.4	Extensive tracts of suitable habitat occur in the central portion of the SGP area. The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package.	Nearest local record is 2.6 km west of the SGP study area (40 km north of Miles) in Gurulmundi State Forest.	Possible
Calytrix gurulmundensis Gurulmundi Fringe Myrtle	Vul	Vul	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 RE 11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks).	Suitable habitats include patches of RE11.7.5 and RE11.7.4 in to the west and north-west of the central assessment area. The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package.	Nearest local record is 12 km west of the SGP study area (30 km north of Miles) within Gurulmundi State Forest. A population also exists in Waaje Scientific Reserve 36 km east of Wandoan.	Possible
Micromyrtus carinata	E	-	Herbrecs records indicate suitable habitat in heathland and low woodland typical of REs 11.7.4 and 11.7.5.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Nearest Herbarium Record is 10km north-west of Miles and 4 km west of the SGP study area on the Wyona Property.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Eucalyptus curtisii Plunkett Mallee	NT	-	Lateritic sandstone and sandstone rises/ridges and slopes often with *Eucalyptus exserta, E. fibrosa* subsp. *nubila, Corymbia trachyphloia,* and *Callitris glaucophylla*. Typical habitats include RE11.7.7, 11.7.5 and 11.7.5.	Has potential to occur throughout the SGP study area in suitable habitats. Estimated extent of suitable habitat within the SGP provided in GIS package.	Numerous local records mostly west of the SGP study area with the nearest record 2.5 km west of the SGP study area and 35km north of Miles	Possible
Acacia lauta Tara Wattle	Vul	Vul	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 (TSSC 2008o).	Populations are localised to the area surrounding Tara and Inglewood. Due to a lack of survey record following comprehensive survey, this species is considered unlikely to occur.	Nearest record is 20km west of the Kumbarilla State Forest in the vicinity of Tara (64 km west of Dalby).	Unlikely
Acacia wardellii	NT	-	The species inhabits gravelly soils on shallow weathered sandstone in eucalypt woodland (Pedley, 1978). Herbrecs data (EHP 2013) indicates typical habitats including RE 11.7.4, RE 11.7.7 and RE 11.7.5.	Potential habitats include REs 11.7.4 and 11.7.7 to in the vicinity of Kogan although extensive ground survey in this locality suggest a new population within the SGP is unlikely.	Three populations recorded all approximately 16 km west of the SGP study area and 25 km west of Chinchilla. Greater than 30km west of the nearest suitable habitat near Kogan.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Cadellia pentastylis Ooline	Vul	Vul	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) and also residual trees in cleared paddocks. Substrates include clay plains, sandstone and residual ridges (Eddie 2007).	Although Ooline occupies a range of substrates, local records are located in sandstone ravines in Gurulmundi State Forest. There are no known similar habitats in the SGP study area.	Nearest local record is 23 km west of the SGP study area and 50 km NE of Miles, No other local records.	Unlikely
Denhamia parviflora Small-leaved Denhamia	Vul	Vul	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).	Suitable habitat and substrate within the assessment area is extremely limited.	2 pre-1985 records located to the east of Chinchilla, approximately 20 km east of the SGP study area.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Eucalyptus argophloia Chinchilla white gum	Vul	Vul	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.	Suitable red high fertility loamy substrates have not been identified in the assessment area.	Nine records located east of the SGP study area with the nearest population 25 km from the SGP boundary and 18 km north-west of Chinchilla	Unlikely
Eucalyptus virens Shiny-leaved Ironbark	Vul	Vul	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.	Suitable habitat present although extensive field survey did not identify any new populations.	Extremely localised population with 2 records from the vicinity of Tara, 9 km west of the SGP study area (64 km west of Dalby).	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Digitaria porrecta Finger Panic Grass	NT	-	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; 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.	The most suitable habitats are associated with derived grassland habitats, typically associated with roadside easements between Chinchilla and Cecil Plains.	Two records within the SGP study area , both in non-remnant derived grasslands adjacent to roadside easements between Dalby and Cecil Plains. Both records collected in 1995. A further 15 records within 25 km east of the SGP study area boundary.	Present
Fimbristylis vagans	E	-	A sedge to 80cm tall that that fringes ephemeral watercourses and lagoons on alluvium.	A large number of potential habitats associated with swamps and drainage lines.	A single record from the SGP study area associated with the swampy inlet of Lake Broadwater. Has not been recorded or collected since 1984.	Present
Homopholis belsonii	E	V	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 is most likely to be associated with RE11.3.1, 11.3.17, 11.4.3, 11.9.5, 11.9.10.	Regional ecosystems associated with heavy clay, typically brigalow. Scattered remnants of REs 11.3.1, 11.3.17, 11.4.3, 11.9.5, 11.9.10 occur throughout the SGP EIS Area.	A considerable number of records to the east of Dalby with the nearest 12 km from the eastern boundary of the SGP study area. Two records within 8 km of the boundary of the northern study region within 10 km of Wandoan.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Cyperus clarus	V	-	Known from heavy soils with records from remnant and disturbed *Eucalyptus orgadophila* woodland on basaltic soils and grassland on heavy alluvium.	Limited suitable remnant habitat in the assessment area and the species is not known to be associated with non-remnant habitats.	A single 1995 herbarium record exists in the Jandowae area, 18 km east of the SGP study area and 25 km north of Dalby.	Unlikely
Solanum papaverifolium	E	-	Occurs in wetter (swampy) areas of grasslands or open eucalypt woodland on heavy alluvial soils (Goodland 2000). The species is often recorded in non-remnant habitat.	Suitable habitat occurs within derived grassland and associated woodlands typically associated with roadside reserves.	Two records contained within the SGP study area to the south of Dalby with an large number of herbarium records to the east of the SGP study area between Chinchilla and Dalby.	Present
Cymbonotus maidenii	E	-	The species is associated with a range of remnant and non-remnant habits with records occurring on disturbed roadside drains, native and derived grasslands. It is typically associated with heavy brown to grey cracking clay soils (Holland & Funk 2006).	Suitable habitat occurs within derived grassland habitats to the south of Dalby.	Five Herbrecs specimens recorded within 10 m of the eastern boundary of the SGP study area, mostly in the Cecil Plains / Millmerran Area including collections on road reserves on the Cecil Plains - Millmerran Road.	Possible
Picris barbarorum	V	-	Known from native grassland (12.3.21) of Dichanthium sericeum in stock routes, road reserves adjacent to disturbed areas such as cultivated paddocks and road and rail lines on black clay soil.	Potential habitat associated with derived grassland in road reserves to the north and south of Dalby.	Four herbarium records within 5km of the SGP study area with the nearest less than 2 km from the assessment area boundary, 14km north-west of Dalby.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Rutidosis lanata	NT	-	Mainly found in roadside vegetation of Acacia and Eucalypt woodland/open forest on red sandy ridges and clay flats between 280-320m altitude adjacent to cleared or partly cleared grazing and cropping land (DNR 2000).	Most likely to be recorded within REs 11.3.4, 11.3.2 and 11.3.3 in the vicinity of Chinchilla although may occur in these habitats throughout the entire project area.	Eight Herbarium records within 20 km from the SGP study area, all recorded in the Miles / Chinchilla area.	Possible
Solanum stenopterum	V	-	Occurs in disturbed grassland, *Casuarina cristata* forest or *Eucalyptus populnea* woodland on clay soils (Bean 2004).	Derived grassland, Brigalow and grassy woodlands of *Eucalyptus populnea* between Dalby and Cecil Plains.	Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5 km east of Cecil Plains in a roadside gravel pit; and approximately 6 km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2). All herbarium records outside SGP study area.	Possible
Xerothamnella herbacea	E	E	Occurs in remnant and disturbed brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) dominated communities in shaded situations, often in leaf litter (TSSC 2008n).	Numerous brigalow habitats (RE11.3.1, 11.4.3, 11.9.5), both remnant and disturbed have potential to host this species.	Two herbarium records to within 20km of the SGP Boundary, 20km to the east and north of Chincilla.	Possible
Cryptandra ciliata	NT	-	Suitable habitat in eucalypt dominated woodland, lancewood (Acacia shirleyi) woodland and Triodia grassland on rocky on low lateritic and sandstone ridges. Habitat in the PDA is consistent with RE 11.7.5, 11.7.4, 11.7.6, 11.5.1, 11.5.4, 11.5.21.	Woodlands in the Chinchilla / Miles region in the Central assessment area provide for potential habitat for the species.	Three herbarium records within 5km of the assessment area boundary with a single record within 1km of the eastern boundary, 30km to the north of Miles.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Pomaderris coomingalensis	E	-	Occurs in Eucalyptus and Callitris woodland in shallow sandy soil or Eucalyptus woodland on hard sandstone jump ups. Herbarium records (DERM 2011) include woodland of narrow leaved ironbark (*Eucalyptus crebra*) and *E. fibrosa subsp nubila*.	Extensive areas of potential habitat in the Kogan / Kumbarilla areas in RE11.5.1, 11.7.4 and 11.7.7.	A single record to then west of Kumbarilla State forest, 10km from the west of the SGP study area. Not recorded in field surveys despite extensive survey effort in suitable habitat	Unlikely
Thesium australe Austral toadflax	V	V	Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE 11.3.2) north-west of Dalby, within the project development area.	Most likely to occur on habitats formed on heavy clay associated with the Condamine Alluvium. RE11.3.2 provides the most suitable habitat within the assessment area.	Two herbarium records within 10km of the SGP study area, with the nearest record 2.7k east of the eastern SGP study area boundary, 25km north west of Dalby.	Possible
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Jalmenus eubulus Pale imperial hairstreak	Vul	-	Restricted to Brigalow (*Acacia harpophylla*)-dominated woodlands and open-forests, particularly those areas with Belah (*Casuarina cristata*), emergent eucalypts such as *Eucalyptus populnea* and understorey shrubs (Breitfuss and Hill 2003; Eastwood et al. 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Three records are located within the SGP, the most recent of which is nearly 20 years old. An additional five records are within 10km of the SGP boundary. The species requires targeted surveys to detect, even during suitable conditions. Current number of records are likely to underestimate abundance and distribution	Likely
Rheodytes leukops Fitzroy River turtle	Vul	Vul	Reliant on faster flowing riffle habitats and generally does not move far from them within its home range (Tucker et al. 2001)	No suitable habitat within the SGP.	Only found in the Fitzroy River catchment. No records within 50km of the SGP boundary.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Elseya albagula Southern snapping turtle	End	CE	Restricted to clear, flowing, well-oxygenated waters with the Fitzroy, Mary and Burnett Rivers and associated smaller drainages (Todd et al. 2013).	No suitable habitat within the SGP.	No records within 50km of the SGP boundary and not known to occur outside the Fitzroy, Mary and Burnett River catchments.	Unlikely
Strophurus taenicauda Golden-tailed gecko	NT	-	Found mainly in association with brigalow (Acacia harpophylla), cypress (Callitris spp.) and ironbark (Eucalyptus spp.).	Recorded during surveys. Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Delma torquata Collared delma	Vul	Vul	Rocky areas associated with dry open forest, and brigalow	Some suitable habitat for the species exists within the SGP, however, rarely recorded within the Brigalow Belt.	No records within 50km of the SGP boundary.	Unlikely
Anomalopus mackayi Long-legged worm-skink	Vul	End	Open grasslands with cracking black soil.	Marginal habitat (derived grasslands) for the species exists within the SGP, particularly in the southern region.	No records within the SGP; one record within 10km of the SGP. Most recent records (<20 years old) centred around Oakey and the Dalby. Never recorded west of the Condamine River.	Unlikely
Egernia rugosa Yakka skink	Vul	Vul	Usually occurs on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Wilson and Swan 2008; Richardson 2006), but can also be found on loam and clay soils (Eddie 2012).	Some suitable habitat for the species exists within the SGP, though the bulk is marginal or unsuitable.	Limited records within the region, one old historic record from within 25km of the SG, and anecdotally said to have been recently recorded somewhere in Barakula SF.	Unlikely
Tympanocryptis condaminensis Condamine Earless Dragon	End	End	Open grasslands and cropland with cracking black soil	Marginal habitat (derived grasslands) for the species exists within the SGP, particularly in the southern region.	Closest record 20km from SGP. No records known west of the Condamine River.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Aspidites ramsayi Woma	NT	-	Open habitats, brigalow and mulga woodlands, spinifex deserts	Some suitable habitat for the species exists within the SGP.	No records of the species within 50 km of the SGP. SGP outside species typical range.	Unlikely
Acanthophis antarcticus Common Death Adder	Vul	-	Found in a wide variety of habitats, including rainforest, open woodland, shrubland and heath (Wilson and Swan 2003).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Two records of the species are located within 5km of the SGP boundary, including one from 2015.	Possible
Furina dunmalli Dunmall's snake	Vul	Vul	Wide range of habitats, including forests and woodlands dominated by brigalow (*Acacia harpophylla*) and other Acacia spp., cypress (*Callitris* spp.) or bulloak (*Allocasuarina luehmannii*) on black alluvial cracking clay and clay loams (Covacevich *et al*. 1988; Stephenson and Schmida 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Two old records (i.e. >20 years) exist in the southern portion of the SGP. An additional two records are located within 8km outside the SGP area, with the most recent record from 2000.	Possible
Hemiaspis damelii Grey snake	End	-	Inhabits dry eucalypt forest and occasionally pasture, favouring areas of cracking, flood-prone soils along floodplains and near watercourses within the Brigalow Belt (Wilson 2005).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Denisonia maculata Ornamental Snake	Vul	Vul	Found in Brigalow (*Acacia harpophylla*), Gidgee (*A. cambagei*), Blackwood (*A. argyrodendron*) or Coolibah (*Eucalyptus coolabah*)-dominated vegetation communities; can occur in regrowth. Typically associated with black soils (particularly gilgai).	Some suitable habitat for the species exists within the SGP, though suitable remnant habitat is typically fragmented and isolated.	No records within 50km of the SGP boundary. SGP considered outside species typically range.	Unlikely
Botaurus poiciloptilus Australasian Bittern	LC	End	Freshwater wetlands with dense vegetation, particularly reeds and sedges.	There are scattered areas of suitable habitat (i.e. ephemeral waterbodies with dense fringing vegetation in the western portion of Lake Broadwater and Long Swamp). However, these areas are marginal for the species.	Three records exist within 50km of the project area, with the most recent being in 1999. This species is highly vagrant and would be a very rare visitor to the SGP area.	Unlikely
Calidris ferruginea Curlew Sandpiper	End	CE	Saline and freshwater wetlands, saltmarshes, estuaries, mudflats. Prefers areas with exposed mud for foraging.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Four records known from the southern section of the SGP, three at Lake Broadwater. While it is likely to occur at Lake Broadwater, the species has a low probability of occur at other locations within the SGP during Life of Operation.	Transient
Limosa lapponica baueri Bar-tailed Godwit	Vul	Vul	Saline and freshwater wetlands, saltmarshes, estuaries, mudflats. Prefers areas with exposed mud for foraging, usually within proximity to the coast.	Only likely at Lake Broadwater.	With the exception of two pre-1900 records, this species has been recorded on only three occasions between 1980 and 1987. All records are from Lake Broadwater	Unlikely/ Transient

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Rostratula australis Australian Painted Snipe	Vul	End	Found in a wide range of habitats including ephemeral swamps, dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant and Higgins 1993).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Six records known from the southern section of the SGP, in the vicinity of Lake Broadwater. The species could occur with the SGP Life of Operation, though most likely restricted to these two areas.	Possible
Pedionomus torquatus Plains-wanderer	Vul	Vul	Open grasslands with patches of bare ground, low sparse shrublands	There is little suitable habitat within the SGP.	Outside of known range and all records are old (ie. >40 years).	Unlikely
Turnix melanogaster Black-breasted button-quail	Vul	Vul	Leaf litter in drier rainforests, vine thickets, lantana on rainforest edges, hoop pine plantation	There is no suitable habitat within the SGP.	Known from state forests north of, but connected to, Barakula State Forest. No known record from the SGP.	Unlikely
Falco hypoleucos Grey Falcon	NT	-	Lightly treed inland plains, gibber deserts, pastoral lands	Open areas of grazing land and derived grasslands might be considered marginal habitat.	Rarely recorded within the Brigalow Belt. The species does not occur with any frequency in the Project Area.	Unlikely
Erythrotriorchis radiata Red goshawk	End	Vul	Open forests, woodlands, wetlands, rainforest fringes	Suitable habitat for the species exists within the SGP.	One record from within the southern portion of the SGP and an addition three records within 20km of the SGP boundary. All records are old (i.e. >30 years) and the species rarely recorded in the Brigalow Belt.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Geophaps scripta scripta Squatter Pigeon	Vul	Vul	Occurs mainly in dry grassy eucalypt woodlands and open forests and also inhabits cypress pine (Callitris spp.) and Acacia dominated woodlands (Frith 1982)	Suitable habitat for the species exists within the SGP.	Two records exist within the SGP in the central region of the SGP, the most recent in 2012. Despite suitable habitat being present, this species is likely to vagrant, with individuals not representing a resident or seasonal population. May sporadically occur in the northern and central regions of the SGP during Life of Operation.	Transient
Calyptorhynchus lathami Glossy black-cockatoo	Vul	-	Inhabits woodlands and forests that have abundant Allocasuarina species and abundant large hollows suitable for nesting. Many populations are restricted to remnant vegetation within hills and gullies surrounded by agricultural land (Higgins 1999).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Lophochroa leadbeateri Major Mitchell's cockatoo	Vul	-	Sparsely timbered open grasslands, *Callitris* and *Casuarina* woodlands, mulga woodlands, trees in proximity to watercourses	Some areas of habitat SGP are marginal. Large areas are unsuitable.	Two records exist within the project site in the Lake Broadwater area. However, these records are more than 30 years old and indicate the species does not occur in the area with any frequency.	Unlikely
Lathamus discolour Swift parrot	End	CE	Flowering trees in forests and woodlands	Suitable habitat for the species exists within the SGP.	Records known from outside the SGP and are more than 50 years old. Any possible current or future occurrence would be of vagrant individuals.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Ninox strenua Powerful owl	Vul	-	Eucalypt forests on ranges with densely vegetated gullies, drier and lower elevation forest with sufficient prey and large hollows	Suitable habitat for the species exists within the SGP.	No records within the SGP and all records are old (i.e. >20 years). Rarely recorded within the Brigalow Belt.	Unlikely
Anthochaera phrygia Regent Honeyeater	End	CE	Forests and woodlands of ironbark, box, swamp mahoghany and river oak.	Suitable habitat for the species exists within the SGP.	Only two records exist within 10km of the SGP. Vagrant within the southern Brigalow Belt.	Unlikely
Grantiella picta Painted honeyeater	Vul	Vul	Found mainly in dry open woodlands and forests, particularly box-ironbark woodlands. It may also occur in riparian forest, on plains with scattered eucalypts and in remnant trees on farmland and their occurrence is strongly associated with mistletoe.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Three records within the SGP in the southern portion near Lake Broadwater, and several records located within 10km of the SGP boundary, including records from the past few years. Likely to occur within the SGP infrequently.	Possible
Poephila cincta cincta Black-throated finch	End	End	Grassy scrublands, woodlands, dunes, Pandanus near water	Most areas of open woodland or grassland are heavily grassed and dominated by exotic grasses. Some areas of derived grassland may be suitable.	No longer occurs within local area or region. One record exists of the species within 10 km of the Project Area, however, this record is more than 50 years old.	Unlikely
Dasyurus hallucatus Northern Quoll	LC	End	Most common in rocky eucalypt woodland and open forest within 200 kilometres of the coast.	Some suitable habitat for the species exists within the SGP	No records within 50km of the SGP.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Dasyurus maculatus maculatus Spotted-tailed quoll	Vul	End	Inhabits a variety of forested habitats including subtropical and temperate rainforests, vine thickets, wet and dry sclerophyll forests, woodland and coastal scrub.	Some suitable habitat for the species exists within the SGP	Three records within the SGP and several within 20km of the SGP boundary, however, all records are old (i.e. >20 years), with the exception of a confirmed sighting of an injured animal near Tara within the past 5 years. This was likely a transient individual. The current status of this species in the Brigalow Belt is uncertain, and transient individuals may occur throughout the SGP, although this would a rare occasion.	Unlikely
Petauroides volans Greater Glider	Vul	Vul	Mainly restricted to eucalypt forests and woodlands where they typically occur in highest abundance in taller, montane, moist eucalypt forests with larger, relatively old trees and abundant hollows (Eyre 2004). In areas west of the Great Dividing Range, they are found in low woodlands (McKay 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Phascolarctos cinereus Koala	Vul	Vul	Found in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas (Dyck & Stratham 2008). On the western side of the Great Dividing Range at the western edges of their range, the species is often associated with riparian vegetation although are not restricted to them (Melzer et al. 2000; Sullivan et al. 2003).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Petrogale penicillata Brush-tailed Rock-wallaby	Vul	Vul	Inhabits rock piles and cliff lines in vegetation ranging from rainforest to dry sclerophyll forests.	No suitable habitat for the species exists within the SGP	No records within 50km of the SGP.	Unlikely
Pteropus poliocephalus Grey-headed flying-fox	LC	Vul	Foraging habitat includes rainforests, open eucalypt forests, woodlands, Melaleuca swamps and Banksia woodlands. Roosts are commonly within dense vegetation close to water, primarily rainforest patches, stands of Melaleuca, mangroves or riparian vegetation (Nelson 1965).	Suitable foraging habitat for the species exists within the SGP.	Three records within 50km of SGP, including records from 2011. Individuals are known to occasionally use a seasonal flying-fox camp along Myall Creek in Dalby. The species is a typically a vagrant west of the Great Dividing Range and would be a rare visitor to the SGP.	Unlikely
Macroderma gigas Ghost Bat	End	Vul	Habitats used for foraging vary from dry open woodlands to tropical rainforests (Wilmer 2012).	Suitable foraging habitat for the species exists within the SGP.	One very old record (i.e. >200 years) outside of the SGP. Presumed locally extinct in the area.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Chalinolobus dwyeri Large-eared Pied Bat	Vul	Vul	Often observed along ecotones on rainforest edges or in association with sandstone escarpments (DoE 2017).	No suitable habitat for the species exists within the SGP.	No records within 50km of the SGP.	Unlikely
Nyctophilus corbeni South-eastern long-eared bat	Vul	Vul	Found more commonly in box/ironbark/cypress pine woodland on sandy soils. It also occurs in bulloak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities (Turbill and Ellis 2006; Churchill 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Pseudomys australis Plains Rat	End	Vul	Cracking clay depressions and small drainage lines on arid gibber plains, and vast, cracking clay plains (Van Dyck et al 2013).	No suitable habitat for the species exists within the SGP	One very old record (i.e. >100 years) within 10km outside of the SGP. Presumed locally extinct in the area.	Unlikely

[#] LC = Least Concern, NT = Near Threatened, Vul = Vulnerable, E = Endangered, CE = Critically Endangered, Mig = Migratory

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Appendix D.
Threatened Ecological Communities and Regional Ecosystem Descriptions

THREATENED ECOLOGICAL COMMUNITIES

Brigalow Dominant and Co-dominant

Status

Endangered EPBC Act: Component Regional Ecosystem 11.3.1, 11.4.3/11.4.3a, 11.9.5 Endangered under the VM Act and Biodiversity Act.

Total number of survey sites:

70 Sites in Total (RE11.3.1- 11 Secondary, 23 Quaternary; RE11.4.3 - 8 Secondary, 19 Quaternary; 11.9.5 – 2 Secondary, 7 Quaternary).

Within the SGP assessment area, the Brigalow Dominant and Co-dominant Ecological Community comprises the following REs:

- RE11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains)
- RE11.4.3/ 11.4.3a *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)

Other relevant habitats included in the ecological community include Brigalow regrowth >15 yrs old which have similarly been mapped under the Brigalow ecological community.

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.

Tall brigalow woodland (RE11.3.1) on the alluvial plain of Wilkie Creek (Site AS138).

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 woollsiana* 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 habitat for confirmation.

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.

Well-developed woodland of Acacia harpophylla and Casuarina cristata characteristic of RE11.4.3.

Regional Ecosystem 11.9.5

This ecosystem was sampled in one locality to the west of Wandoan where it formed an open forest of *Acacia harpophlla* mixing with *Casuarina cristata* and emergent of *Brachychiton rupestris*. The canopy typically form 60% cover and canopy heights reaching 23m. Shrub layers are typically mid-dense and predominantly occupied by *geijera parviflora, Eremophila mitchellii* and *Santalum lanceolatum*. RE11.9.5 forms small scattered remnants throughout the rolling sedimentary landscapes of the Wandoan region in the northern portion of the SGP assessment area.

Fragmented patch of RE11.9.5 in the Wandoan area.

Weeping Myall Woodlands

Status

Endangered EPBC Act (Not Represented in VM Act)

Total Number of Survey Sites

2 Secondary

In Queensland, the Weeping Myall Woodlands TEC is known to occur as small patches within REs 11.3.2 and 11.3.28 (DEWHA, 2009a), 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 per cent of trees present) by living, dead or defoliated weeping myall trees.
- The patch has more than two layers of regenerating weeping myall present.

A single occurrence of the Weeping Myall Ecological Community was observed in the Theten area although the habitat was was not recorded within any other location within the SGP assessment 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 3m to 6m, 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 is formed by predominantly native graminoids and soils were moist, becoming saturated in depressions. The community was fringed by regrowth woodland of Poplar Box and Queensland Blue 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 of the Weeping Myall TC 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 community distribution.

The Weeping Myall TEC in the Theten area (survey site GB82).

Coolibah – Black Box Woodland

Status

Endangered EPBC Act: Component Regional Ecosystems 11.3.3 (Of Concern VM Act and Biodiversity Status)

Total number of survey sites across project area

3 Sites in Total (3 Secondary).

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.

Whilst RE11.3.3 is mapped relatively broadly in certified regional ecosystem mapping (Version 8.0, 2017) in the Chinchilla region, and Eucalyptus coolibah occurs as a component tree in riparian habitats of the Condamine River, the majority of these patches are considered too small or degraded to provide representation of the TEC. A few minor occurrences are however identified on the Theten property and the adjacent habitats of Wilkie Creek where they occupy a combined area of 23 ha with the largest patch covering an area of 10ha. Typical canopy heights range from 10 – 15m 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 typically occupies broad drainage depressions and overflow channels on major watercourses.

Coolibah / Black Box Woodland Ecological Community (RE11.3.3) on Theten (survey site GB74 _ 2433)

OTHER ENDANGERED/OF CONCERN REGIONAL ECOSYSTEMS

Regional Ecosystem 11.3.17

Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains

Status

VMA Status: Endangered

Biodiversity Status: Endangered

Total number of survey sites across project area

15 Sites in Total (1 Secondary and 14 Quaternary / Observation).

This community occurs on alluvial plains, typically near watercourses with the largest representations in the southern survey area in the Lake Broadwater Region. The habitat is also mapped in the northern assessment area near Wandoan. In a typical occurences, the canopy is dominated by Poplar Box (*Eucalyptus populnea*) and ranges between 16-26m in height with a mean PPC of 40%. Additional trees in the canopy layer are Belah (*Casuarina cristata*), Brigalow (*Acacia harpophylla)* and occasional Grey Box (*Eucalyptus woollsiana*). The second tree layer is well developed and comprises the above canopy species together with Western Rosewood (*Alectryon oleofolius*), Weeping Pittosporum (*Pittosporum angustifolium*) Sally Wattle (*Acacia salicina*), *Casuarina cristata* and other associated species including *Callitris glaucophylla, Alectryon oleofolius* subsp*. elongatus*, *Melaleuca bracteata,* and *Alphitonia excelsa.* The shrub layer is typically dominated by a sparse cover of *Geijera parviflora, Citurs glauca, Capparis mitchellii,* and *Elaeodendron australe* var*. integrifolium*. Exotic ground covers, in particular Lippia (*Phyla canescens**) in the south and Buffel Grass (*Cenchrus ciliaris*Green Panic (*Megathyrsus maximus var. trichoglume)* contribute to approximately 50% of the overall cover, with scattered infestations of Harissa Cactus (*Harissia martini**), Noogoora Bur (*Xanthium occidentale**), and Mayne's Pest (*Verbena aristigera**), African Love Grass (*Eragrostis curvula**), Paspalum (*Pasplalum dilatatum**), and Giant Panic (*Magathrysus maximus* var. *maximus**). Native grasses and sedges dominate the cover.

Degraded patch of RE11.3.17 in the Wandoan region (Site DS155_300).

Regional Ecosystem 11.3.2

Eucalyptus populnea woodland on alluvial plains.

Status

VMA Status: Of concern

Biodiversity Status: Of concern

Total number of survey sites across project area

54 Sites in Total (9 Secondary and 45 Quaternary / Observation).

This community is consistently dominated by poplar box (*Eucalyptus populnea*) with a canopy height ranging between 10-16m and a mean crown cover of 41%. Associated canopy trees may include Queensland Blue Gum (*Eucalyptus tereticornis*) and Moreton Bay Ash (*Corymbia tessellaris*). A sparse second tree layer comprises the above canopy species. The shrub layer is generally poorly developed with scattered poplar box saplings and occasional shrubs of velvet pear (*Opuntia tomentosa**).

The groundcover is often weedy, affected by infestations of Buffel Grass (*Cenchrus* ciliaris), African Love Grass (*Eragrostis curvula**), Lippia (*Phyla canescens*), Mayne's pest (*Verbena aristigera**), Harissa Cactus (*Harissia martini**) and Mother of Millions (*Bryophyllum*

delagoense) in some localities, which contribute to a mean exotic cover of 35% across all survey sites. Dominant graminoid species include *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea,* and *Paspalidium* sp., with common native herbs of *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis*.

There is often some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers in most habitats.

Well preserved representation of RE11.3.2 in the Central Assessment Area (Site DS132_275).

Regional Ecosystem 11.3.4

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

Status

VMA Status: Of concern

Biodiversity Status: Of concern

Total number of survey sites across project area

52 Sites in Total (12 Secondary and 40 Quaternary / Observation).

This ecosystem occurs on seasonally flooded alluvial plains associated with both minor and major drainage lines. The canopy height ranges between 14-24m and a mean crown cover of 28 - 45%. A typical representation is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and rough-barked apple *(Angophora floribunda)* mixed with other species including Moreton Bay Ash (*Corymbia tessellaris)* and occasional Poplar Box (*Eucalyptus populnea)*. The relative proportions of these tree varies with rough-barked apple dominant in some habitats, particularly along the frontage of Wambo Creek.

The second tree layer is sparse and comprises the above canopy species together with *Acacia salicinia* and kurrajong (*Brachychiton populnea*). The shrub layer ranges between 1-4 m in height with a mean cover of 22%. Dominant species are Moon Wattle (*Acacia semilunata*) in the northern area with frequent Yellow Tea Tree (*Leptospermum polygalifolium*), Black Wattle (*Acacia leiocalyx),* Glory Wattle *(Acacia spectabilis),* Wilga *(Geijera parviflora),* and Paper Bark *(Melaleuca decora).*

The ground layer is variable ranging from good condition in the habitats surrounding Miles to highly degraded in habitats associated with the Condamine River Flood Plain in the Dalby region. Typical native groundcover species include *Lomandra longifolia, Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea, Gahnia aspera, Heteropogon contortus, Juncus continuus.,* and *Paspalidium* sp., with common native herbs including *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Dianella longifolia* var*. longifolia, Rostellularia adscendens,* and *Wahlenbergia communis*. Exotic species associated with this regional ecosystem include Green Panic (*Panicum maximum var. trichoglume)* limited to scattered occurrences Mayne's Pest (*Verbena aristigera**), Buffel Grass (*Pennisetum ciliare**) and Liverseed Grass (*Urochloa mosambicensis**).

There is some evidence of selective thinning in many locations and canopy recruitment is lacking in some habitats along the Condamine River where grazing pressure is particularly high. Heavily grazed fringe of RE11.3.4 along the Condamine River

Heavily grazed fringe of RE11.3.4 along the Condamine River

Regional Ecosystem 11.3.25

Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.

Status

VMA Status: Least concern

Biodiversity Status: Of concern

Total number of survey sites across project area

130 Sites in Total (17 Secondary, 4 Tertiary and 109 Quaternary / Observation).

Maximum development of RE11.3.25 is associated with the riparian margins of the lines of Condamine River and larger tributaries such as Wilkie Creek. The ecosystem however occurs broadly throughout the SGP assessment areas where it fringes both major and minor drainage lines. At its maximum development, canopy heights range from 23 - 33 metres and a mean crown cover of 46%. Dominant canopy trees are River Red Gum (*Eucalyptus camaldulensis* and Queensland Blue Gum *(Eucalyptus tereticornis),* Rough Barked Apple (*Angophora floribunda*) and Moreton Bay Ash (*Corymbia tessellaris*). A sparse sub-canopy is dominated by the above species with occasional willow wattle (*Acacia salicina*) and cooba (*Acacia*

stenophylla). Shrub cover is very sparse (0-5% cover) with scattered willow wattle, cooba and prickly mimosa (*Acacia farnesiana**). The sparse ground cover which averages at 23% is attributed to scouring of groundcover species from recent flood events. Mean cover is dominated by exotic species with grasses such as Green Panic (*Megathyrsus maximus var. trichoglume**), Purple Top Rhodes (*Chloris virgata**), and Couch Grass (*Cynodon dactylon**). Saltwater Couch (*Sporobolus virginicus)* was also a dominant cover on some sections of Wilkie Creek, being an indication of salinity. Natives such as Mat rush (*Lomandra longifolia*) and Blady Grass (*Imperata cylindrica*) characterise the native component of the groundcover in most habitats examined.

Weedy representation of RE11.3.25 on the Condamine River.

Regional Ecosystem 11.3.27

Palustrine wetland (vegetated swamp).

Status

VMA Status: Least concern

Biodiversity Status: Of concern

Total number of survey sites across project area

28 Sites in Total (7 Secondary, 21 Quaternary / Observation).

Floodplain wetlands are generally associated with the flood overflow channels characteristic of the flood plains of major river systems throughout the SGP assessment area. The wetlands play an important hydrological role, facilitating nutrient exchange between aquatic and terrestrial ecosystems during periods of seasonal overbank flow. The Condamine River floodplain hosts a complex wetland system with RE11.3.27 forming mosaics with RE11.3.25, 11.3.2 and 11.3.4 throughout its entire length with a variety of wetland types recognised.

Lake Broadwater, mapped as RE11.3.27a (Freshwater Lake) is a seasonal water feature that is recognised nationally for its natural values, being significant at a national and state level. The lake is listed on the Directory of Important Wetlands and is recognised as being a rare example of a semi-permanent freshwater lake in the bioregional area (Blackman *et al.* 1999).

Long Swamp, a similar vegetated wetland ecosystem that discharges on a seasonal basis into Wilkie Creek. Representation of the feature as RE11.3.2 in Certified RE Mapping (DERM 2009b) is incorrect with field survey confirming features typical of RE11.3.27d (palustrine wetland). Long Swamp is heavily utilised for irrigation purposes which has undoubtedly affected hydrological function, species composition of the ground layers, the vigour of the canopy trees and reduced its overall biodiversity values. Long Swamp is a sinuous hydrological feature (overland flow path) that flows across the Condamine Alluvium in a north-westerly direction to the east and north of Lake Broadwater, before joining with Wilkie Creek to the west. The feature occupies a broad depression on the alluvium with the central portion of the depression formed by heavy clay. Surface water is present seasonally and following dry spells the associated vertosol soils form deep hummocks and cracks. There was no flow, nor any significant pooled water within Long swamp during the field visits, despite heavy recent rains. These observations together with the observations of deep, open cracks in the central swamp channel soil surface confirmed that the feature is only active during flooding.

Vegetation is predominantly native with although exotic groundcovers predominant in some localities. The canopy is formed by tall, broadly spaced River Red Gum (*Eucalyptus camaldulensis)* at approximately 15 - 30% cover with Poplar Box (*Eucalyptus populnea)* forming on the swampy margins. The canopy is significantly stressed in some areas with signs of senescence and foliage loss in the Red Gums which predominate the canopy. The noted senescence can largely be attributed to historic groundwater drawdown in shallow sandy alluvial aquifers, compounded by surface water extraction for irrigation (Kath et al 2014; 3D Environmental 2016).

Of the four secondary vegetation survey sites completed during the dry season survey (DS21, DS22, DS26, DS31 completed when the swamp was dry), exotic vegetation cover contributed on average to 15% to the total groundcover, and formed 39% of the total living groundcover mixing with native species including Nardoo (*Marsilea drummondii),* Water Chestnut (*Eleocharis dulcis)* and scattered native grasses including *Panicum decompositum*. Lippia (*Phylla canescens)* was the most abundant exotic forb blanketing the clay soils, particularly where grazing pressure is most intense. It should be noted that groundcover composition will vary seasonally with native aquatic sedges, particularly Water Chestnut becoming dominant during periods of standing surface water.

Long Swamp with characteristic River Red Gum (*Eucalyptus camaldulensis)* showing moderates signs of stress as suggested by foliage loss.

The most extensive of the wetland types is RE11.3.27c which forms by the extensive floodplain system of channel overflows and anabranches that are seasonally activated during periods of overbank flow. The regional ecosystem sub-type is associated with the alluvial depressions along the Condamine River floodplain. It is a palustrine wetland ecosystem with an overstorey of scattered River Red Gum over a sedgeland groundcover with semi-permanent water. The composition of the ground cover is simple and limited to Water Chestnut (*Eleocharis plana),* Juncus (*Juncus continuus)* with scattered native herbs such as Lesser joyweed (*Alternanthera denticulata*) and Eclipta (*Eclipta prostrata*). Infestations of Lippia (*Phyla canescens*) occur throughout the ecosystem, although are generally only evident when wetlands are dry.

Overflow channel of the Condamine River providing representation of RE11.3.27c. The system was seasonally dry and ground cover was dominated by a dense infestation of Lippia.

Regional Ecosystem 11.9.7

Acacia harpophylla, Eucalyptus populnea open forest on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

1 Quaternary

A single small polygon of 1.5ha is located in the northern assessment area, representing a remnant sliver that runs along a footslope, contiguous with remnant riparian vegetation on a creek line. The canopy has been fragmented with a cover of up to 30% and canopy heights range from 18 to 23m. The sub-canopy and shrub layers are sparse, typically < 5% cover formed by Wilga (*Geijera parviflora*) and Sandalwood (*Santalum lanceolatum*). Whilst the habitat has been subject to heavy grazing, the ground covers are predominantly native and are formed by *Themeda triandra, Dicanthium sericeum, Paspalideum caespitosum, and Chloris ventricosa.*

Regional Ecosystem 11.9.10

Acacia harpophylla, Eucalyptus populnea open forest on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

3 Sites in Total (3 Quaternary)

Small scattered remnants are located in the northern assessment area with the fragmented landscapes surrounding Wandoan where patch sizes are typically 1 to 2ha. The ecosystem exists in small remnants that are isolated from larger patches of remnant vegetation. Canopy heights are generally in the range of 9 to 16m with up to 35 % projected canopy cover formed by *Eucalyptus populnea* and a sub-canopy of *Acacia harpophylla, Casuarina cristata* and occasional *Callitris glaucophylla*. Shrub layers are sparse (10 – 20%) dominated by *Geijera parviflora, Eremophila mitchellii* and *Atalaya hemiglauca.* Ground covers are formed by a mix of native and exotic species including *Paspalidium caespitosum, Sporobolus creber, Aristida ramosa, Capparis lasiantha, Sclerolaena sp., Enchylaena tomentosa, Sida sp., Nyssanthes diffusa, Senecio brigalowensis, Salsola australis, Bothriochloa decipiens, Enteropogon acicularis, Aristida calycina, Enteropogon ramosus, Sporobolus caroli* and patches of Buffel Grass (*Cenchrus ciliaris).*

Regional ecosystem 11.9.10 at Site Q69_631 near Wandoan.

LEAST CONCERN REGIONAL ECOSYSTEMS

Regional Ecosystem 11.3.14

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

31 Sites in Total (8 Secondary, 1 Tertiary and 22 Quaternary / Observation).

This ecosystem is associated with both shallow alluvial depressions and sandy rises on flood plains where it is characterised by mix of eucalyptus species including River Red Gum (*Eucalyptus camaldulensis),* Rough Barked Apple (*Angophora floribunda),* Smooth Barked Apple (*Angophora leiocarpa)* and an often dense to mid-dense sub-canopy of *Callitris glaucophylla*. Sub-canopy is variable although habitats on sandy substrates are often characterised by a mid-dense sub-canopy of *Callitris glaucophylla* and Black Wattle (*Acacia leiocalyx).* The canopy height ranges between 18-26m and canopy cover that ranges from 40 to 65%. Ground covers are generally intact, formed by dense swards of Blady Grass (*Imperata*

cylindrica), Reed Grass (*Arundinella nepalensis), Heteropogon contortus* and often dense cover of Mat-rush (*Lomandra longifolia).*

RE11.3.14 associated with a sandy rise above the Condamine River Flood Plain (AS12_2346)

Regional Ecosystem 11.3.18

Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii shrubby woodland on alluvium

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

13 Sites in Total (2 Secondary, 11 Quaternary / Observation).

Regional ecosystem RE 11.3.18 is restricted to the southern assessment area where it occupies sandy alluvial associated with largely with ephemeral watercourses. Canopy heights range from 12 – 23m with typical canopy cover of 35 – 45%. The dominant canopy tree is Poplar Box (*Eucalyptus populnea)* with occasional Moreton Bay Ash (*Corymbia tessellaris),* Rough Barked Apple (*Angophora floribunda)* and Narrow leafed Ironbark (*Eucalyptus crebra).* The sub-canopy and shrub layer is universally occupied by a dense to mid-dense sub-canopy of White Cypress (*Callitris glaucophylla)* and less abundant Bulloke (*Allocasuarina leuhmannii)* with Sally Wattle (*Acacia salicinia)* and Black Wattle (*Acacia leiocalyx)* generally associated. Ground cover is typically native, often with dense mats of Matrush (*Lomandra longifolia)* and native grasses including *Chrysopogon fallax,* Kangaroo Grass (*Themeda triandra), Chloris truncata,* Black Spear Grass (*Heteropogon contortus)* and *Aristida caput-medusae* in areas of poorer soil. African Love Grass (*Eragrostis curvula)* is prominent in some occurrences south of Dalby and Mother of Millions forms a dense infestation in habitats associated with Braemar Creek.

RE11.3.18 at site on a broad drainage channel in the Tipton Area (GB101_2402)

Regional Ecosystem 11.3.26

Eucalyptus moluccana or E. microcarpa woodland to open forest on margins of alluvial plains.

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

8 Sites in Total (3 Secondary, 5 Quaternary / Observation).

Small areas (25ha in total) occur in the southern and central assessment areas on broad loamy flats formed from alluvial outwash. Canopy heights range from 12 – 22m with typical canopy cover ranging from 25 to 55%. The dominant canopy tree is Grey Box (*Eucalyptus woollsiana)* occasionally with scattered Poplar Box (*Eucalyptus populnea)* in the sub-canopy. Shrub layers are typically sparse formed by Grey Box, *Acacia semilunata* and Bulloke (*Allocasuarina leuhmannii).* The ground layer is also sparse with up to 40% living cover of *Eragrostis bimaculate, Aristida caput-medusae, Gahnia aspera,* Variable Sword Sedge (*Lepidosperma laterale)* and the low shrub *Dodonaea macrossanii*. Regional Ecosystem 11.3.26 provides habitat for the Endangered sedge *Fimbristylis vagans* in the Lake Broadwater area.

Regional Ecosystem 11.5.1

Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains/remnant surfaces.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

542 Sites in Total (30 Secondary, 2 Tertiary, 510 Quaternary / Observation).

Regional Ecosystem 11.5.1, including sub-type 11.5.1a is the most extensive habitat type in the SGP assessment area. The ecosystem occurs on loamy to sandy clay soils which are associated with extensive areas of broad, flat to gently undulating plains. The typical canopy height ranges between 10-22m and a mean crown cover of 37%. It is dominated by Narrow Leaf Ironbark *(Eucalyptus crebra / Eucalyptus elegans)* with associated Smooth Barked Apple *(Angophora leiocarpa),* White Cypress *(Callitris glaucophylla)* and Poplar Box *(Eucalyptus populnea).* Where Poplar Box is dominant, the ecosystem is mapped as RE11.5.1a. A sparse second tree layer has an average height of 8.5m and is dominated by White Cypress (*Callitris glaucophylla*) and Bulloke (*Alloacasuarina Luehmannii)* with less frequent narrow leaf ironbark.

A diverse upper shrub layer ranges between 5-30% in cover with a mean height of 4%. Bulloke and White Cypress predominate across all sites surveyed. Other typical species are Moon Wattle (*Acacia semilunata*), *Acacia ixiophylla, Melaleuca decora, Acacia apprepta, Acacia crassa* subsp. *crassa*, *Acacia* l*eiocalyx*, *Acacia spectabilis*, *Petalostigma pubescens, Alphitonia excelsa,*

Grevillea striata, and *Ozanthamnus diosmifolius.* The lower shrub layer averaging at 2m in height and 18.5 % in cover, is similarly diverse comprising species which include *Leucopogon* sp.*, Callitris glaucophylla*, *Acacia crassa* subsp*. crassa* and *Allocasuarina Luehmannii.*

Diversity of the the ground layer varies dependent on disturbance history and grazing regimes although in tends to be relatively diverse. Dominant species include *Aristida caput-medusae, Fimbristylis dichotoma, Chrysopogon fallax, Cyanthillium cinereum, Dodonaea macrossanii, Panicum decompositum, and Themeda triandra.* Frequent species include *Aristida calycina, Commelina lanceolata, Eragrostis sororia, Goodenia* sp. and *Lomandra multiforla*. Naturalised species are limited to scattered occurrences of *Melinus repens*, Opuntia stricta**, *Opuntia tomentosa**, *Paspalum dilatatum** and *Pennisetum ciliare*.*

Most occurrences have been moderately to heavily logged with selective targeting of the Narrow Leaf Ironbark.

Typical occurrence of RE11.5.1 in Kumbarilla State Forest. Habitat in this location is in good condition.

Regional Ecosystem 11.5.4

Eucalyptus chloroclada, Callitris glaucophylla, C. endlicheri, Angophora leiocarpa woodland on Cainozoic sand plains and/or remnant surfaces

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

55 Sites in Total (2 Secondary, 53 Quaternary / Observation).

Regional Ecosystem 11.5.4 shares floristic similarities with RE11.5.1 merging in regard to floristic attributes and landform associations. The ecosystem tends to occur on sandier soils than RE11.5.1, often occupying low sandy rises. The canopy height tends to vary with examples of lower stature ranging in height between 10-22m with some taller representations in Kumbarilla State Forest attaining heights of up to 30m. Crown cover values range from Canopy cover also tends to vary ranging from 30 to 60%. Smooth Bark Apple (*Angophora leiocarpa)* and Dirty Gum (*Eucalyptus chloroclada)* are the dominant species with Narrow Leaf Ironbark *(Eucalyptus crebra)* generally present*. A sparse to mid-dense second tree layer has an average height of 8.5m and is generally present attaining heights of 12m and dominated by Smooth Barked Apple, Dirty Gum and White Cypress (Callitris glaucophylla),* Budgeroo (*Lysicarpus angustifolius),* Stringy Bark She-oak (*Allocasuarina inophloia), Melaleuca decora* with less frequent Bulloke *(Alloacasuarina Luehmannii).*

Shrub layers are generally dominated by White Cypress, Budgeroo, Stringy Bark She-oak, *Acacia ixiophylla, Melaleuca decora, Acacia crassa subsp. crassa, Acacia leiocalyx, Acacia spectabilis, Petalostigma pubescens, Alphitonia excelsa* and *Acacia semilunata* in the northern occurrences.

Ground cover tends to be sparse to mid-dense (15 to 40% living cover) with dominant species include *Aristida caput-medusae, Ancistrachne uncinellata, Gahnia aspera, Lomandra multflora, Aristida ramosa, Aristida salicinia* and Grass Tree (*Xanthorrhoea johnsonii*) in some localities.

Representative structure of RE11.5.4 in Kumbarilla State Forest with sparse canopy cover.

Regional Ecosystem 11.5.20

Eucalyptus moluccana and/or E. microcarpa/ E. pilligaensis +/- E. crebra woodland on Cainozoic sand plains.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

80 Sites in Total (8 Secondary, 72 Quaternary / Observation).

Regional ecosystem 11.5.20 is represented most abundantly in the southern assessment area, particularly Kumbarilla State Forest by a woodland of 16-23m in height. Grey Box (*Eucalyptus woollsiana*) is the dominant species, occasionally with associated narrow leaf ironbark (*E. crebra*). Canopy species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.).

A typically sparse native groundcover (15 – 25% cover) is dominated by Many-Headed Wire Grass (*Aristida caput-medusae),* Barbed Wire Grass *(Aristida calycina),* Love Grass (*Eragrostis*

lacunaria), barbed wire grass *(Cymbopogon refractus),* Paspalidium *(Paspalidium distans),* and Windmill Grass (*Chloris truncata*) and *Gahnia aspera*.

This ecosystem has almost universally been subject to heavy logging regimes greatly simplified the original habitat structure.

Regional ecosystem 11.5.20 in the Kumbarilla State Forest with heavily modified structure through timber extraction and Grazing.

Regional Ecosystem 11.5.21

Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa woodland on Cainozoic sand plains/remnant surfaces.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

62 Sites in Total (7 Secondary, 1 Tertiary, 54 Quaternary / Observation).

This woodland ecosystem generally occupies sandier localities on Tertiary age plains. The canopy height ranges between 14-23m and a mean crown cover of 32%. It is dominated by yellow bloodwood *(Corymbia bloxsomei)* in association with smooth barked apple *(Angophora*

leiocarpa), narrow leaf ironbark *(Eucalyptus crebra),* Queensland blue gum *(Eucalyptus tereticornis),* and white cypress *(Callitris glaucophylla).*

The second tree layer is poorly formed and often absent with white cypress, bull oak (*Allocasuarina luehmanii*) and occasional narrow leaf ironbark. The shrub layer ranges between 1-5 m in height with a very sparse cover average of 11%. Characteristic species are *Acacia spectabilis*, *Callitris glaucophylla*, *Allocasuarina Luehmannii*. Others include *Acacia amblygona, Acacia ixiophylla, Eucalyptus crebra, Hakea purpuea, Leptospermum polygalifolium, Leucopogon sp., Micromyrtus sessilis, Opuntia tomentosa *,* and *Xylomelum cunninghamianum.*

The ground layer is in good condition with a mean PFC of 62%, and comprises native species which include *Triodia scariosa, Aristida caput-medusae, Brachyscome sp., Cheilanthes sieberi, Chrysocephalum apiculatum, Cymbopogon refractus, Dianella brevipedunculata, Eragrostis sp., Eulaia aurea, Fimbristylis dichotoma, Homoranthus melanostictus, Lomandra leucocephala subsp. leucocephala, Murdannia graminea, Pimelea novae-hollandaei, Pleurocarpaea sp., Tricoryne elatior and Xanthorrhoea johnsonii* which forms a dominant cover in some localities.

The habitat is generally well preserved with limited disturbance evident in most representations.

Regional ecosystem 11.5.21 in Barakula State Forest, central assessment area.

Regional Ecosystem 11.7.2

Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

25 Sites in Total (5 Secondary, 20 Quaternary / Observation).

Regional ecosystem 11.7.2 occupies areas of extremely shallow soil, typically growing on rudosols formed on indurated sandstones in the central assessment area. The habitat is dominated by Lancewood (*Acacia shirleyi)* although have other species scattered throughout its canopy including *Eucalyptus fibrosa subsp. nubile,* Narrow Leaf Ironbark (*Eucalyptus crebra*) and Queensland Peppermint (*Eucalyptus exserta).* Canopy heights range from 14-23m and crown cover varies between 30 to 80%.

The second tree layer is often absent or sparse Lancewood. The upper shrub layer is formed by Lancewood, *Alphitonia excelsa, Ehretia membranifolia,* Bitter Bark (*Alstonia constricta)* while the lower layer consists of *Dodonaea biloba, D. macrossanii, Prostanthera cryptandroides subsp. euphrasioides. Leucopogon sp., Dodonaea triangularis* and *Acacia triptera.*

The ground layer generally retains near natural condition with up to 70% cover of wiry grasses include *Ancistrachne uncinellata* and *Thyridolepis mitchelliana.* The habitat is generally well preserved although clearing and timber harvesting affects some localities.

Tall straight stand of Lancewood characteristic of RE11.7.2

Regional Ecosystem 11.7.4

Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius on lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

538 Sites in Total (20 Secondary, 4 Tertiary, 514 Quaternary / Observation).

An extensive habitat type within the central and southern assessment areas. This woodland ecosystem is restricted to low hills and rises where soils are shallow and gravelly ridges. Characteristic species in the canopy are Queensland peppermint (*Eucalyptus exserta),* Brown Bloodwood (*Eucalyptus trachyphloia)* and Smooth Barked Apple *(Angophora leiocarpa)* with less frequent White Cypress *(Callitris glaucophylla),* Narrow Leaf Ironbark *(Eucalyptus crebra)* and Lancewood (*Acacia shirleyi*). The canopy height ranges from 11 – 18m and average crown cover is around 40%.

A well-developed second tree layer has an average cover of around 50% and comprises Queensland Peppermint, Miles Mulga (*Acacia apprepta),* White Cypress, False Mahogany *(Eucalyptus rubiginosa),* Stringy Bark Sheoak (*Allocasuarina inophloia)* and Budgeroo *(Lysicarpus angustifolius).* Tall shrubs of *Acacia crassa* subsp*. crassa, Acacia julifera*, and *Acacia semilunata* dominate a sparse upper shrub layer. A distinct yet very sparse lower shrub layer features a range of low shrubs in particular *Leucopogon* sp*., Westringea cheellii, Acacia conferta,* and *Micromyrtus sessilis.*

The ground layer is mid dense and diverse with 42 species recorded. The native graminoids, include *Ancistrachne uncinellata, Thyridolepis mitchelliana, Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Panicum decompositum, Scleria sphacelata* and *Triodia scariosa* occupy the predominant living groundcover with the remainder of cover comprising perennial native herbs such as *Brunoniella acaulis, Cheilanthes sieberi, Goodenia sp*. and *Pleurocarpaea sp.* The woodland ecosystem generally retains good condition although some timber extraction is evident and severe fire damage is evident in Kumbarilla State Forest and some portions of the central assessment area to the north-west of Miles.

Typical structure of RE11.7.4 in the central assessment area (Site AG313_129).

Regional Ecosystem 11.7.5

Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

15 Sites in Total (2 Secondary, 13 Quaternary / Observation).

This shrubland ecosystem is restricted to shallow sandy soils on the surface of lateritic duricrust. Although most commonly found around Barakula State Forest in the central assessment area, small patches also occur in the south within Kumbarilla State Forest. The habitat is typified by a mid-dense upper shrub layer of Broombush (*Melaleuca uncinata*) or *Melaleuca nodosa* forms the ecological dominant layer with scattered Miles Mulga (*Acacia apprepta),* micromyrtus *(Micromyrtus sessilis),* Budgeroo (*Lysicarpus angustifolius)* and emergent White Cypress *(Callitris glaucophylla)* and Yellowjacket (*Corymbia bloxomeii).* A distinct lower shrub layer is also dominated by Broombush and Micromyrtus in association with dodder laurel *(Cassytha*

pubsecens), Leucopogon sp. (GBS3/7), Hakea purpurea, Pimelea nova-anglica, and *Callitris glaucophylla.*

In comparison to woodland habitats this shrubland ecosystem is depauperate in species. Low species diversity is reflected in the ground layer that supports a limited number of grasses including Spinifex (*Triodia scariosa*), *Aristida leichardtiana, Aristida ramose, Panicum decompositum, Panicum queenslandicum, Paspalidium distans* and the herbs *Cheilanthes sieberi, Drosera indica, Cassytha filiformis,* and *Boronia bipinnata.*

Recently burnt heath in Kumbarilla State Forest with dominant *Melaleuca uncinnata.*

Regional Ecosystem 11.7.6

Corymbia citriodora or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

17 Sites in Total (5 Secondary, 12 Quaternary / Observation).

Regional ecosystem 11.7.6 is largely restricted to the central assessment area to the north of Miles. This woodland to open forest ecosystem typically occurs on hills and ridge crests hills

with associated shallow gravelly soils. Spotted Gum *(Corymbia citriodora)* characterises the habitat and forms a relatively tall, continuous canopy cover up to 25m tall and cover ranging from 40 to 70%. Associated species include Narrow Leaf Ironbark *(Eucalyptus crebra)* Brown Bloodwood (*Eucalyptus trachyphloia)* and Smooth Barked Apple *(Angophora leiocarpa)* with less frequent White Cypress *(Callitris glaucophylla),* and Lancewood (*Acacia shirleyi*) although these are more commonly associated with a sparse sub-canopy layer forming 15 to 25% cover.

Tall shrubs of *Acacia crassa subsp. crassa, Alphitonia excelsa, Acacia semilunata, Acacia conferta* and *Allocasuarina leuhmanni* dominate a sparse shrub layer. Lower shrub layers are also sparse and are formed by *Dodonaea macrossanii, Mirbellia pungens, Acacia melliodora, Prostranthera sp., Westringea cheellii, Acacia conferta, Callitrix tetragona* and *Leucopogon muticus*.

The ground layer is mid dense and generally diverse with native covers including *Arundinella nepalensis, Ancistrachne uncinellata, Thyridolepis mitchelliana, Gahnia aspera, Lomandra leucocephala, Lomandra multiflora, Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Panicum decompositum, Scleria sphacelata* and *Triodia scariosa*.

A heavily logged representation of RE11.7.6 in the central assessment area.

Regional Ecosystem 11.7.7

Eucalyptus fibrosa subsp. nubila +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

212 Sites in Total (16 Secondary, 2 Tertiary, 194 Quaternary / Observation).

This widespread and relatively abundant woodland and open forest ecosystem occurs on low hills and ranges formed from deeply weathered sediments. Soils are shallow with sandy and gravelly surface horizons. Blue Leaved Ironbark (*Eucalyptus fibrosa* subsp*. nubila)* forms a distinct canopy which ranges between 11 and 25m in height. The canopy may also include Narrow Leaf Ironbark (*E. crebra* and *E. elegans*), Queensland peppermint (*E. exserta*) and white cypress (*Callitris glaucophylla*). These species also characterize a distinct yet discontinuous second tree layer. *Eucalyptus elegans* dominates the canopy in restricted locations although *Eucalyptus fibrosa* is always present.

Scattered tall shrubs such as *Acacia semilunata, Acacia conferta* and *Callitris glaucophylla* form a sparse to very sparse upper shrub layer. The lower shrub layer is similarly sparse and poorly formed and also comprises *Leucopogon* sp., *Acacia ixiophylla, Acacia muelleriana, Hakea purpurea* and *Westringea cheelii*.

The native species dominated ground layer is mid dense with grasses such as *Eulalea aurea, Paspalidium* sp., *Chloris truncata* and *Gahnia aspera* forming the majority of the cover. Characteristic native herbs and low herbaceous shrubs are *Dodonaea macrossanii, Dianella longifolia var. longifolia, Cheilanthes sieberi, Boronia bipinnata*, and *Brunoniella acaulis*.

Regional Ecosystem 11.7.7 on Girraween, central assessment area.

Regional Ecosystem 11.9.2

Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

1 Quaternary Site

Only a few, scattered remnants of this regional ecosystem are mapped in the northern assessment area to the north of Miles. The habitat is invariably dominated by a sparse canopy layer of Silver Leaf Ironbark (*Eucalyptus melanophloia)* with a mid-dense sub-canopy and shrub layer of White Cypress Pine. Canopy heights generally do not exceed 10m which is in part testament to a repetitive and heavy disturbance regime. There is limited canopy recruitment in these fragments and a significant portion of the original Silver Leaf Ironbark canopy layer is suffering from dieback and senescence. Ground covers are universally displaced by exotic Buffel Grass (*Cenchrus ciliaris).*

An extremely degraded patch of Callitris regrowth with scattered Silver Leaf Ironbark. The habitat in non-remnant in this location although remnants of the original ecosystem (RE11.9.2) are preserved in the vicinity.

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Appendix E.
Present, Likely or Possible Threatened Flora Species Profiles and Mapping Criteria

TREES AND SHRUBS

Kogan Waxflower (*Philotheca sporadica*)

Status

Near Threatened (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Philotheca sporadica 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 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 (TSSC 2008j). Field survey indicates that the species occurs almost exclusively within RE 11.7.4 (*Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius* on *lateritic duricrust*) and possibly RE11.7.5 with a few individual plants overlapping with RE11.7.7. The species has a tendency to form dense, locally restricted populations, particularly on scalded areas with limited soil

Known Threats to the Species

This species is threatened by clearing, particularly localised populations that might be impacted by well pads and linear infrastructure.

Records Relevant to the SGP

Six localised populations are identified within the assessment area to the east of Kogan, both within both private land and State Forest. Populations may cover extensive areas although the margins of populations are generally discrete.

Rule(s) for Habitat Mapping:

1. The species will most likely occur within a 25km wide buffer surrounding Kogan although cannot be discounted as occurring within suitable habitats throughout the SGP assessment area.
2. REs 11.7.4 and 11.7.7 are classified as "Core habitat Possible" within 25km from Kogan.
3. Regrowth habits (non-remnant) derived from RE11.7.4 within 25km from Kogan are classified as "General Habitat'.
4. All "Core Habitat Possible" and "General Habitat" within 1km of a recent (1980+), accurate (± 100m) record is reclassified as "Core Habitat Known".
5. The remaining areas of RE11.7.4 throughout the SGP assessment area are classified as "General Habitat"
6. All other areas are classified as "Absence Suspected".

Mapping Confidence

The detailed ground surveys undertaken throughout habitats for this species in the SGP area and highly localised populations gives habitat mapping is presented with high confidence.

Photograph: David Stanton

Waaje Wattle (Acacia barakulensis)

Status

Vulnerable (NC Act)

Distribution and Habitat

Waaje Wattle is a Queensland and bioregional endemic that is Restricted to Barakula State Forest north of Chinchilla where it grows on sandy soils in eucalypt communities in the Waaje Wildflower Area (Lithgow 1997, Chinchilla Field Naturalists Club 1997, Maslin 2001).

HERBRECS specimen records indicate habitat in flat gently undulating plains on the crest of the slope on deep yellow loamy sand soil derived from sandstone or laterite. Vegetation is tall shrubland with *Eucalyptus tenuipes, Corymbia trachyphloia, Calytrix gurulmundensis*, and *Triodia mitchellii* (DEHP 2017). Habitat is consistent with RE 11.7.4, 11.7.5, 11.7.6, and 11.7.7. Survey records identified the species in woodland of narrow leaf ironbark (*Eucalyptus crebra*) + smooth barked apple (*Angophora leioclada*) + white cypress pine (*Callitris*

glaucophylla) with a subcanopy of white cypress and bulloak (*Allocasuarina luehmanii*) on old loamy plains (RE 11.5.1, 11.5.4, 11.5.21).

Ecology

Similarity to many Acacias, there is a likelihood that Acacia barakulensis will respond to disturbance, or populations rejuvenated by fire. Knowledge of the species biology and response to disturbances such as habitat fragmentation, changed fire regimes and edge effects requires is poorly understood.

Known Threats to the Species

The species may be impacted by habitat clearing or fragmentation that leads to changes in fire frequency and intensity. As known populations are well away from the SGP assessment area impacts are more likely to be generated during forestry operations.

Records Relevant to the SGP

Herbrecs identifies 5 confirmed populations 28 km to the north-east of the SGP area within Barakula State Forest. Due to contiguity of habitats between populations and the SGP assessment area, it is considered possible that the species may occur.

General Rule(s) for Habitat Mapping:

1. The species will only likely occur in the Central assessment area.
2. Within the central area of the SGP, RE's 11.5.1, 11.5.14, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 are mapped as "General Habitat" due to lack of local records.

Mapping Confidence

Due to the relatively broad habitat tolerances, mapping of general habitat is considered to be of moderate accuracy.

Curly-bark Wattle (*Acacia curranii*)

Status

Vulnerable (NC Act)

Distribution and Habitat

The only known 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 is restricted to an area of less than 20 km diameter and represents a highly disjunct northern limit of distribution with southern populations in NSW.

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 2008a). The Gurlumundi population has been reported as growing in dense "groves" (Pedley 1987). Queensland collections of curly-bark wattle, recorded in Herbrecs, 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.

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 observed 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).

Known Threats to the Species

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. Additional threats include clearing of vegetation for road widening, gravel extraction and mining

Records Relevant to the SGP

Sixteen records of the species are confirmed in Herbrecs with the nearest population 11 km west of the SGP area with Gurulmundi State Forest (excluding low precision records).

General Rule(s) for Habitat Mapping:

1. The species will only occur in the central portion of the SGP assessment area to the north of Miles.
2. In the absence of survey records within the SGP area, RE11.7.5, 11.7.4, 11.7.7 in the potential area of occurrences have been allocated as "General Habitat".

3. All other regional ecosystems, regrowth and cleared areas are mapped as "Absence Suspected".

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment.

Curly-bark wattle (*Acacia curranii).* Photograph M. Fagg, Australian National Botanical Gardens

Hando's Wattle (*Acacia handonis*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act Act)

Distribution and Habitat

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).

Hando's wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest (Maslin 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 RE 11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. One collection is also recorded in RE 11.7.6: *Corymbia citriodora* or *Eucalyptus crebra* woodland on lateritic duricrust.

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. 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).

Known Threats to the Species

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.

Records Relevant to the SGP

Seventeen records in Herbrecs with the nearest population 35 km east of the SGP assessment area within Barakula SF.

Rule(s) for Habitat Mapping:

Regional Ecosystems 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 in the Central region of the SGP (North of Miles) should be classed as "General Habitat" on account of the intensive survey undertaken in the assessment area

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment.

Photograph M. Fagg, Australian National Botanical Gardens.

Bailey's Callitris (*Callitris baileyii*)

Status

Near Threatened (NC Act)

Distribution and Habitat

In Queensland, Baileys Cypress occurs from the state border to Goomeri in the north and west to the Bunya Mountains. The distribution is predominantly within the Southeast

Queensland bioregion extending into the Brigalow Belt near the bioregional boundary (EHP 2017b). The species also occurs in the drier ranges of NSW.

Typical habitat is open woodland and woodland of *Eucalyptus exserta*, *E. crebra* and *Callitris glaucophylla* with a mid-dense shrubby understorey typical of RE11.7.4. Stanley & Ross (1983) describe its habitat as eucalypt woodland, with ironbark, blue gum and spotted gum on rocky slopes, hilly or mountainous areas, in shallow and often clay soils.

Ecology

Little is known concerning the ecology of this species. Male and female flowers occur on the same tree and fruiting has been recorded all year round.

Known Threats to the Species

This species is threatened by direct loss as a result of clearing as well as inappropriate fire regimes.

Records Relevant to the SGP

Nearest local record is 2.6 km west of the SGP assessment area (40 km north of Miles) in Gurulmundi State Forest. The record was collected during SGP EIS studies in 2011.

Rule(s) for Habitat Mapping:

REs 11.5.1, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected".

Mapping Confidence

The general nature of habitat for this species makes preferred habitats relatively easy to predict and habitat mapping for the species is considered to have high to moderate confidence.

Gurulmundi Fringe Myrtle (*Callitrix gurulmundensis)*

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

The species is endemic to the Gurulmundi and Barakula areas north of Chinchilla (Halford 1996). Gurulmundi fringe myrtle has been recorded growing in patches of shrubland on very shallow soils. 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 RE 11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks). The coordinates of Gurulmundi fringe myrtle collections

derived from Herbrecs place them in areas mapped by as RE11.7.4, 11.7.5, 11.7.6 and 11.7.7.

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 (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 2013a).

Known Threats to the Species

Clearing, disturbance for track creation and maintenance and inappropriate fire regimes are the key threats to habitat for this species. At least one population is identified as having been damaged in the past due to gravel extraction (Williams 1979).

Records Relevant to the SGP

The nearest local record is 12 km west of the SGP assessment area (30 km north of Miles) within Gurulmundi State Forest. A population also exists in Waaje Scientific Reserve 36 km east of Wandoan.

Rule(s) for Habitat Mapping:

REs 11.5.1, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment that did not locate any additional populations.

Gurulmundi fringe myrtle (*Calytrix gurulmundensis)* foliage and flower. Copyright © Boobook

Gurulmundi Heath-myrtle (*Micromyrtus carinata*)

Status

Endangered (NC Act)

Distribution and Habitat

Endemic to Queensland, *Micromyrtus carinata* is known only from the Gurulmundi State Forest 40 km to the north of Miles with a sub-population also located on the Wyona Property 10km to the north of Miles (Herbrecs).

Herbarium records indicate *Micromyrtus carinata* is associated with landscapes formed on lateritised sediments with an upper soil layer of red to yellow sand (DEHP 2017c). Associated regional ecosystems include inhabits the tops of laterised ridges, on shallow to deep, yellow or red sands. Associated habthitats include heath and shrubland (RE11.7.5) and low woodland dominated by *Eucalyptus exserta, Corymbia trachyphloia* and *Callitris glaucophylla* (RE11.7.4).

Ecology

Little is known regarding the ecology of this species. Bean (1997) suggest that it likely flowers at any time in response to rain although fruits and flowers have been collected between May and October (DEHP 2017c).

Known Threats to the Species

The species is considered to be threatened by mining activity, gravel extraction and inappropriate fire regimes (Bean, 1997, DEHP 2017c).

Records Relevant to the SGP

Nearest Herbarium Record is 10km north-west of Miles and 4 km west of the SGP assessment area on the Wyona Property. The major population of the species occurs in Gurulmundi State Forest 12km west of the SGP assessment area (Herbrecs)

Rule(s) for Habitat Mapping:

REs 11.7.4 and 11.7.5 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment that did not locate any additional populations.

Plunkett Mallee (*Eucalyptus curtisii*)

Status

Near Threatened (NC Act)

Distribution and Habitat

The plant is scattered but nowhere common occurring on coastal hinterland to 80 km north and south of Brisbane and inland over 300 km north west to the Dalby and Miles districts (DNR 2000). Occurs in the Burnett, Leichhardt, Moreton and Darling Downs pastoral districts (Bostock and Holland 2016). Conserved in Expedition Range, Robinson Gorge and Isla Gorge National Parks (Brooker and Kleinig 2004).

DEHP (2017d) suggests *Eucalyptus curtisii* has two growth forms that occur in different habitats with a shorter shorter mallee associated with shrublands dominanted by banksia in poorly drained lowland sites with a larger growth occurring as scattered individuals on better drained soils in the more open areas of mixed eucalypt forests. The species is most typically associated with lateritised landscapes within regional ecosystems 11.7.4 and 11.7.5. Commonly associated species include *C. trachyphloia, Eucalyptus exserta* and *Callitris endlicheri* and less commonly associated with *E. fibrosa*.

Ecology

Flowering of *Eucalyptus curtisii* has been recorded between the months of September and November, and fruiting occurs throughout the year (Queensland Herbarium, 2012 cited in DEHP 2017d). Response to fire is not documented.

Known Threats to the Species

Known threatening process related largely to clearing, timber harvesting and inappropriate grazing and fire regimes.

Records Relevant to the SGP

Numerous local records mostly west of the SGP with the nearest record 2.5 km west of the SGP assessment area and 35km north of Miles. A number of records in Kumbarilla State Forest to the south although well outside the SGP assessment area.

Rule(s) for Habitat Mapping:

Eucalyptus curtisii may occur throughout the entire assessment area. Through the assessment area, REs 11.7.2, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 should be classified as "General Habitat" in recognition of the extensive survey effort undertaken. All other REs and non-remnant vegetation should be classified as "Absence Suspected".

Mapping Confidence

Due to the extensive survey effort and known habitat preferences, mapping of *Eucalyptus curtisii* is attributed as having a high degree of confidence.

GRASSES AND SEDGES

Finger Panic Grass (*Digitaria porrecta*)

Status

Near Threatened (NC Act)

Distribution and Habitat

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).

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; 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.

Ecology

Finger panic grass is a spreading perennial that can reproduce vegetatively (Halford 1995a). 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 1995a). 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).

Known Threats to the Species

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.

Records Relevant to the SGP

Two records within the SGP assessment area, both in non-remnant derived grasslands adjacent to roadside easements between Dalby and Cecil Plains. Both records collected in 1995. A further 15 records within 25km east of the SGP boundary.

Rule(s) for Habitat Mapping:

1. The species is most likely to occur on heavy clay soils associated with the Condamine Alluvium although may occur throughout the entire assessment area.
2. Regional Ecosystem 11.3.2 should be treated as "General Habitat".
3. Derived native grassland where it is associated with the Condamine Alluvium or other heavy clay soil should be considered "General Habitat".
4. High precision (+/- 500m) species records should be buffered by 1km and all General Habitat upgraded to "Core Habitat Known".
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "Absence Suspected".

Mapping Confidence

Digitaria porrecta has relatively predictable habitat preferences and with the availability of project scale mapping (1:50 000), it is considered that the habitat mapping has a high level of confidence. It should be noted that no records of the species have been formally documented since 1995 and

Fimbristylis vagans

Status

Endangered (NC Act)

Distribution and Habitat

A little-known Queensland and bioregional endemic restricted to the Darling Downs district between Lake Broadwater and Nudley Creek area (30 km NE of Chinchilla) (DERM 2011). The species occupies habitats that fringe ephemeral watercourses and lagoons on alluvium. Typical regional ecosystems include RE11.3.2, 11.3.4, 11.3.14 and 11.3.26 where they fringe watercourses and wetlands (RE11.3.27). The species is not known to be associated with non-remnant habitats.

Ecology

Species ecology is poorly documented although like most species associated with wetland habitats, is likely to be a seasonally dependent species that flowers and reproduces following rainfall.

Known Threats to the Species

Threats are poorly documented although major threats are likely to be associated with damage created by feral animals, particularly pigs and intensive grazing.

Records Relevant to the SGP

A single herbarium record from the SGP assessment area associated with the swampy inlet of Lake Broadwater. The species has not been recorded or collected since 1984.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. "Core Habitat Possible" includes the wetland fringe of Lake Broadwater characterised by RE11.3.27f and wetland habitats of Long Swamp.
3. REs 11.3.2, 11.3.3, 11.3.4, 11.3.25 and 11.3.26 throughout the broader SGP assessment area is classified as "General Habitat".
4. All Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
5. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Habitat characteristics for this species are well understood and can be matched to regional ecosystem descriptions. The mapping is considered to be highly accurate.

Belson's Panic (Homopholis belsonii)

Status

Endangered (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

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). Also known from the north-western slopes and plains of NSW (TSSC 2008g).

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). Based on Herbrecs specimens, the species is most commonly associated with habitats on heavy clay soils, particularly those dominated by Brigalow including REs 11.3.1, 11.3.17, 11.4.3, 11.9.5 ad 11.9.10. Herbarium records also indicate some potential for the species to overlap with RE11.3.2.

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 (TSSC 2008g).

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).

Known 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).

Records Relevant to the SGP

A considerable number of records to the east of Dalby with the nearest 12km from the eastern boundary of the SGP assessment area. Two records within 8km of the boundary of the northern assessment area within 10km of Wandoan.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area although is most likely to occur in Brigalow associated habitats in the northern assessment area.

2. Regional Ecosystems 11.9.5, 11.9.10 and 11.3.17 including derived non-remnant regrowth is mapped as "Core Habitat Possible" in the northern assessment area.
3. REs 11.3.1, 11.3.17, 11.4.3 and 11.9.5 including non-remnant derived regrowth in central and southern portions of the SGP assessment area are classified as "General Habitat"

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Belson's panic (*Homopholis belsonii)*. Copyright © Boobook

FORBS AND HERBS

Solanum papaverifolium

Status

Endangered (NC Act)

Distribution and Habitat

Recorded in the Darling Downs from between Jimbour and Warwick, where it is known from three locations (Bean 2004). Known from a number of very old records in the Dalby-Cecil Plains area. Goodland (2000) reports two populations west of Dalby on the Warrego Highway before Kogan Rd), and large populations up to 100m extent off Cecil Plains Rd. Known in NSW north from Inverell to Quirindi and Singleton area and west to Narrabrii and Moree (Bean 2004). Occurs in wetter (swampy) areas of grasslands or open eucalypt woodland on heavy alluvial soils (Goodland 2000, Bean 2004).

Ecology

Little is documented on the ecology of the species. It has been observed flowering thoughout the year and populations are most likely rejuvenated following rainfall.

Known Threats to the Species

The species occurs on soils utilised by intensive agriculture and remains on roadside reserves and stock routes. Populations remain threatened by habitat destruction, weed invasion, and roadworks (Goodland 2000, Bean 2004).

Records Relevant to the SGP

Two records are contained within the SGP assessment area to the south of Dalby with an large number of herbarium records to the east of the SGP assessment area between Chinchilla and Dalby.

Rule(s) for Habitat Mapping:

1. The species is most likely to occur on habitat formed by heavy clay soils associated in particular with the Condamine Alluvium.
2. Regional Ecosystems 11.3.2 and Derived Native Grassland (non-remnant) provide the most suitable habitats for the species. Where these habitats occur on the alluvial landforms to the west and south of Dalby, they are mapped as "General Habitat".
3. All General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Solanum papaverifolium (Photograph David Stanton).

Solanum stenopterum

Status

Vulnerable (NC Act)

Distribution and Habitat

Recorded in Queensland from Gayndah in the Burnett Pastoral district to Moonie and west to Glenmorgan and Yuleba (Bean 2004, Bostock and Holland 2016). Known in NSW from Ashford (Bean 2004). The species is Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5km east of Cecil Plains in a roadside gravel pit; and approximately 6km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2).

Ecology

Little is documented on the ecology of the species although similar to many solanum species in the Brigalow Belt, likely flowers at multiple times throughout the year in response to rainfall events.

Known Threats to the Species

The species occurs on soils utilised by intensive agriculture and occurs on roadside reserves. Populations remain threatened by habitat destruction from land clearing, agricultural practices, weed invasion, roadworks and roadside maintenance (Bean 2004).

Records Relevant to the SGP

Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5km east of Cecil Plains in a roadside gravel pit; and approximately 6km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2). All herbarium records are outside SGP assessment area.

Rule(s) for Habitat Mapping:

1. REs 11.3.2, 11.3.1 and 11.3.17 to the west and south of Dalby should be classed as "General Habitat" on account of comprehensive surveys.
2. Derived grasslands on alluvium and regrowth vegetation derived from the aforementioned REs

All other remnant vegetation and cleared agricultural land in the project development area should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Cymbonotus maidenii

Status

Endangered (NC Act)

Distribution and Habitat

The species occurs in scattered populations throughout central areas of NSW and in southern inland districts as far west as Mitchell (Holland and Funk, 2006).

The species is associated with a range of remnant and non-remnant habits with records occurring on disturbed roadside drains, native and derived grasslands. It is typically associated with heavy brown to grey cracking clay soils (Holland & Funk 2006). Habitats favoured by the species are RE11.3.21 from which it is known to occur. The woodland RE11.3.2 and derived native grassland also present potential habitat for the species. It can however occur in a range of highly disturbed locations and hence its occurrence may not be readily predicted.

Ecology

Other than being a perennial, very little is known about this species although, though as a daisy it is probably fairly short-lived (e.g. living < 5 years). The species is known to flower throughout the year but most prominently in spring, possibly in response to rainfall. The

seeds are likely to be wind dispersed, which should assist colonisation. It has the ability to survive along disturbed roadsides in in other highly disturbed habitats.

Known Threats to the Species

The species is threatened by roadside clearing and herbicide drift. It may also be threatened by invasion of exotic species of which lippia (*Phyla canescens)* and green panic (*Megathyrsus maximus var. pubiglumis)* pose the most immediate threat.

Records Relevant to the SGP

Five Herbrecs specimens recorded within 10 km of the eastern boundary of the SGP assessment area, mostly in the Cecil Plains / Millmerran Area including collections on road reserves on the Cecil Plains - Millmerran Road.

Rule(s) for Habitat Mapping:

The species is most likely to occur from the Dalby area (-27.00) south to Millmerran (-27.9) generally on the Condamine Alluvium. RE 11.3.2 and associated derived grasslands occuring between in this area should be treated as "general habitat".

All other remnant vegetation and cleared agricultural land in the project development area should be treated as "absence suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence. There may however be a number of potential habitats adjacent to roadsides that are beyond mapping resolution.

Picris barbarorum

Status

Vulnerable (NC Act)

Distribution and Habitat

Occurs from the Darling Downs and Warrego pastoral districts in southern Queensland (Bostock & Holland 2016), to north of the north-west plains of NSW. Herbrecs data indicates that in the Darling Downs, it has a restricted distribution but may be locally abundant along roadsides. Known to occur from the Jandowae, Macalister, Norwin locailities and along the Warrego highway west of Dalby.

Herbrecs specimens indicate occurrence in native grassland (12.3.21) of Dichanthium sericeum in stock routes, road reserves adjacent to disturbed areas such as cultivated paddocks and road and rail lines on black clay soil (DERM 2011).

Ecology

Very little is known about this species although, though as a daisy it is probably fairly short-lived (e.g. living < 5 years). Flowering period is not documented although it is likely to be re-invigorated in response to rainfall, particularly in the spring period.

Known Threats to the Species

Vouchered records of Plains Picris suggest that the annual herb may be tolerant of light disturbance. Its known occurrence on roadsides suggest it may be impacted by roadworks. In similarity to Picris evae it may well be intolerant of grazing and capable of surviving other forms of disturbance.

Records Relevant to the SGP

Four herbarium records within 5km of the SGP assessment area with the nearest less than 2 km from the assessment area boundary, 14km north-west of Dalby.

Rule(s) for Habitat Mapping:

The following REs and habitats should be classified as "General Habitat" where they area association with the Condamine Alluvium.

1. RE 11.3.2 and derived regrowth vegetation.
2. Non-remnant derived native grasslands

All other remnant vegetation in the SGP Assessment area and cleared agricultural and grazing land should be treated as "absence suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence. There may however be a number of potential habitats adjacent to roadsides that are beyond mapping resolution.

Rutidosis lanata

Status

Vulnerable (NC Act)

Distribution and Habitat

Endemic to south central Queensland from near Jackson to Hannaford on the western Darling Downs (DNR 2000). Mainly found in roadside vegetation of Acacia and Eucalypt woodland/open forest on red sandy ridges and clay flats between 280-320m altitude adjacent to cleared or partly cleared grazing and cropping land (DNR 2000). Based on Herbrecs notes, associated vegetation includes open grassy woodland of *Eucalyptus populnea* with *Eremophila mitchellii; Acacia harpophylla, Casuarina cristata*, and *Eucalyptus woollsiana* woodland on reddish-brown loamy clay; remnant *Acacia harpophylla, Eucalyptus coolabah,*

Eucalyptus populnea open forest on alluvium clay loam and gentle sedimentary rises; and in cleared areas along powerlines adjoining *Acacia aprepta* thicket.

Ecology

Rutidosis lanata flowers and fruits from October to March and produces a soil-stored seed bank that lasts for less than one year (DEHP 2017e; Pollock, 1997).

Known Threats to the Species

The species and habitat are known to be threatened by clearing with possible threats of inappropriate grazing, road verge maintenance, and habitat disturbance by weeds and introduced pastures (DNR 2000).

Records Relevant to the SGP

Eight Herbarium records within 20km from the the SGP Assessment area, all recorded in the Miles / Chinchilla area.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire project area although is more likely north from Chinchilla based on vouchered herbarium records. Throughout the assessment area, the following REs should be treated as 'General Habitat'; 11.3.4, 11.3.2, 11.3.17, 11.9.5 and 11.9.7.
2. All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Xerothamnella herbacea

Status

Endangered (NC Act): Endangered (EPBC Act)

Distribution and Habitat

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 population occur between Goondiwindi and Millmerran.

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 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 typically dominated by Brigalow or Belah and include REs 11.3.1, 11.4.3 and 11.9.5.

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.

Known Threats to the Species

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).

Records Relevant to the SGP

Two herbarium records to within 20km of the SGP Boundary, 20km to the east and north of Chinchilla.

Rule(s) for Habitat Mapping:

The species may occur throughout the entire project area where it may be associated with Brigalow dominant habitats. Throughout the assessment area, the following REs and any derived regrowth Brigalow > 15 yrs age should be treated as 'General Habitat'; 11.3.1, 11.4.3 and 11.9.5.

All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Xerothamnella herbacea. Photograph Copyright © Boobook

Cryptandra ciliata

Status

Near Threatened (NC Act)

Distribution and Habitat

Restricted to the Gurulmundi, Barakula and Cracow areas of south-eastern Queensland (Chinchilla Field Naturalists Club 1997, DNR 2000). Typical habitat is eucalypt dominant woodland, lancewood (*Acacia shirleyi*) woodland and Triodia grassland on rocky on low lateritic and sandstone ridges. Habitat in the PDA is consistent with RE 11.7.5, 11.7.4, 11.7.6, 11.5.1, 11.5.4, 11.5.21.

Ecology

There is little documented information on the ecology of this species.

Known Threats to the Species

DNR (2000) indicate that the species and habitat is possibly threatened by clearing associated with gravel extraction. Other potential threats may include road construction and maintenance, and inappropriate fire regimes.

Records Relevant to the SGP

Three herbarium records within 5km of the assessment area boundary with a single record within 1km of the eastern boundary, 30km to the north of Miles.

Rule(s) for Habitat Mapping:

1. The species is only likely to occur in the central portion of the SGP assessment area where the following REs should be treated as "General Habitat"; 11.5.1, 11.5.4, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7.
2. All General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
3. All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the general habitat requirements, intensity of the field survey and detailed mapping revision available, mapping is considered to have a high degree of confidence.

Austral Toadflax (*Thesium australe*)

Status

Vulnerable (NC Act): Vulnerable (EPBC Act)

Distribution and Habitat

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 2016). The Dalby area represents the species western limits on the Darling Downs.

Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE 11.3.2) north-west 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*). RE11.3.2 in the Dalby region is considered the most likely habitat in the SGP assessment area.

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).

Known Threats to the Species

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. 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.

Records Relevant to the SGP

Two herbarium records within 10km of the SGP assessment area, with the nearest record 2.7k east of the eastern SGP assessment area boundary, 25km north west of Dalby.

Rule(s) for Habitat Mapping:

Intact representation of Poplar Box dominant woodland (RE11.3.2) associated with the Condamine River Alluvium (Condamine River Floodplain) should be treated as "General Habitat'. All other REs, non-remnant regrowth and cultivated areas should be treated as "Absense Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

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Appendix F.
Recorded Vertebrate Fauna List

List of Terrestrial Vertebrate Fauna Recorded during the 2016-17 SGP surveys

GROUP		Status		SGP Region		
Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
AMPHIBIAN						
Crinia parinsignifera	Beeping froglet		LC	X	X	
Pseudophryne major	Great brown broodfrog		LC		X	
Uperoleia laevigata	Eastern toadlet		LC	X		
Uperoleia rugosa	Chubby toadlet		LC	X	X	
Uperoleia sp.			LC	X	X	
Limnodynastes fletcheri	Barking marsh frog		LC		X	
Limnodynastes salmini	Salmon-striped frog		LC		X	
Limnodynastes tasmaniensis	Spotted marsh frog		LC	X	X	
Limnodynastes terraereginae	Scarlet-sided pobblebonk		LC	X	X	
Neobatrachus sudellae	Meeowing frog		LC	X	X	
Notaden bennettii	Holy cross frog		LC		X	
Platyplectrum ornatum	Ornate burrowing frog		LC	X	X	
Cyclorana alboguttata	Greenstripe frog		LC	X	X	
Cyclorana brevipes	Superb collared frog		LC		X	
Cyclorana novaehollandiae	Eastern snapping frog		LC	X	X	
Litoria caerulea	Green tree frog		LC	X	X	
Litoria fallax	Eastern sedge frog		LC	X	X	
Litoria latopalmata	Broad-palmed rocketfrog		LC	X	X	
Litoria peronii	Emerald-spotted treefrog		LC	X	X	
Litoria rubella	Ruddy treefrog		LC	X	X	
Rhinella marina	Cane toad		I	X	X	
Amphibian Total	20			16	20	0
REPTILE						
Underwoodisaurus milii	Thick-tailed gecko		LC	X	X	
Amalosia sp. cf. jacovae			LC		X	
Amalosia sp. cf. rhombifer			LC		X	
Diplodactylus vittatus	Eastern stone gecko		LC	X	X	
Lucasium steindachneri	Box-pattern gecko		LC	X	X	
Nebulifera robusta	Robust velvet gecko		LC	X	X	
Oedura tryoni	Southern spotted velvet gecko		LC		X	
Strophurus taenicauda	Golden-tailed gecko		**NT**	X	X	
Gehyra dubia	Dubious dtella		LC	X	X	X
Heteronotia binoei	Bynoe's gecko		LC	X	X	X
Delma plebeia	Common delma		LC		X	
Lialis burtoni	Burton's legless lizard		LC		X	
Pygopus schraderi	Eastern hooded scaly-foot		LC		X	
Anomalopus leuckartii	Two-clawed Worm-skink		LC		X	
Carlia munda	Striped rainbow skink		LC		X	
Carlia pectoralis	Open-litter rainbow skink		LC	X		

GROUP			Status		SGP Region		
	Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
	Carlia rubigo	Orange-flanked rainbow skink		LC	X	X	X
	Carlia sp.	Rainbow skink		LC	X	X	
	Carlia vivax	Tussock rainbow-skink		LC	X		
	Cryptoblepharus pulcher	Elegant snake-eyed skink		LC	X	X	X
	Cryptoblepharus sp.			LC	X	X	
	Ctenotus allotropis	Brown-blazed wedgesnout ctenotus		LC	X	X	
	Ctenotus spaldingi	Straight-browed ctenotus		LC	X	X	
	Cyclodomorphus gerrardii	Pink-tongue lizard		LC	X		
	Egernia striolata	Tree skink		LC	X		
	Lerista fragilis	Eastern mulch-slider		LC	X	X	X
	Lerista punctatovittata	Eastern robust slider		LC	X	X	
	Lerista timida	Timid slider		LC	X	X	
	Lygisaurus foliorum	Tree-base litter-skink		LC	X	X	
	Menetia greyii	Common dwarf skink		LC	X	X	
	Menetia sp.			LC	X		
	Morethia boulengeri	South-eastern morethia skink		LC	X	X	X
	Pygmaeascincus timlowi	Dwarf litter-skink		LC	X	X	
	Tiliqua rugosa	Shingleback		LC	X		
	Tiliqua scincoides	Eastern blue-tongue lizard		LC	X		
	Amphibolurus burnsi	Burns' dragon		LC	X		
	Amphibolurus sp.			LC	X		
	Diporiphora australis	Tommy round-head dragon		LC		X	
	Intellagama lesueurii	Eastern water dragon		LC	X	X	
	Pogona barbata	Eastern bearded dragon		LC	X	X	
	Varanus gouldii	Sand monitor		LC	X	X	
	Varanus panoptes	Yellow-spotted monitor		LC	X	X	
	Varanus tristis	Black-headed monitor		LC		X	
	Varanus varius	Lace monitor		LC	X	X	
	Morelia spilota	Carpet python		LC			
	Boiga irregularis	Brown tree snake		LC		X	
	Dendrelaphis punctulata	Common tree snake		LC	X		
	Tropidonophis mairii	Keelback		LC		X	
	Brachyurophis australis	Coral snake		LC		X	
	Cryptophis nigrescens	Eastern small-eyed snake		LC		X	
	Demansia psammophis	Yellow-faced whipsnake		LC	X	X	
	Furina diadema	Red-naped snake		LC	X	X	
	Hemiaspis damelii	Grey snake		**End**	X		
	Hoplocephalus bitorquatus	Pale-headed snake		LC	X	X	
	Parasuta dwyeri	Dwyer's snake		LC	X		
	Pseudechis porphyriacus	Red-bellied black snake		LC	X	X	
	Pseudonaja textilis	Eastern brown snake		LC		X	
	Vermicella annulata	Bandy Bandy		LC	X		
Reptile Total		55			44	44	6

GROUP		Status		SGP Region		
Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
BIRD						
Dromaius novaehollandiae	Emu		LC	X	X	
Cygnus atratus	Black Swan		LC	X		
Chenonetta jubata	Australian wood duck		LC	X		X
Nettapus coromandelianus	Cotton pygmy-goose		LC		X	
Anas gracilis	Grey teal		LC	X	X	
Anas superciliosa	Pacific black duck		LC	X	X	X
Tachybaptus novaehollandiae	Australasian grebe		LC	X	X	
Columba livia	Rock dove		I			
Phaps chalcoptera	Common bronzewing		LC	X	X	
Ocyphaps lophotes	Crested pigeon		LC	X	X	X
Geopelia striata	Peaceful dove		LC	X	X	
Geopelia humeralis	Bar-shouldered dove		LC	X	X	
Podargus strigoides	Tawny frogmouth		LC	X	X	
Eurostopodus mystacalis	White-throated nightjar		LC	X	X	
Eurostopodus argus	Spotted nightjar		LC	X	X	
Aegotheles cristatus	Australian owlet-nightjar		LC	X	X	X
Hirundapus caudacutus	White-throated needletail	**M**	LC	X	X	
Apus pacificus	Fork-tailed swift	**M**	LC		X	
Elanus axillaris	Black shouldered kite		LC	X		
Microcarbo melanoleucos	Little pied cormorant		LC	X	X	
Phalacrocorax sulcirostris	Little black cormorant		LC	X		
Pelecanus conspicillatus	Australian pelican		LC	X		
Ardea pacifica	White-necked heron		LC	X		
Egretta novaehollandiae	White-faced heron		LC	X	X	
Nycticorax caledonicus	Nankeen Night-Heron		LC	X	X	
Threskiornis molucca	Australian white ibis		LC		X	
Threskiornis spinicollis	Straw-necked Ibis		LC	X		
Aviceda subcristata	Pacific baza		LC			
Haliaeetus leucogaster	White-bellied sea-eagle		LC	X		
Haliastur sphenurus	Whistling kite		LC	X		
Accipiter fasciatus	Brown goshawk		LC	X		X
Accipiter cirrocephalus	Collared sparrowhawk		LC		X	
Circus approximans	Swamp harrier		LC	X		
Aquila audax	Wedge-tailed eagle		LC	X		
Falco cenchroides	Nankeen kestrel		LC	X		
Falco berigora	Brown falcon		LC	X	X	X
Falco longipennis	Australian Hobby		LC		X	
Gallirallus philippensis	Buff-banded Rail		LC		X	
Gallinula tenebrosa	Dusky moorhen		LC		X	
Fulica atra	Eurasian coot		LC		X	
Ardeotis australis	Australian bustard		LC			
Burhinus grallarius	Bush stone-curlew		LC		X	
Vanellus miles	Masked lapwing		LC	X		

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Dendrocygna arcuata	Wandering whistling duck		LC			
	Turnix varius	Painted button-quail		LC	X	X	
	Calyptorhynchus banksii	Red-tailed Black-cockatoo		LC			
	Calyptorhynchus lathami	Glossy black-cockatoo		**Vul**	X	X	
	Calyptorhynchus funereus	Yellow-tailed Black-cockatoo		LC			
	Eolophus roseicapillus	Galah		LC	X	X	X
	Cacatua sanguinea	Little corella		LC	X		
	Cacatua galerita	Sulphur-crested cockatoo		LC	X	X	X
	Nymphicus hollandicus	Cockatiel		LC	X		
	Trichoglossus haematodus	Rainbow lorikeet		LC	X	X	
	Trichoglossus chlorolepidotus	Scaly-breasted lorikeet		LC	X	X	
	Daphoenositta chrysoptera	Varied sitella		LC	X	X	
	Glossopsitta pusilla	Little lorikeet		LC	X	X	
	Alisterus scapularis	Australian king-parrot		LC	X	X	
	Aprosmictus erythropterus	Red-winged parrot		LC	X	X	X
	Platycercus adscitus	Pale-headed rosella		LC	X	X	X
	Psephotus haematonotus	Red-rumped parrot		LC	X		
	Centropus phasianinus	Pheasant coucal		LC	X	X	
	Eudynamys orientalis	Eastern koel		LC		X	
	Scythrops novaehollandiae	Channel-billed cuckoo		LC		X	
	Chalcites basalis	Horsfield's bronze-cuckoo		LC	X	X	
	Chalcites osculans	Black-eared cuckoo		LC		X	
	Chalcites lucidus	Shining bronze-cuckoo		LC	X	X	
	Chalcites minutillus	Little bronze-cuckoo		LC		X	
	Cacomantis flabelliformis	Fan-tailed cuckoo		LC		X	
	Cacomantis variolosus	Brush cuckoo		LC	X	X	
	Cacomantis pallidus	Pallid cuckoo		LC	X	X	
	Tyto delicatula	Eastern barn owl		LC		X	
	Ninox boobook	Southern boobook		LC	X	X	
	Ceyx azureus	Azure kingfisher		LC		X	
	Dacelo novaeguineae	Laughing kookaburra		LC	X	X	X
	Todiramphus pyrrhopygius	Red-backed Kingfisher		LC	X		
	Todiramphus sanctus	Sacred kingfisher		LC	X	X	
	Merops ornatus	Rainbow bee-eater		LC	X	X	
	Eurystomus orientalis	Dollarbird		LC	X	X	
	Cormobates leucophaea	White-throated treecreeper		LC	X	X	
	Climacteris picumnus	Brown treecreeper		LC	X		
	Malurus cyaneus	Superb fairy-wren		LC	X	X	X
	Malurus melanocephalus	Red-backed fairy-wren		LC		X	X
	Malurus lamberti	Variegated fairy-wren		LC	X	X	X
	Chthonicola sagittata	Speckled warbler		LC	X	X	
	Smicrornis brevirostris	Weebill		LC	X	X	X
	Gerygone fusca	Western gerygone		LC			
	Gerygone olivacea	White-throated gerygone		LC	X	X	X

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Acanthiza nana	Yellow thornbill		LC	X	X	X
	Acanthiza chrysorrhoa	Yellow-rumped thornbill		LC		X	X
	Acanthiza uropygialis	Chestnut-rumped Thornbill		LC			X
	Acanthiza reguloides	Buff-rumped thornbill		LC	X	X	
	Acanthiza apicalis	Inland thornbill		LC	X	X	X
	Acanthiza pusilla	Brown thornbill		LC	X	X	
	Pardalotus punctatus	Spotted pardalote		LC	X	X	
	Pardalotus striatus	Striated pardalote		LC	X	X	X
	Lichenostomus chrysops	Yellow-faced honeyeater		LC	X	X	X
	Gavicalis virescens	Singing honeyeater		LC		X	
	Lichenostomus leucotis	White-eared honeyeater		LC	X	X	
	Lichenostomus melanops	Yellow-tufted honeyeater		LC	X		
	Ptilotula fusca	Fuscous honeyeater		LC	X	X	
	Lichenostomus penicillatus	White-plumed honeyeater		LC	X	X	
	Manorina melanocephala	Noisy miner		LC	X	X	X
	Manorina flavigula	Yellow-throated miner		LC	X	X	
	Acanthagenys rufogularis	Spiny-cheeked honeyeater		LC	X	X	X
	Myzomela sanguinolenta	Scarlet honeyeater		LC	X	X	
	Lichmera indistincta	Brown honeyeater		LC	X	X	X
	Melithreptus gularis	Black-chinned honeyeater		LC	X	X	
	Melithreptus brevirostris	Brown-headed Honeyeater		LC	X	X	
	Melithreptus albogularis	White-throated honeyeater		LC	X		
	Melithreptus lunatus	White-naped Honeyeater		LC		X	
	Entomyzon cyanotis	Blue-faced honeyeater		LC	X	X	
	Philemon corniculatus	Noisy friarbird		LC	X	X	
	Philemon citreogularis	Little friarbird		LC	X	X	
	Plectorhyncha lanceolata	Striped honeyeater		LC	X	X	X
	Pomatostomus temporalis	Grey-crowned babbler		LC	X	X	X
	Coracina novaehollandiae	Black-faced cuckoo-shrike		LC	X	X	
	Coracina papuensis	White-bellied cuckoo-shrike		LC	X	X	
	Coracina tenuirostris	Cicadabird		LC	X	X	
	Lalage tricolor	White-winged triller		LC	X	X	
	Pachycephala pectoralis	Golden whistler		LC	X	X	
	Pachycephala rufiventris	Rufous whistler		LC	X	X	X
	Colluricincla harmonica	Grey shrike-thrush		LC	X	X	
	Oriolus sagittatus	Olive-backed oriole		LC	X	X	X
	Artamus leucorynchus	White-breasted woodswallow		LC	X	X	
	Artamus superciliosus	White-browed woodswallow		LC	X	X	
	Artamus cyanopterus	Dusky woodswallow		LC	X	X	
	Artamus minor	Little woodswallow		LC	X		
	Cracticus torquatus	Grey butcherbird		LC	X	X	X
	Cracticus nigrogularis	Pied butcherbird		LC	X	X	
	Cracticus tibicen	Australian magpie		LC	X	X	X
	Strepera graculina	Pied currawong		LC	X	X	

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Dicrurus bracteatus	Spangled Drongo		LC	X		
	Rhipidura rufifrons	Rufous fantail	**M**	LC	X		
	Rhipidura albiscapa	Grey fantail		LC	X	X	
	Rhipidura leucophrys	Willie wagtail		LC	X	X	X
	Corvus coronoides	Australian raven		LC	X	X	X
	Corvus orru	Torresian crow		LC	X	X	
	Myiagra rubecula	Leaden flycatcher		LC	X	X	
	Myiagra inquieta	Restless flycatcher		LC	X	X	
	Grallina cyanoleuca	Magpie-lark		LC	X	X	X
	Corcorax melanorhamphos	White-winged chough		LC	X	X	
	Struthidea cinerea	Apostlebird		LC	X	X	X
	Microeca fascinans	Jacky winter		LC	X	X	
	Petroica goodenovii	Red-capped robin		LC	X	X	
	Eopsaltria australis	Eastern yellow robin		LC	X	X	
	Zosterops lateralis	Silvereye		LC	X		
	Hirundo neoxena	Welcome Swallow		LC	X		
	Petrochelidon nigricans	Tree martin		LC	X	X	
	Dicaeum hirundinaceum	Mistletoebird		LC	X	X	X
	Taeniopygia bichenovii	Double-barred finch		LC	X	X	X
	Anthus novaeseelandiae	Australian pipit		LC			X
	Sturnus tristis	Common myna		I	X		
Bird Total		151			122	116	38
MAMMAL							
	Tachyglossus aculeatus	Short-beaked echidna		LC	X	X	X
	Antechinus flavipes	Yellow-footed Antechinus		LC	X		
	Planigale maculata	Common planigale		LC	X	X	
	Sminthopsis murina	Common dunnart		LC	X	X	
	Phascolarctos cinereus	Koala	**Vul**	**Vul**	X	X	
	Trichosurus vulpecula	Common brushtail possum		LC	X	X	
	Petaurus breviceps	Sugar glider		LC	X	X	
	Petaurus norfolcensis	Squirrel glider		LC	X	X	
	Petauroides volans	Greater glider	**Vul**	**Vul**	X	X	
	Acrobates frontalis	Broad-toed Feathertail glider		LC		X	
	Aepyprymnus rufescens	Rufous bettong		LC		X	
	Macropus dorsalis	Black-striped wallaby		LC	X	X	
	Macropus giganteus	Eastern grey kangaroo		LC	X	X	
	Macropus robustus	Wallaroo		LC	X		
	Macropus rufogriseus	Red-necked wallaby		LC	X	X	X
	Wallabia bicolor	Swamp wallaby		LC	X	X	
	Saccolaimus flaviventris	Yellow-bellied sheathtail bat		LC	X	X	
	Austronomus australis	White-striped freetail bat		LC	X	X	
	Mormopterus lumsdenae	Northern free-tailed bat		LC	X	X	
	Mormopterus ridei	Ride's free-tailed bat		LC	X	X	

GROUP			Status		SGP Region		
	Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
	Mormopterus petersi	Inland free-tailed bat		LC	X	X	
	Mormopterus sp.			LC	X		
	Chalinolobus gouldii	Gould's wattled bat		LC	X	X	
	Chalinolobus picatus	Little pied bat		LC	X	X	
	Nyctophilus geoffroyi	Lesser long-eared bat		LC	X		
	Nyctophilus gouldi	Gould's long-eared bat		LC	X	X	
	Nyctophilus corbeni	South-eastern long-eared bat	**Vul**	**Vul**	X	X	
	Nyctophilus sp.				X	X	
	Scotorepens balstoni	Inland broad-nosed bat		LC	X	X	
	Scotorepens greyii	Little Broad-nosed bat		LC	X	X	
	Vespadelus baverstocki			LC	X	X	
	Vespadelus troughtoni	Eastern cave bat		LC		X	
	Vespadelus vulturnus	Little forest bat		LC	X	X	
	Pseudomys delicatulus	Delicate Mouse		LC		X	
	Rattus tunneyi	Pale field rat		LC	X		
	Mus musculus	House mouse		I		X	
	Canis lupus	Dingo/dog		I	X	X	
	Felis catus	Feral cat		I	X	X	
	Lepus capensis	Brown hare		I	X	X	
	Oryctolagus cuniculus	European rabbit		I	X	X	
	Sus scrofa	Feral pig		I	X	X	
	Vulpes vulpes	Red fox		I	X		
		Unidentified deer species		I	X		
Mammal Total		40			38	35	2
Grand Total		**266**			**220**	**215**	**46**

Appendix G. Present, Likely or Possible Threatened Fauna Species Profiles and Mapping Criteria Mapping Criteria

BUTTERFLIES

Pale Imperial Hairstreak (*Jalmenus eubulus*)

Status

Vulnerable (NC Act)

Distribution and Habitat

Jalmenus eubulus is restricted to the eastern Brigalow Belt Bioregion. The northern limit of its distribution appears to be around the latitude of Mackay and ranges south to around Boggabilla in northern NSW. The eastern limit of its distribution is roughly designated by the Great Dividing Range, being found near Kroombit Tops, Binjour Plateau, Bunya Mountains and Jondaryan (Eastwood et al. 2008). It may be found as far west as Carnarvon (Sands and New 2002).

The species is restricted to Brigalow (*Acacia harpophylla*)-dominated woodlands and open-forests. Its core habitat is old-growth Brigalow, particularly those areas with Belah (*Casuarina cristata*), emergent eucalypts such as *Eucalyptus populnea* and understorey shrubs and adults are always observed in association with old-growth (remnant) *A. harpophylla* communities (Breitfuss and Hill 2003; Eastwood et al. 2008). Being highly mobile, isolated patches may also provide suitable habitat.

Ecology

Jalmenus eubulus feeds exclusively on Brigalow (*A. harpophylla*) shrubs ranging in height from 0.5 to 5m and (Braby 2000; Breitfuss and Hill 2003; Eastwood et al. 2008). The species has also been documented as feeding on other *Acacia* species (Sands and New 2002), but this has been discarded as erroneous in recent reviews (Eastwood et al. 2008).

It is likely that eggs enter diapause shortly after being laid. Emergence is triggered by summer rainfall, which may fall irregularly throughout the species' range, resulting in apparent different activity patterns between populations and years. Adults have been recorded between October and April, with peak activity in February and March. Peak activity appears to occur approximately two months after the wettest months of the year (December and January) (Eastwood et al. 2008).

Larvae feed singly, or occasionally in small groups of up to three individuals (Braby 2000). As in many lycaenid butterflies, the larvae are always attended by ants of the *Iridomyrmex* group, on which they are likely to be reliant for survival (Braby 2000; Sands and New 2002; Eastwood et al. 2008).

Known Threats to the Species

This species is threatened by clearing of suitably sized stands of old-growth Brigalow woodland (Sands and New 2000).

Records Relevant to the SGP

Three records are located within the SGP, the most recent is nearly 20 years old. An additional five records are within 10km of the SGP boundary. The species requires targeted

surveys by experts experienced in butterfly identification. The lack of records is likely to reflect low survey effort as the species is expected to be more widespread and abundant than indicated in databases.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire SGP area.
2. Within the SGP, all areas of remnant Brigalow (11.3.1, 11.3.17, 11.4.3 11.4.3a, 11.9.5) are classed as "Core Habitat Possible".
3. All "Core Habitat Possible" within 2km of a recent (1980+), accurate (± 500m) record is reclassified as "Core Habitat Known".
4. The remaining Regional Ecosystems and non-remnant areas are classed as "Absence Suspected".

Specific Map Modifications

None.

Mapping Confidence

The life-cycle and habitat requirements for the Pale Imperial Hairstreak is well documented and understood. Correlation between important habitat characteristics and Regional Ecosystem descriptions is high. The habitat mapping for this species is expected to be highly accurate.

REPTILES

Golden-tailed Gecko (*Strophurus taenicauda*)

Status

Near Threatened (NC Act)

Distribution and Habitat

Golden-tailed geckoes are distributed from the western slopes of the Great Dividing Range to Carnarvon, and from Emerald in the north to Inglewood/Millmerran in the south. Areas within and surrounding Barakula State Forest may represent a stronghold for this species (Richardson 2006).

This species is a Brigalow Belt endemic. They are found in a wide variety of woodland and forest habitats, mainly in association with brigalow (*Acacia harpophylla*), cypress (*Callitris* spp.) and ironbark (*Eucalyptus* spp.). They can also be common in areas with a shrubby understorey (particularly *Acacia* spp. and *Callitris* spp, including regrowth). Ground cover, tree hollows and loose or peeling bark on standing trees and tree stumps may be important shelter sites for this species (Richardson 2006).

Ecology

During the daytime, golden-tailed geckos shelter under loose bark and in tree hollows (Wilson 2015). They may also bask during the daytime. In Spring/Summer, females lay a clutch of two eggs. Females may lay more than one clutch in a season.

Movement patterns of the species have not been documented. However, individuals have been recorded crossing dual lane roads during warm summer nights.

Known Threats to the Species

Habitat loss and degradation including inappropriate roadside management, inappropriate fire regimes, clearing and thinning of vegetation for agriculture appear to be the species main threats (Richardson 2006). Deaths on roads and predation from introduced carnivores (e.g., foxes and cats) may also affect populations.

Records Relevant to the SGP

The Golden-tailed Gecko have been frequently recorded during these surveys as well during previous ecological works. It is currently known from 82 observations within the SGP, but is likely to be much more widely distributed than indicated by these records. It has been recorded in both the central and southern regions of the SGP, but not the northern region where possible habitat is fragmented and minor in extent. The species has also been regularly recorded in the surrounding area.

General Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire SGP area.
2. Within the SGP, RE's 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.4.3 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.2, 11.9.5 are mapped as "Core Habitat Possible".

3. Within the SGP, RE's 11.3.2, 11.3.4, 11.3.26, 11.7.5, 11.7.5b, and 11.7.5x are mapped as "General Habitat".
4. All areas of advanced regrowth (10+) should be treated as remnant vegetation and classed according to the above rules.
5. Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. Habitat patches <5ha and not adjacent or near other remnant vegetation (i.e., isolated) are reclassed as "Absence Suspected".
7. "Core Habitat Possible" or "General Habitat" between 5ha and 10ha in size and not adjacent or near other remnant vegetation (i.e., isolated) are reclassed as "General Habitat" and "Absence Suspected" respectively.
8. Remaining regrowth and RE's are classed as "Absence Suspected".
9. Cleared agricultural, grazing land and palustrine and lacustrine wetlands (RE 11.3.3c, 11.3.27c) is classed as "Absence Likely".

Specific Map Modifications

Habitats in the northern section of the SGP (Wondoan) are open and heavily impacted by grazing activities. They generally lack a shrubby understory preferred by this species. All habitats classed as "Core Habitat Possible" or "General Habitat" using the above rules in the northern (Wondoan) section have been reclassified as "Absence Suspected".

Inspections along Wilkie Creek and the Condamine River suggest the bulk of vegetation in this alluvial system lack a suitable shrubby understorey and have been classed as "Absence Suspected".

A small number of small fragments which are unlikely to be valuable for the species based on their landscape position have been manually removed from the mapping product or dropped to a lower mapping category (i.e., Core Habitat Possible to General Habitat).

Mapping Confidence

Golden-tailed Geckos appear to be unevenly distributed throughout suitable habitat. However, they can also inhabit regrowth or cleared habitats with abundant shrubs. As such, the mapped habitat area is likely to have a moderate accuracy.

Common Death Adder (*Acanthophis antarcticus*)

Status

Vulnerable (NC Act)

Distribution and Habitat

This species is widespread throughout Queensland, with the exception of Cape York Peninsula and the Mulga Lands in the south-west (Wilson 2015). Once abundant in the Brigalow Belt, it is now rarely observed and in the southern Brigalow belt the species seems

to be particularly aligned with large contiguous tracts of vegetation (e.g. state forests around Inglewood and Southwood National Park may represent strongholds) which maintains a healthy ground strata (and in particular ground debris) (EPA 2008).

It is found in a wide variety of habitats, including rainforest, open woodland, shrubland and heath (Ehmann 1992; Wilson and Swan 2013).

Ecology

The Common Death Adder is a slow-moving, sedentary snake that lies motionless while partially buried in leaf litter, vegetation or soil. Breeding takes place in spring and autumn (Ehmann 1992).

Diet consists of lizards and small mammals, and to a lesser extent, birds and frogs. However, diet changes with age, young animals consuming more reptiles and frogs, whilst adults feed predominantly on small mammals and birds (Shine 1980).

Known Threats to the Species

Threats to this species are poorly known. Land clearing and fragmentation are likely to have extensively affected the occurrence of this species in the Brigalow Belt. Alteration to microhabitats is also likely to detrimentally affected ambush snakes such as death adders, as they require ground cover to ambush their prey. Grazing, agriculture, urbanisation and inappropriate fire regimes modify ground cover considerably, reducing potential ambush sites (Ehmann 1992; Reed and Shine 2002, EPA 2008). Similar patterns of decline have been seen in other ambush snake species (Shine 1994). The species is also at risk from Cane Toad ingestion in areas where toad abundance is high.

Records Relevant to the SGP

Two records of the species are located within 5km of the SGP boundary, including one from 2015. It is possible the species is present within the SGP although this species is very cryptic and difficult to detect, even during suitable conditions.

General Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. Vegetation with a combined extent >5,000ha should be classed as "Core Habitat Possible".
3. Core Habitat Possible within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
4. Vegetation not connected to larger patches, but within close proximity (<500m) can be classed as "General Habitat".
5. Regrowth and cleared areas are mapped as "Absence Suspected".
6. Cleared farmland or tilled crops are classed "Absence Likely".

Specific Map Modifications

Areas along the Kogan-Condamine Rd (in the north-west corner of the southern region) include suitable habitat types (e.g., brigalow communities) but are limited in extent reducing

their value for the species. However, this vegetation connects larger remnant patches in the west (just outside the SGP) and has been mapped as "General Habitat".

A number of small linear patches, which are mapped as "Core Habitat Possible" or "General Habitat" using the above guidelines were removed.

Mapping Confidence

Habitat use by Death Adders is difficult to predict; they may occur in any remnant habitat, yet are absent from seemingly good habitats within their range. This may reflect historic land use or events that have affected ground structure. Historical fires, for example, may have reduced ground cover and resulted in local extinctions. Following fire, recolonisation may only occur if remaining patches are large or well connected to nearby populations. Due to these difficulties, the habitat map for this species is considered to have a low accuracy.

Dunmall's Snake (*Furina dunmalli*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act Act)

Distribution and Habitat

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).

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. leiocalyx*), 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*) and ironbark (*Eucalyptus crebra* and *E. melanophloia*) on sandstone-derived soils and there is a record from the edge of dry vine scrub (Stephenson and Schmida 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 elevation (Hobson 2012a). The species can, on rare occasions, inexplicably appear in in sub-optimal vegetation. Advanced regrowth habitat should not be excluded, particularly when adjacent or linking areas of suitable habitat. It is unlikely to occur in highly fragmented vegetation, particularly narrow linear strips.

Ecology

Dunmall's snake is a nocturnal, cryptic, secretive species that is possibly genuinely scarce and very rarely encountered (Wilson 2015; 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 geckoes (Gow and Swanson 1977; Shine

1981). Nothing is known of its breeding biology other than that it lays eggs (Wilson and Swan 2013).

Known Threats to the Species

Due to the paucity of records and secretive nature of Dunmall's snake, it is not known if the species has declined, although 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 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), and
- Increased mortality from vehicle strike.

Other possible threats include loss of fallen timber and ground litter (e.g., fuel reduction burns, firewood collection), weed invasion and drainage of swamps (DoE 2017a).

Records Relevant to the SGP

Two old records (i.e. >20 years) exist in the southern portion of the SGP. An additional two records are located within 8km of the SGP, most recent from 2000. The species is cryptic and difficult to detect, even during suitable conditions.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. All remnant vegetation >50ha in extent and within 500m of a larger vegetation patch of RE 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.4.3, 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.6, and 11.7.7 should be classed as "Core Habitat Possible".
3. Smaller vegetation patches of the above RE's may be mapped as "General Habitat" if they are in close proximity to large areas of "Core Habitat Possible".
4. Core Habitat Possible within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
5. Advanced regrowth of all the above RE's are mapped as "General Habitat" if they are adjacent to or connect large areas of "Core Habitat Possible" or "General Habitat".
6. Remaining regrowth is mapped as "Absence Suspected".

Specific Map Modifications

A number of narrow linear fragments (particularly Brigalow communities) were removed based on their limited extent and surrounding land use (high intensity farming practices).

Mapping Confidence

This species is very poorly understood and records are scarce. Predicting its occurrence is extremely difficult and the mapping is likely to have low accuracy.

Grey Snake (*Hemiaspis damelii*)

Status

Endangered (NC Act)

Distribution and Habitat

Grey snakes occur throughout the Brigalow Belt, from coastal districts near Rockhampton, south-east to the Lockyer Valley in South East Queensland (Wilson 2015).

Grey snakes inhabit dry eucalypt forest and pasture (Covacevich and Wilson 1995), favouring cracking, flood-prone soils along floodplains and near watercourses within the Brigalow Belt (Hobson 2002; Wilson 2015).

Ecology

Grey Snakes are nocturnal frog specialists (Wilson and Swan 2013), sheltering during the day under fallen logs, within soil cracks and down in animal burrows. They are known to give birth to up to 10 live young (Covacevich and Wilson 1995), but little else is known of their breeding biology.

Known Threats to the Species

This species is threatened by habitat loss, habitat degradation and fragmentation. Existing habitats and populations are under threat from agriculture and urban development (Eyre et al. 1997), as well as mining activities and the loss of waterways or wetlands. In addition, ingestion of cane toads and subsequent death from poisoning pose a threat to the species.

Records Relevant to the SGP

The Grey Snake was recorded during these surveys as well during previous ecological works. It is currently known from 16 observations within the SGP and has been recorded in both the central and southern regions of the SGP, but not the northern region where the habitat is fragmented and minor in extent.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. All remnant vegetation where surface water could collect provides potential habitat for these species. In particular, vegetation on Landzones 3, and 4 should be classed as "Core Habitat Possible". In addition, the following RE's have clay soils, gilgai's or are likely to be subject to temporal ponding and should also be "Core Habitat Possible"; 11.9.5.
3. Derived Grasslands, which occur in alluvial floodplains in the SGP, are mapped as "Core Habitat Possible".

4. Larger contiguous areas of RE's 11.5.1, 11.5.1a, 11.5.20, and 11.5.21, or where these are immediately adjacent Core Habitat Possible, are included as "General Habitat".
5. Artificial waterbodies are mapped as "General Habitat".
6. All remnant vegetation, non-remnant vegetation, regrowth or cleared land within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
7. Regrowth be classed according to its parent regional ecosystem.
8. Cleared farmland or tilled crops are mapped as "Absence Suspected".

Specific Map Modifications

Field investigations in the northern area (Wondoan) showed riparian habitats in this area were highly fragmented and heavily impacted from cattle grazing leading to loss of soil structure (ie., reduced soil cracks etc). Habitats in this area have been reduced to "General Habitat" in recognition of their reduced value.

Some unsuitable farm dams were removed.

Mapping Confidence

This species may occur in a number of habitats, including artificial grazing land. Predicting its occurrence is therefore difficult based on RE mapping. The habitat map for this species is moderately accurate.

BIRDS

Glossy Black-Cockatoo (*Calyptorhynchus lathami*)

Status

Vulnerable (NC Act)

Distribution and Habitat

Glossy Black-Cockatoos (*Calyptorhynchus lathami*) have a patchy distribution along the east coast and ranges south from near the Paluma Range to Gippsland in Victoria. An isolated population is located on Kangaroo Island in South Australia. They are uncommon and declining, especially in the south-western parts of its range, and are now extinct in mainland South Australia (Garnett *et al.* 2011). There has been concern for the status of Glossy Black-Cockatoos in the Southern Downs due to the loss of feeding and nesting resources (EPA 2003).

Birds inhabit woodlands and forests that contain abundant *Allocasuarina* spp. and abundant large hollows suitable for nesting. Many populations are restricted to remnant vegetation within hills and gullies surrounded by agricultural land (Higgins 1999); however, some populations move through artificial landscapes such as semi-urban parks, gardens and golf courses to access favoured food resources (Higgins 1999, M. Sanders pers. obs.). Groups are never far from waterbodies, which are visited daily. Being highly mobile, birds may travel considerable distances to isolated fragments in search of food. Advanced regrowth may also provide some foraging opportunity.

Ecology

Typically encountered in small family parties, Glossy Black-Cockatoos are dietary specialists, feeding exclusively on the seeds of *Allocasuarina* and *Casuarina* spp. Favoured species include *A. torulosa*, *A. littoralis*, *A. luehmannii*, *A. distyla*, *A. diminuta*, *A. gymnanthera* and *A. verticillata* (Chapman 2007). It is poorly documented, but Glossy Black-Cockatoos also feed on *A. inophloia* in and around the Kumbarilla to Inglewood area (M. Sanders pers. obs.).

Observations of the species feeding on other resources (e.g., *Callitris* and *Banksia* spp.) are likely to represent food switching during periods of poor *Allocasuarina* cone production (Chapman 2007). It is unclear if the use of *A. inophloia* by local populations reflect food switching, or if local populations rely on stands of *A. inophloia*. However, given the abundance of orts (feeding signs) in some locations, and their repeated observation over consecutive years, the latter seems plausible.

Birds show a preference for productive trees (e.g., higher seed/cone weight ratio), notwithstanding the influence of other factors such as distance from water or breeding hollows (Clout 1989; Pepper et al. 2000; Crowley and Garnett 2001; Cameron and Cunningham 2006; Chapman and Paton 2006; Chapman 2007). Stands of *Allocasuarina* spp. are therefore not of uniform value, and the loss of individual stands or trees may have disproportionate impacts.

The production of cones by *Allocasuarina* spp. closely tracks rainfall (Cameron 2006a), and hence the availability of resources for resident Glossy Black-Cockatoos fluctuate between

years. While resources may be sufficient to support existing birds, drought is likely to reduce breeding success (Cameron 2009).

Pairs breed during winter, mainly from April to July, although breeding has been recorded as late as August or as early as March (Beruldsen 2003). Nests are located in a large vertical hollow extending one or two meters deep. Hollows may be reused over many years (Beruldsen 2003). Females incubate and care for the young alone, but are regularly attended and fed by the male. Only one egg is produced, which hatches in about 30 days. Once hatched the chick fledges in around 60 days, but remains with its parents and is fed for another three months (Garnett et al. 1999).

Known Threats to the Species

Threats to Glossy Black-Cockatoo populations include:

- Clearing of habitat remains a serious threat. Previous clearing has reduced the species' range in the south and west of the Great Dividing Range (Garnett and Crowley 2000),
- Fire can reduce or remove suitable feed trees from large areas for several years and, if followed by grazing, prevent regeneration of previous habitats.,
- Fragmentation of habitats may also result in an increase in predation of nestlings and eggs or alternatively result in higher competition for hollows (Downes et al. 1997). This threat may be particularly severe where species adapted to altered or open habitats are abundant. These 'edge' species may include Common Brushtail Possum (*Trichosurus vulpecula*), Little Corella (*Cacatua sanguinea*), Galah (*Eolophus roseicapilla*) and Sulphur-crested Cockatoo (*Cacatua galerita*). By out-competing cockatoos for nest hollows, these predators and/or competitors can significantly reduce recruitment of Glossy Black-Cockatoos (Garnett et al. 1999),
- Prolonged and severe drought can significantly reduce *Allocasuarina* cone production, reducing feeding resources and therefore breeding success. Global climate change may therefore negatively impact the species on a broad scale, particularly on the western slopes of the Great Divide (Cameron 2009), and
- The loss of suitable hollow-bearing trees through processes such as fire or logging (Cameron 2006).

Records Relevant to the SGP

The Glossy Black-cockatoo has been frequently recorded during these surveys as well as previous ecological works. It is currently known from 29 observations within the SGP. It has been recorded in both the central and southern regions of the SGP, although it has been more commonly recorded in the southern portion where there is possibly more suitable foraging habitat available.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. Regional Ecosystems containing *Casuarina cristata* (11.3.1. 11.3.17, 11.4.3, 11.4.3a, 11.9.5) and *Allocasuarina inophloia* (11.5.4) are classed as "Core Habitat Possible". South

of the Warrego Highway areas of RE 11.7.4 may also have *Allocasuarina littoralis* and have been mapped as "Core Habitat Possible".

3. Regrowth of the above RE's, which could contain larger trees with suitable foraging resources, are mapped as "Core Habitat Possible".
4. Core Habitat Possible and General Habitat within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
5. All remaining Regional Ecosystems are classed "Absence Suspected".

Specific Map Modifications

None

Mapping Confidence

Within the SGP Core Habitat Possible accurately predicts the presence of *Allocasuarina* foraging resources, though it is acknowledged that individual trees can be scattered throughout remnant vegetation or modified landscapes. While Core Habitat Possible is abundant in the southern region (Dalby region) of the SGP, it is more scattered in the central region, reducing the likelihood that Glossy Black-cockatoos will occur.

A hot wildfire severely damaged large areas of Glossy Black-cockatoo habitat in Kumbarilla State forest in late 2016. It may take several decades for foraging resources to recover in this area.

General Habitat will be an overestimate as areas of suitable regrowth vegetation (mapped as "General Habitat") will not contain trees of sufficient size to attract foraging birds.

Nests are located in large tree hollows, usually in proximity to foraging resources. Predicting where suitable nest trees might occur is difficult and no attempt has been made to capture possible nest areas in the mapping product.

A supply of water is also important for Glossy Black-cockatoo populations, and suitable locations which may attract birds are likely to be scattered throughout areas of vegetation not mapped.

Painted Honeyeater (*Grantiella picta*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Endemic to Australia, the Painted Honeyeater (*Grantiella picta*) may be found from the eastern section of the Northern Territory to Victoria and southern regions of South Australia (Pizzey and Knight 2007). Rare in the Northern Territory, they are widespread throughout Queensland, absent only from Cape York and high rainfall areas.

Painted Honeyeaters occur mainly in dry open woodlands and forests, particularly box-ironbark woodlands. They may also be located in riparian forest, on plains with scattered

eucalypts, and in remnant trees on farmland. Their occurrence is strongly associated with mistletoe, on which they feed (Higgins et al. 2001) and fragmented or disturbed *Acacia* communities often have the highest density of Mistletoe. More advanced stands of *Acacia* regrowth may also have abundant mistletoe.

Ecology

Painted Honeyeaters feed almost exclusively on mistletoe fruit, but may also collect nectar and invertebrates (Oliver *et al*. 2003). Most foraging is undertaken within the canopy of trees (Higgins *et al.* 2001).

Nesting occurs during spring-summer (Sept.-Feb.), predominantly in the south-east of its range north to and around Brisbane. The breeding season is determined by photoperiod to coincide with warmer summer months, but actual breeding is cued in relation to the progression of mistletoe fruiting. This ensures that breeding is matched by peak resource availability, avoiding temporal variation inherent in unpredictable environments (Barea and Watson 2007).

Small, frail cup-shape nests with narrow sides are constructed in the outer foliage and branchlets of eucalypts, casuarinas and acacias. However, a disproportionately large number of nests are placed in mistletoe clumps in taller trees (Whitemore and Eller 1983; Beruldsen 2003; Barea 2008).

While not well understood, movement patterns are generally described as a north-south migration (Keast 1968). Populations move north during winter and return south of approximately 26° during spring-summer to breed (Higgins *et al.* 2001).

Known Threats to the Species

Large areas of suitable woodland habitat have been extensively cleared throughout this species' range. However, increased mistletoe abundance in degraded woodlands and roadside reserves may have benefited the species and alleviated somewhat the impacts of broad-scale habitat loss (Higgins *et al.* 2001; Bowen et al. 2009).

Records Relevant to the SGP

Three records are located within the SGP in the southern portion near Lake Broadwater where mistletoe is abundant in tall *Eucalyptus* spp., and several records exist within 10km of the SGP boundary, including records from the past few years. Likely to occur within the SGP infrequently, depending on availability and density of mistletoe fruit.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. RE's 11.3.1, 11.3.17, 11.4.3, 11.4.3a and 11.9.5 (including 'disturbed' communities) are mapped as "Core Habitat Possible".
3. The above RE's and RE's 11.5.20 and 11.5.27 are mapped as "Core Habitat Known" around Lake Broadwater.
4. Regrowth RE 11.3.1, 11.3.17, 11.4.3, 11.4.3a, 11.9.5, and 'Regrowth Brigalow (>15yrs)' are mapped as "General Habitat".

5. All "Core Habitat Possible" within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. All remaining regional ecosystems and non-remnant areas are "Absence Suspected"

Specific Map Modifications

A small non-remnant (below patch threshold size) of Weeping Myall (Acacia pendula woodland) was added as "Core Habitat Possible".

Mapping Confidence

The presence of abundant mistletoe can only be accurately determined through field assessment, though it can be predicted to occur with moderate accuracy in areas of Core Habitat Possible. The mapped General habitat, to capture more advanced Acacia regrowth, is likely to over evaluate habitat extent and will have a low accuracy.

Australian Painted Snipe (*Rostratula australis*)

Status

Australian Painted Snipe - Vulnerable (NC Act); Endangered (EPBC Act)

Distribution and Habitat

Most records of the species 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).

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).

Ecology

The Australian painted snipe 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 (Beruldsen 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 the species (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).

Known Threats to the Species

Threats to Australian Painted Snipe populations include:

- 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).

Records Relevant to the SGP

Six records for Australian Painted Snipe are known from the southern section of the SGP, all in the vicinity of Lake Broadwater. The species is likely to be a vagrant and rare visitor to the SGP, though there is a low possibility the species might occur at Lake Broadwater and breed in the surrounding habitat during the SGP life of operation..

Rule(s) for Habitat Mapping:

1. Lake Broadwater (RE 11.3.27c and 11.3.27f) is mapped as 'Core Habitat Known'.
2. Long Swamp (RE 11.3.27d and 11.3.27f) is mapped as "Core Habitat Possible'.c
3. All remaining regional ecosystems are "Absence Suspected"

Specific Map Modifications

None

Mapping Confidence

While the Australian Painted Snipe can occur on a variety of wetlands (including minor waterbodies), it is only known to occur within the immediate area of Lake Broadwater. Habitats outside these are likely to be marginal.

MAMMALS

South-eastern long-eared Bat (*Nyctophilus corbeni*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

The south-eastern long-eared bat (*Nyctophilus corbeni*) 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 the southern areas of the Brigalow Belt (Reardon 2012). The distributional limits in Queensland are uncertain. McFarland et al. (1999) states 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. It is unknown if possible misidentifications of the species have resulted in the uncertainty attached to its distribution.

The species 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, approximately 5000+ ha in size (e.g., Southwood National Park) (EPA 2008), although the species can be occasionally recorded from smaller vegetation tracts of 600 ha (e.g., Erringibba National Park). Field observations and published literature also suggests it may use riparian habitats, though these habitats may be more important for providing roosting sites (hollow-bearing trees) and water.

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 kilometres between roosts and foraging areas. Roosts may be changed frequently, each used for 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).

Known Threats to the Species

The main threats the south-eastern long-eared bat 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, and
- 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).

Records Relevant to the SGP

The South-eastern Long-eared Bat has been recorded during these surveys as well as during previous ecological works. It is currently known from eight observations within the SGP and has been recorded in both the central and southern regions, although it was captured more frequently in the central region.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. Only remnant vegetation which contributes to significantly large contiguous vegetation patches (>500ha) is considered suitable. Within these larger continuous vegetation patches:
   a. RE's 11.3.14, 11.3.25, 11.3.27d, 11.3.27f, 11.5.1, 11.5.1a, 11.5.4, and 11.5.21 are mapped as "Core Habitat Possible", and
   b. RE's 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.3.2, 11.3.26, 11.4.3, 11.4.3a, 11.5.20, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.7, and 11.9.5 are mapped as "General Habitat"
3. All "Core Habitat Possible" or "General Habitat" within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Specific Map Modifications

None

Mapping Confidence

Identifying suitably large tracts of remnant vegetation within the SGP is relatively easy. Predicting where the species might occur within this vegetation is more complex. While those RE's listed as "Core Habitat Possible" accurately reflect the best areas of habitat, large tracts of "General Habitat" may have suitable structure and provide good habitat for the

species. A precautionary approach would be to consider all areas of Core Habitat Possible or General Habitat as suitable.

While several RE's have been excluded as not suitable ("Absence Suspected") in the mapping product, their landscape position often contributes to patch integrity and they may therefore provide an important role in ensure a populations persistence.

Greater Glider (*Petauroides volans*)

Status

Vulnerable (EPBC Act)

Distribution and Habitat

The Greater Glider (*Petauroides volans*) is the largest gliding possum in Australia. Its distribution extends from the Windsor Tableland in north Queensland, south to Wombat State Forest in central Victoria (Woinarski et al. 2014). Inland isolated subpopulations are also known from the Gregory Range (west of Townsville) (Winter et al. 2004), and another in the Einasleigh Uplands bioregion of Queensland (Vanderduys et al. 2012).

The species is predominately restricted to eucalypt forests and woodlands. Greater gliders occur in highest abundance in taller, montane, moist eucalypt forests with larger, relatively old trees and abundant hollows (Andrews et al. 1994; Kavanagh 2000; Eyre 2004; van der Ree *et al*. 2004; Vanderduys et al. 2012). In areas west of the Great Dividing Range, they are found in low woodlands (McKay 2008). The species prefers forests with a diverse range of eucalypt species, due to seasonal variation in its favoured tree species (usually one or two species of eucalypt in any particular area) (Kavanagh 1984). Even in suitable habitat, the distribution may be patchy (Kavanagh 2000).

Ecology

The species is an arboreal nocturnal marsupial which is primarily folivorous, foraging on eucalypt leaves and occasionally flowers (Kehl and Borsboom 1984; Kavanagh and Lambert 1990; van der Ree et al., 2004). It shelters during the day in large tree hollows (Henry 1984; Kehl and Borsboom 1984; Lindenmayer et al., 1991; Smith et al., 2007; Goldingay 2012) and its abundance is often link to hollow density (Andrews et al. 1994; Smith et al. 1994, 1995). Research has shown that in southern Queensland, the species require at least 2–4 live den trees for every 2 ha of suitable forest habitat (Eyre 2002).

Home ranges are usually 1-4ha in size (Henry 1984; Kehl and Borsboom 1984; Comport et al. 1996; Gibbons and Lindenmayer 2002; Pope et al. 2005), however in lower productivity forest and more open woodland habitats home ranges can be up to 16 ha (Eyre 2004; Smith et al. 2007). Males have a larger home range size than females and sexes usually share a den when the breeding season commences (Kavanagh and Wheeler 2004; Pope et al. 2005; McKay 2008).

Females give birth to only one young from March to June. Juveniles emerge from the pouch when three to four months old and become independent at around nine months. However,

greater gliders do not reach their sexual maturity and start breeding until their second year (Tyndale-Biscoe and Smith 1969; McKay 2008). It is estimated that the species can live up to 15 years (Harris and Maloney 2010).

Known Threats to the Species

The main threats to the greater glider are:

- Major habitat loss and fragmentation, mostly through clearing, clearfell logging and the loss of senescent trees due to prescribed fire regimes (Eyre 2006; Lindenmayer et al., 2000; Taylor and Goldingay 2009),
- Inappropriate fire regimes (Lindenmayer et al. 2013),
- Effects from climate change such as range contraction (particularly in northern parts of its range) and declines in the health of eucalypt trees (Kearney et al. 2010; Matusick et al. 2013),
- Hyper-predation by owls (McKay 2008; Bilney et al. 2010; Lindenmayer et al. 2011), and
- Increased competition for hollows from other species (e.g. sulphur-crested cockatoos).

Records Relevant to the SGP

The Greater Glider was recorded several times during these surveys and is currently known from 11 observations within the SGP, in both the central and southern regions. Although, it was detected more frequently in the central portion, particularly along riparian areas.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area. "Core Habitat Possible" includes RE's 11.3.4, 11.3.25 and 11.3.26.
2. Patches of RE 11.3.2, 11.3.3, 11.3.14, 11.3.17, 11.3.18 and 11.3.26 immediately adjacent the above RE's are mapped as "General Habitat".
3. All Core Habitat Possible within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Specific Map Modifications

Isolated fragments of Core Habitat Possible or General Habitat were removed as Absence Suspected.

Mapping Confidence

Important habitat characteristics for this species are well understood and can be matched to regional ecosystem descriptions. The mapping is considered to be highly accurate.

Koala (*Phascolarctos cinereus*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Endemic to eastern Australia, the Koala is a solitary species that is widespread across coastal and inland areas from Cooktown, Queensland to the Mt. Lofty ranges, South Australia (Martin et al. 2008). Restricted to altitudes below 800m elevation (Munks et al. 1996),

Koalas occur in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas (Martin and Handasyde 1999; Martin et al. 2008). Koalas on the western side of the Great Dividing Range at the western edges of their range are often associated with water courses though are not restricted to them (Melzer et al. 2000; Sullivan et al. 2003). Favoured feed tree species in these areas include *E. camaldulensis, E. coolabah* and *Eucalyptus populnea.*

Koalas have been translocated into a range of areas where they did not occur historically, such as Magnetic, Kangaroo and Phillip Island's.

Ecology

Koalas are well known to have a preference for eucalypt trees as a food source, though not all eucalypts species are equal and diet varies between regions. Although an arboreal species, preferences for individual trees and the distances between feed trees forces individuals to the ground, this is when they are most vulnerable to predation and human-induced mortalities (Hindell et al. 1985; Martin 1985).

Koalas are not strongly territorial and home ranges will overlap. Home ranges vary in size from 1-2 hectares in optimum habitat, and up to 135 hectares in semi-arid regions (Ellis et al. 2002; Martin et al. 2008). Movements are often as short as the distance between feed trees, however dispersing individuals will move over larger distances. Established individuals have been known to make exploratory movements over larger distances before returning to home ranges (Dique 2003).

The breeding season occurs between October and May with females producing up to one offspring per year (Martin et al. 2008). Juveniles become independent from one year of age with males living for over 12 years and females living for over 15 years (Martin and Handasyde 1999). Breeding occurs from two years of age, and is often determined by the establishment of a male hierarchy as males become vocal and fiercely fight for females (Martin et al. 2008).

Known Threats to the Species

Significant threats to Koalas include loss and fragmentation of habitat, vehicle strike, and predation by pet dogs (*Canis lupus familiaris*), whilst wildfire, disease, drought and extreme heat can also be damaging to both individual and population health.

Koalas inhabiting the north-western portion of their range are sparse and insufficiently studied. Although threats are similar to those in areas such as South-east Queensland where more research has been undertaken on Koala populations, it is likely that the severity of some threats is different. In particular, threats such as drought, and extreme heat events, may be more frequent and severe (Munks et al. 1996; Sullivan et al. 2003).

Records Relevant to the SGP

The Koala has been detected numerous times during these surveys as well during previous ecological works. It is currently known from a total of 73 observations within the SGP and has been recorded in both the central and southern regions. However, there are far more records in the southern portion where the Condamine and Wilkie Creek catchments appear to be a stronghold for the species in the southern Brigalow Belt.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. RE's 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.25, 11.3.26, 11.3.27d and 11.3.27f are mapped as "Core Habitat Possible".
3. RE's 11.4.3, 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.20, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.2 and 11.9.7 are mapped as "General Habitat".
4. Regrowth and disturbed vegetation should be mapped as per their parent RE.
5. All Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. All remaining remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Important habitat for this species is reasonably well understood and can be matched to regional ecosystem descriptions. Core Habitat Possible is likely to closely reflect the species distribution, particularly in the southern region of the SGP where the species remains relatively abundant. However, field studies from this work frequently found Koala's in habitats not previously considered high value (mapped as General Habitat), and as such these areas may be more important for the local population than previously understood.

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Appendix H.
Metadata and description of fields for floristic survey database

Appendix F. Metadata and description of fields for floristic survey database.

Metadata Field	Description	Additional Information
Survey Event	The survey program during which the data was collected	Includes data collected during Surat Gas Pipeline Survey, Surat Gas Project EIS and Supplementary EIS, Daandine and Surat Gas Advanced Exploration Surveys.
Survey Event Recorders	Field personnel responsible for recording information	Survey event during which data was collected and personnel responsible for collection of the information.
PP Meander	Timed meander points for Protected Plants within Protected Plant 'High Risk' buffer areas.	Recorded every 5 mins for a 30 minute interval as per the Department of Environment and Heritage Protection (DEHP) (2014). Flora Survey Guidelines – Protected Plants. Department of Environment and Heritage Protection, Queensland Government, Brisbane.
Waypoint Number	Waypoint number from combined survey efforts	Renumbered waypoints based on combined data collected from field personnel.
Ind. Ref. Number	The site number recorded by the individual field personnel. Retained to allow Site Nos to be readily referenced if required by field personnel in the future.	
Survey Type	The intensity of recorded site data as described in Neldner et al (2012)	Secondary: Secondary site data quantifies structural and floristic information for all strata. This includes structural and floristic data for the Emergent (E), Canopy / Sub-canopy (T1, T2), Shrub (S1, S2) and Ground (G) layers. Plot size is a standard 10 x 50 m plot. Ground covers are measured in standard 5 x 1m^2 or 10 x 1m^2 quadrats along a measured centreline. Tertiary: Quantifies structural and floristic information for woody vegetation (T1, T2, S1, S2) in a 10 x 50m plot. Does not record non woody vegetation in ground-covers. Quaternary: Estimates and describes structural and floristic information at a given location. Identifies dominant only and is not plot based. Observation: Provides a description of dominant species and structural formation only. Non-plot based rapid survey effort.
Lat	Latitude in decimal degrees	
Long	Longitude in decimal degrees	
Elevation	Recorded elevation from GPS	
Q Herbarium Mapped RE_2	RE indicated in mapping databases produced by Qld Government agencies (DSITIA).	Most current version is produced by Department of Resources and Mines (Version 8.0, 2014).
RE Ground Truthed	RE recorded at a specific location during field survey.	RE recorded by field ecologists at a specified waypoint. Used to verify RE mapping databases.
VMA Status	Status of RE listed under the VM Act	Categories of Endangered, Of Concern, Least Concern and Non-remnant.
Biodiversity Status	Biodiversity Status of RE	Categories of Endangered, Of Concern, No Concern at Present.
EPBC Status	Status of ecological community listed under the EPBC Act 1999.	Categories of Critically Endangered, Endangered, Vulnerable
Vegetation Structure	Vegetation Structural Formation as defined in Neldner et al 2012.	Categories of Vine forest/ Thicket, Open Forest, Woodland, Open Woodland, Shrubland and Grassland. Further information defined in Neldner et al 2012.
Emergent Height	Height of the Emergent structural layer.	Generally defined as the upper structural layer forming less than 5% total cover (Walker and Hopkins 1990). Neldner et al 2012, define the emergent layer as the upper structural layer that does not form the dominant ecological layer (the layer with the dominant biomass) which typically corresponds with the definition by Walker and Hopkins.
T1 Canopy Height	Measured height of the canopy layer.	Canopy (T1) layer is defined as the upper structural layer that forms the dominant biomass. Often represented as a height interval (e.g. 11 – 13m).

Metadata Field	Description	Additional Information
T1 Canopy Cover	Measured cover of the canopy layer.	Measured by projected canopy cover (PCC) rather than projected foliage cover (PFC). Measured over either a 50 or 100m linear transect.
T1 Count	The number of T1 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
T1 Dominant	The dominant species recorded within the T1 structural layer	
T1 Sub-dominant	The sub-dominant species recorded within the T1 structural layer	
T1 Associated	Species associated with the canopy other than dominant and sub-dominant species.	
T2 Canopy Height	Measured height of the sub-canopy layer.	Sub-canopy is the tree layer that lies directly below the canopy (covered by the canopy layer).
T2 Canopy Cover	Measured cover of the canopy layer.	Measured by projected cover of the sub-canopy (PCC).
T2 Count	The number of T2 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
T2 Dominant	The dominant species recorded within the T2 structural layer	
T2 Sub-dominant	The sub-dominant species recorded within the T2 structural layer	
T2 Associated	Species associated with the sub-canopy (T2) structural layer other than dominant and sub-dominant species.	
S1 Canopy Height	Measured height of the tallest shrub layer (S1) layer.	Multi-stemmed woody species typically with upper height limits of 8m.
S1 Canopy Cover	Measured cover of the tallest shrub (S1) layer.	
S1 Count	The number of S1 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
S1 Dominant	The dominant species recorded within the S1 structural layer	
S1 Sub-dominant	The sub-dominant species recorded within the S1 structural layer	
S1 Associated	Species associated with the tallest shrub layer (S1) other than dominant and sub-dominant species.	
S2 Canopy Height	Measured height of the secondary shrub layer (S2) layer.	Secondary shrub layer falls below the upper (S1) shrub layer. Typical S2 heights range from 0.5 – 2m.
S2 Canopy Cover	Measured cover of the secondary shrub (S2) layer.	
S2 Count	The number of S2 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
S2 Dominant	The dominant species recorded within the S2 structural layer	
S2 Sub-dominant	The sub-dominant species recorded within the S2 structural layer	
S2 Associated	Species associated with the secondary (S2) shrub layer other than dominant and sub-dominant species.	

Metadata Field	Description	Additional Information
Ground - % cover live plants.	Total foliage cover of live plants within a standard survey plot. Sometimes represented by an estimate in quaternary plots.	Includes grasses and graminoids, forbs and shrubs <0.5 m, native and exotic species. Excludes leaf litter, timber and bare ground. Measured only in secondary survey plots although estimates can be made in Quaternary survey data. Ground cover measurement is undertaken within 5 or 10 x 1m^2 quadrats (Secondary) and calculated as an average score. Estimates may be made in Quaternary plots.
Ground - % leaf litter	Cover of leaf litter in standard survey plot.	Leaf litter includes dead leaves, bark and other non-specific organic matter.
Ground - % leaf litter	Cover of leaf litter in standard survey plot.	Leaf litter includes dead leaves, twigs, bark and other non-specific organic matter.
Ground - % cover bare ground.	Cover of bare ground in standard survey plot.	Bare ground typically relates to exposed soil and sometimes rock.
Ground - % cover timber.	Cover of timber in standard survey plot.	Timber typical describes woody material (branches) > 5 cm diameter.
Ground - % cover rocks.	Cover of bare rock in standard survey plot.	Exposed rock not covered by soil.
Ground - % Cover Perrenial Native Grass	% cover of perennial native grass measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of native perennial grasses taken as an average of sampled quadrats (Secondary sites) or an estimate (Quaternary plots). Perennial describes plants that persist throughout seasons although might die back in less favourable growing conditions, resprouting when growth conditions improve (i.e following rain).
Ground - % Cover Native Shrubs < 1m	% cover of shrubs measured within quadrats.	% foliage and branch cover of native shrubs < 1m height taken as an average of sampled quadrats (Secondary sites) or an estimate (Quaternary sites)
Ground - % Cover Native Forbs	% cover of native forbs measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of native forbs taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Forbs are herbaceous flowering plants that are not graminoids (grasses and sedges).
Ground - % Cover Exotic Grass	% cover of exotic grass measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of exotic grasses taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Perennial describes plants that persist throughout seasons although might die back in less favourable growing conditions, resprouting when growth conditions improve (i.e following rain).
Ground - % Cover Exotic Forbs	% cover of exotic forbs measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of exotic forbs taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Exotic forbs are herbaceous flowering plants that are not graminoids (grasses and sedges) and are not native (introduced) to the survey area.
Cryptogams - % Cover	% cover of cryptogams covering soils in the ground layers.	Cryptogams are plants that reproduce by spores without flowers, seeds or leaves. Remnants persist as surface crusts during dry periods.
Grass / Forb dominant	The dominant grass/ forb species measured in ground layers. May be one or several species.	Includes both native and exotic species.
Grass / Forb sub-dominant	The sub-dominant grass / forb species measured in ground layers. May be one or several species.	Includes both native and exotic species.
Total spp. No	Total number of species recorded within a standard secondary survey plot.	Includes all woody and non-woody species although excludes cryptogams.
Harissia cactus % cover	Measured ground cover of Harrisia cactus (Harrisia martini), a declared Class 2 exotic pest.	
Opuntia % cover	Measured ground cover of Opuntia spp., a declared Class 2 exotic pest.	

Metadata Field	Description	Additional Information
Bryophyllum. % cover	Measured ground cover of exotic Sporobolus spp. (Sporobolus fertilis, Sporobolus pyramidalis, Sporobolus jacquemontii).	
Geology/ Soil	Field description of landform, soil and geology at a given survey site.	
Notes	Additional relevant information used to describe site characteristics.	
Philotheca S1 Cover	Measured crown cover of *Cerbera dumicola* in the S1 shrub layer in a standard Secondary site.	Philotheca sporadica is the only threatened species recorded during Arrow Surat Gas Project studies.
Philotheca Stems / ha	Stem counts for *Philotheca sporadica* in standard Secondary site in the shrub layer	
Date of Survey	Time and date of field recording	
Altitude	Altitude of survey location taken as metres above sea level, recorded on GPS.	
Photo number.	Photo number for individual survey locations.	Photo points collected by field recorders according to site location.
Additional Information	Reference to additional structural / floristic data	Reference to structural and floristic information specifically relating to native grassland assessments. Held separately from structural summary table. Includes floristic collection numbers.
Seasonal Effort	Relates to wet or dry season survey	Dry season survey undertaken from June to December and wet season typically from January to May.

Attachment 6. - Significant Residual Impact Report

Report

Safe Work. Strong Business.

Surat Gas Project – PL194 Wari Djunben - Kogan North Joint Venture (KNJV) and Tong Park

Significant Residual Impacts to Prescribed Environmental Matters
P-EA-100464322

Version	*1.0*
Released	*02/11/2023*
Document Status	*Final*
Security Classification	*Routine*

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Figures

Tables

1. Introduction

Arrow Energy Pty Ltd (Arrow) is planning to construct Wari Djunben – Kogan North Joint Venture (KNJV) and Tong Park, hereafter the Project, as a component of our Surat Gas Project (SGP). The Project comprises a series of well pads, coal seam gas pipelines, water pipelines, and infrastructure required to transfer coal seam gas and produced water. The key details for the current report are outlined in Table 1.

Table 1 Project details

	Key project details
Project Name	Wari Djunben – KNJV and Tong Park (SGP PL194)
Petroleum Lease	PL194
Environmental Authority	P-EA-100464322
Appropriately Qualified Person and Contact	Dr Paul Finn, Principal Ecologist paul.finn@arrowenergy.com.au

The relevant Environmental Authority (EA) for the Project is the Petroleum Lease (PL) 194 P-EA-100464322 (dated 24 July 2023). This report addresses relevant EA conditions for the above-mentioned project, specifically 'Biodiversity 14, by providing a significant residual impact (SRI) assessment on Prescribed Environmental Matters (PEMs) to determine the Project's environmental offset requirements under the *Environmental Offsets Act 2014* (EO Act).

The Project is located on PL194 in the Surat Basin, approximately 40 km north west of Dalby, in the Southern Brigalow Belt Bioregion. The Project has a total disturbance footprint of approximately 200 ha and is comprised of a mixture of previously cleared land, and remnant and regrowth vegetation. The total footprint located in cleared land (not remnant or regrowth) is 55 ha, and the total area of remnant and regrowth vegetation to be cleared is approximately 145 ha (Table 2).

Table 2 Ground-verified vegetation communities and cleared areas impacted by the Project

Vegetation Community	Area (ha)
11.3.14	0.554
11.3.18	0.408
11.3.25	0.303
11.5.1	51.494
11.7.4	5.971
11.7.7	13.453
Regrowth (11.5.1)	49.609
Regrowth (11.7.4)	23.172
Cleared land (not remnant or regrowth)	54.595
Total	**199.559**

The location of the Project is shown in Figure 1.

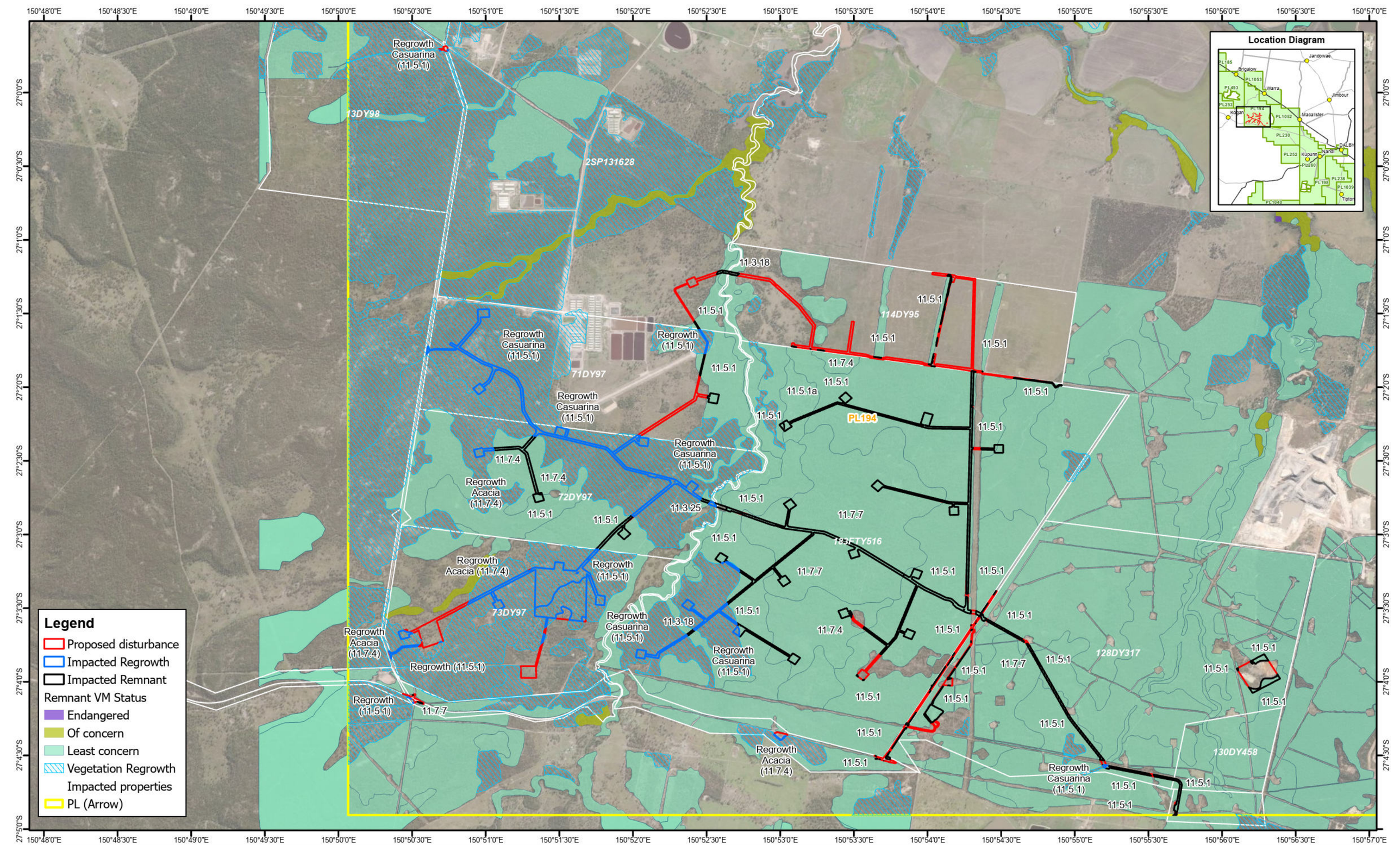

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Figure 1
KNJV Initial Development / Tong Park location along with that of ground-verified remnant and regrowth vegetation

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1.1 Purpose

There are several requirements of EA P-EA-100464322 relating to managing environmental offsets for the proposed activities to be undertaken. This report has been prepared to address the EA Condition Biodiversity 14:

> Prior to the commencement of each stage, a report completed by an appropriately qualified person, that includes an analysis of the following must be provided to the administering authority:
>
> > (a) for the forthcoming stage—the estimated significant residual impacts to each prescribed environmental matter; and
> >
> > (b) for the previous stage, if applicable—the actual significant residual impacts to each prescribed environmental matter, to date.

1.2 Surat Gas Project development

Stage 1 of the Surat Gas Project (SGP) PL194 development may comprise several sub-stages, the first of these is detailed below:

- PL194 Stage 1a: Wari Djunben - Kogan North Joint Venture (KNJV) and Tong Park – this SRI assessment.

Further scope may be added into this Stage 1 development or may be included in subsequent stages. No impacts beyond those included in the PL194 EA PEMs table will be included in Stage 1 (unless authorised via our existing *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval).

The Project scope includes a total of 39 wells with 2 of these being a combination of vertical and deviated wells. Each single well pad will be approximately 1 ha in size and the 2 multi-well pads will be up to 1.5 ha in size. The development also includes gas and water flowlines (gathering), which connect wells and compression facilities and is designed to enable correct operating pressures to be maintained. Proposed activities include the construction and operation of the following:

- Well leases and equipment laydown areas;
- Drilling, completions and workovers;
- Gas and water gathering flowlines/pipelines;
- Access tracks and borrow pits;
- Temporary camps, sewage treatment plants and irrigation;
- Communication systems; and
- Other incidental petroleum activities.

1.3 Surat Gas Project EPBC Act Approval

The areas of the SGP that are located on Arrow PL tenements, of which the Project is a part, is approved under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval (EPBC 2010/5343). As an approval condition, the SGP Stage 1 Offset Strategy (EPBC Act Offset Strategy) was prepared by Arrow to address the offset requirements for Stage 1 of the

SGP. The strategy was approved by The Department of Agriculture, Water and the Environment (DAWE) on 7 July 2019. This EPBC Act approval for Stage 1 incorporates impacts from infrastructure located on PL194 and as such addresses the offsets from any impacts to all relevant Matters of National Environmental Significance (MNES) on this tenure.

1.3.1 MNES and MSES where they are substantially the same matter

On many occasions, remnant and high-value regrowth vegetation listed as PEMs or Matters of State Environmental Significance (MSES) also provide habitat for species listed as MNES. In these situations, the Commonwealth approval takes precedence and therefore offsets provided for MNES also satisfy the requirement for State offsets.

All MNES species identified in the Project (Table 3), are the same matters as those assessed and approved under the EPBC Act SGP Stage 1 Offset Strategy.

While the EPBC Act Offset Strategy area shown in the figures (5.4a and 5.5a) does not cover the entire area of the SGP Stage 1 project footprint, the offset strategy foresees that infrastructure location changes would occur and addresses this with the inclusion of the following statement in section 1:

> '*Figure 1.1 shows an indicative location of the Stage 1 activities in relation to the project. The locations shown are subject to change as the project progresses through the detailed design phase and Arrow shareholder and joint venture partner approval processes*.'

The offset strategy also notes that whilst specific locations may change, the principles and strategies for securing offsets that are presented in the EPBC Act Stage 1 Offset Strategy will be implemented.

2. Methods

2.1 Identifying Prescribed Environmental Matters (PEMs)

The Project's disturbance footprint (Figure 1) has been used to identify areas that may have a SRI on PEMs as defined in the EO Act. The presence/absence of each matter was determined in accordance with the 'Method for mapping Matters of State environmental significance For the State Planning Policy 2017' (DES, 2020).

Detailed and seasonal ecological assessments (Ecosmart Ecology and 3D Environmental, 2017, 2018, 2019 and 2021) were undertaken for the SGP area (covering on-tenure PLs and off-tenure PPLs) which provided ground-verified data on PEMs that are regulated vegetation, protected wildlife habitat, connectivity areas, wetlands and watercourses. These assessments included:

- detailed, seasonal terrestrial ecological surveys across the full range of habitats occurring within the SGP on- and off-tenure areas.
- validating and refining regional ecosystem (RE) mapping for the project, including wetlands of high ecological significance.
- refining mapping for 'core habitat known' and 'core habitat possible' for all relevant species identified under the EPBC Act and *Nature Conservation Act 1992* (NC Act).

This ground-verified data was used to cross-check Queensland Government supplied mapping data on PEMs that are regulated vegetation, protected wildlife habitat, connectivity areas, wetlands and watercourses. Government supplied mapping data was relied upon to identify the following PEMs:

- Wetlands and watercourses.
- Designated precincts in strategic environmental areas.
- Protected areas.
- Highly protected zones of State marine parks.
- Fish habitat areas.
- Waterway providing for fish passage.
- Marine plants.
- Legally secured offset areas.

Additionally, the Queensland Government's Landscape Fragmentation and Connectivity (LFC) Tool was used to assess potential impacts on connectivity areas using ground-verified data.

Conclusions drawn on the presence/absence of PEMs are provided in Section 3.1 (Table 3), which covers all PEMs listed in the PL194 EA and whether or not they were identified within impact areas. Further detailed assessment is provided in Sections 3.2.1 to 3.2.5 for those PEMs that were identified from mapping sources and potentially impacted by the Project.

2.2 Significant residual impact (SRI) assessment

The following documents have been used to assess whether the Project will have a SRI on PEMs:

- *Environmental Offset Act 2014* (EO Act).
- *Environmental Offset Regulation 2014* (EO Regulation).
- Queensland Environmental Offsets Policy (Version 1.13) (DES, 2022).
- Queensland Environmental Offsets Policy Significant Residual Impact Guideline (DEHP, 2014).
- Method for mapping Matters of state environmental significance (DES, 2020).
- Surat Gas Project Threatened Species Mapping Rules Review (Ecosmart Ecology and 3D Environmental, 2023).

3. Results

3.1 Assessment of PEMs for Potential SRI

As per Biodiversity 14 (a), Table 3 includes an analysis and estimated significant residual impact against all of the PEMs listed in the PL194 EA. It identifies five (5) PEMs that warrant further assessment to establish the presence or absence of a significant residual impact. These being:

1) Regulated vegetation – Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse.
2) Regulated vegetation – Essential habitat (not in an urban area) for critically endangered, endangered or vulnerable wildlife.
3) Protected wildlife habitat – Habitat for animals that are critically endangered, endangered or vulnerable wildlife.

4) Protected wildlife habitat – Habitat for an animal that is special least concern.
5) Waterway providing for fish passage – Fish passage (not in an urban area).

Table 3 Analysis of all Prescribed Environmental Matters (PEMs) and whether or not they have the potential for a Significant Residual Impact (SRI)

Item	PEM	Potential for SRI	Comments
1	Regulated vegetation – Endangered regional ecosystems.	No	Not located within the disturbance footprint of the current project.
2	Regulated vegetation – Of concern regional ecosystems.	No	Not located within the disturbance footprint of the current project.
3	Regulated vegetation – Regional ecosystems (not within an urban area) that intersect a wetland on the vegetation management wetlands map.	No	Not located within the disturbance footprint of the current project.
4	Regulated vegetation – Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map.	Yes	Includes a total of 1.739 ha of ground-verified remnant vegetation across the following REs: • 0.501 ha of RE 11.3.14. • 0.256 ha of RE 11.3.18. • 0.408 ha of RE 11.5.1. • 0.574 ha of RE 11.7.7. This vegetation is associated with Braemar Creek and several other unnamed tributaries with stream orders of 1, 2, 3 and 4 (Figure 2). Refer to Section 3.2.1 for the SRI assessment of this PEM. All vegetation polygons are co-located with protected wildlife habitat (Table 4, Figure 2).
5	Regulated vegetation – Essential habitat (not in an urban area) for critically endangered, endangered or vulnerable wildlife.	Yes	A total of 17.981 ha of Queensland Government mapped essential habitat will be impacted for the project (Table 4, Figure 2): • 15.309 ha for the Koala (*Phascolarctos cinereus*), listed as Endangered under both the NC Act and EPBC Act. • 2.312 ha for the Spotted-tailed Quoll (southern subspecies) (*Dasyurus maculatus maculatus*), listed as Endangered under both the NC Act and EPBC Act (overlaps entirely with the Koala essential habitat listed above). • 2.672 ha for the Kogan waxflower (*Philotheca sporadica*), listed as Near Threatened under the NC Act and not listed under the EPBC Act. As a Near

Item	PEM	Potential for SRI	Comments
			Threatened species, it is not relevant to this PEM. Refer to Section 3.2.2 for the SRI assessment of this PEM. All vegetation polygons are co-located with protected wildlife habitat (Table 4, Figure 2).
6	Connectivity Areas – Connectivity area that is a regional ecosystem (not in urban area)	No	Not located within the disturbance footprint of the current project.
7	Wetlands and watercourses – A wetland in a wetland protection area	No	Not located within the disturbance footprint of the current project.
8	Wetlands and watercourses – A wetland of high ecological significance shown on the map of Queensland wetland environmental values	No	Not located within the disturbance footprint of the current project.
9	Wetlands and watercourses – A wetland or watercourse in high ecological value waters	No	Not located within the disturbance footprint of the current project.
10	Designated precinct in a strategic environmental area	No	Not located within the disturbance footprint of the current project.
11	Protected wildlife habitat – An area that is shown as a high risk area on the flora survey trigger map and that contains plants that are critically endangered, endangered or vulnerable.	No	Not located within the disturbance footprint of the current project. A total of 89.383 ha of the project footprint is within an area shown as a high risk area on the flora survey trigger map (Table 4, Figure 2). However, the focal species is Kogan waxflower (*Philotheca sporadica*), listed as Near Threatened under the NC Act and therefore not a PEM under the EO Act. A protected plants flora survey, report and clearing permit or exemption application will be undertaken prior to clearing. However, as it has been determined that the high risk trigger area does not contain plants that are critically endangered, endangered or vulnerable, a SRI assessment of this PEM is not required. This matter will not be assessed any further in this SRI assessment report. All vegetation polygons are co-located with protected wildlife habitat (Table 4, Figure 2).

Item	PEM	Potential for SRI	Comments
12	Protected wildlife habitat – An area that is not shown as a high risk area on the flora survey trigger map, to the extent the area contains plants that are critically endangered, endangered or vulnerable.	No	Not located within the disturbance footprint of the current project.
13	Protected wildlife habitat – A koala habitat area as determined by the chief executive on the koala conservation plan map.	No	Not located within the disturbance footprint of the current project.
14	Protected wildlife habitat – Habitat for an animal that is critically endangered, endangered or vulnerable.	Yes	A total of 199.559 ha will be disturbed with 144.965 ha of ground-verified remnant and regrowth vegetation to be cleared representing core habitat for one or more of the 10 species listed below: • 144.965 ha for the Koala, *Phascolarctos cinereus* (Endangered under both the NC Act and EPBC Act). • 71.776 ha for the Greater Glider, *Petauroides volans* (Endangered under both the NC Act and EPBC Act). • 71.221 ha for the Yellow-bellied Glider, *Petaurus australis* (Vulnerable under both the NC Act and EPBC Act). • 71.880 ha for the South-eastern Long-eared Bat[1], *Nyctophilus corbeni* (Vulnerable under both the NC Act and EPBC Act). • 72.184 for the Diamond Firetail, *Stagonopleura guttata* (Vulnerable under both the NC Act and EPBC Act). • 29.143 ha for the South-eastern Glossy Black-cockatoo, *Calyptorhynchus lathami* (Vulnerable under both the NC Act and EPBC Act). • 72.184 ha for the Common Death Adder, *Acanthophis antarcticus* (Vulnerable under the NC Act). • 71.326 ha for the Dunmall's Snake[1], *Glyphodon (Furina) dunmalli* (Vulnerable under both the NC Act and EPBC Act). • 1.265 ha for the Grey Snake, *Hemiaspis damelii* (Endangered under both the NC Act and EPBC Act).

Item	PEM	Potential for SRI	Comments
			• 0.303 ha for the Brigalow Woodland Snail, *Adclarkia cameroni* (Vulnerable under the NC Act and Endangered EPBC Act). All remnant and regrowth vegetation is mapped as protected wildlife habitat for one or more threatened species, with all vegetation polygons co-located to varying degrees with all other matters, and all the vegetation to be cleared is considered Koala habitat (Table 4, Figure 2). Refer to Section 3.2.3 for the SRI assessment of this PEM.
15	Protected wildlife habitat – Habitat for an animal that is special least concern (i.e. echidna or platypus).	Yes	A total of 53.720 ha of protected wildlife habitat for the Short-beaked Echidna (*Tachyglossus aculeatus*), listed as Special Least Concern under the NC Act, will be impacted for the project (Table 4, Figure 2). Refer to Section 3.2.4 for the SRI assessment of this PEM. All vegetation polygons are co-located with protected wildlife habitat for the Koala and other threatened species (Table 4, Figure 2).
16	Protected areas	No	Not located within the disturbance footprint of the current project.
17	Highly protected zones of State marine parks	No	Not located within the disturbance footprint of the current project.
18	Fish habitat area	No	Not located within the disturbance footprint of the current project.
19	Waterway providing for fish passage – Fish passage (not in an urban area)	Yes	A total of 0.245 ha within in-stream components of watercourses will be impacted. These are associated with Braemar Creek and several other unnamed tributaries with Waterway Barrier Works (fish passage) impact categories of 1, 2, 3 and 4 (Table 4, Figure 2). Refer to Section 3.2.5 for the SRI assessment of this PEM. Most are remnant or regrowth vegetation polygons and are therefore co-located with protected wildlife habitat (Table 4, Figure 2).
20	Marine plants	No	Not located within the disturbance footprint of the current project.
21	Legally secured offset area	No	Not located within the disturbance footprint of the current project.

([1]) Instances where the PEM corresponds to a MNES assessed under EPBC Act Approval (EPBC 2010/5344).

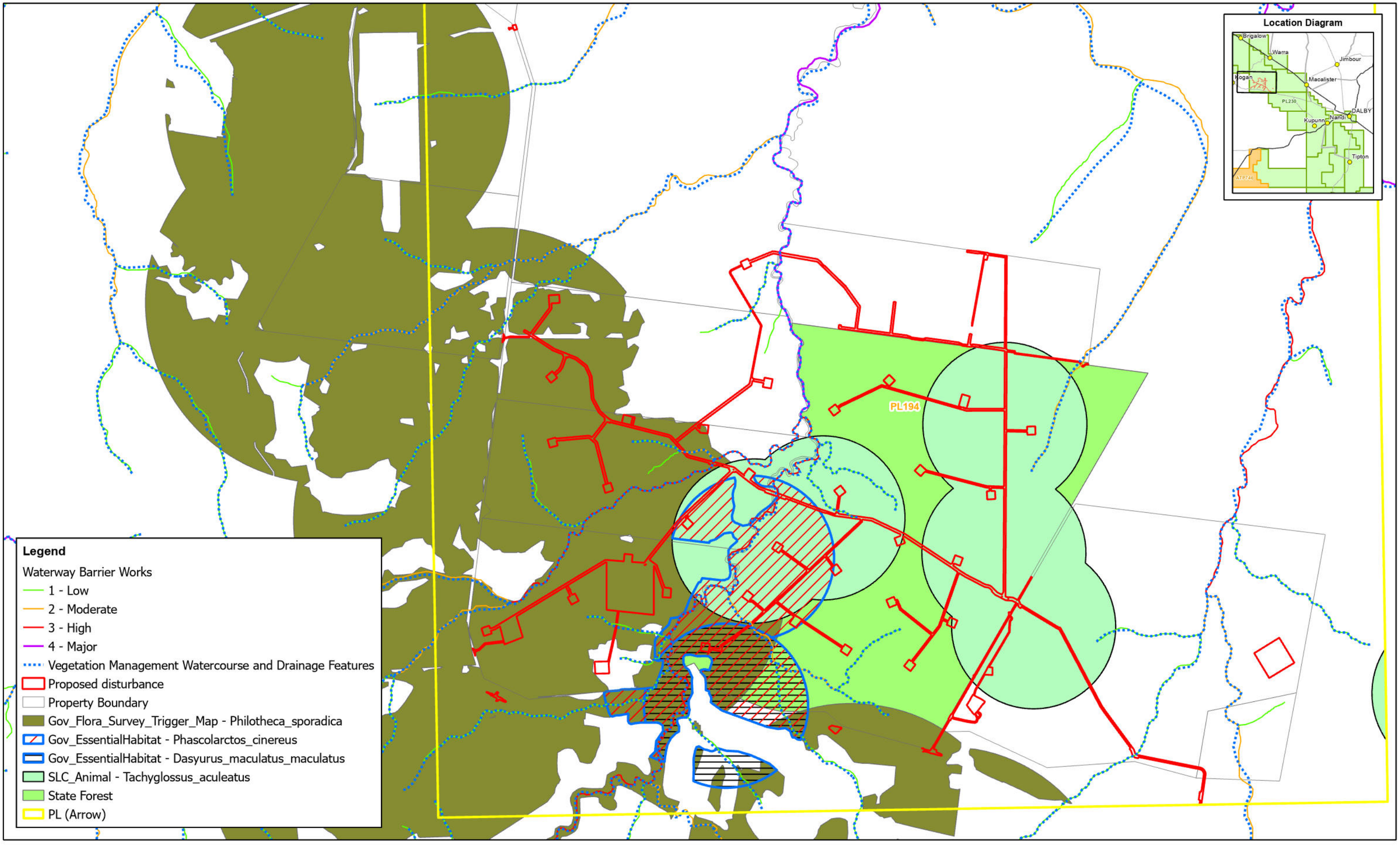

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Figure 2a
Prescribed Environmental Matters (PEMs) occurring within the project footprint

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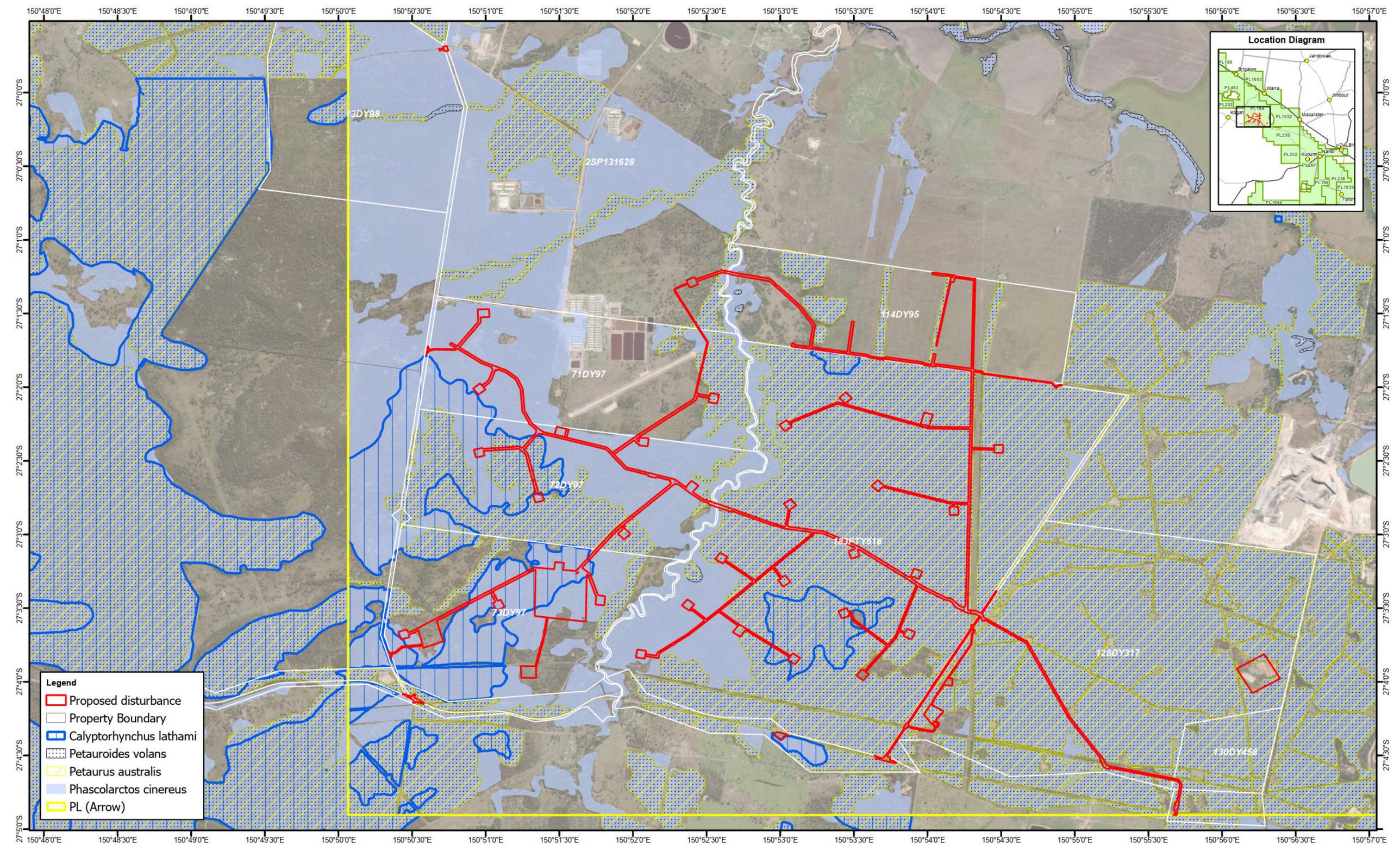

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Figure 2b
Prescribed Environmental Matters (PEMs) occurring within the project footprint

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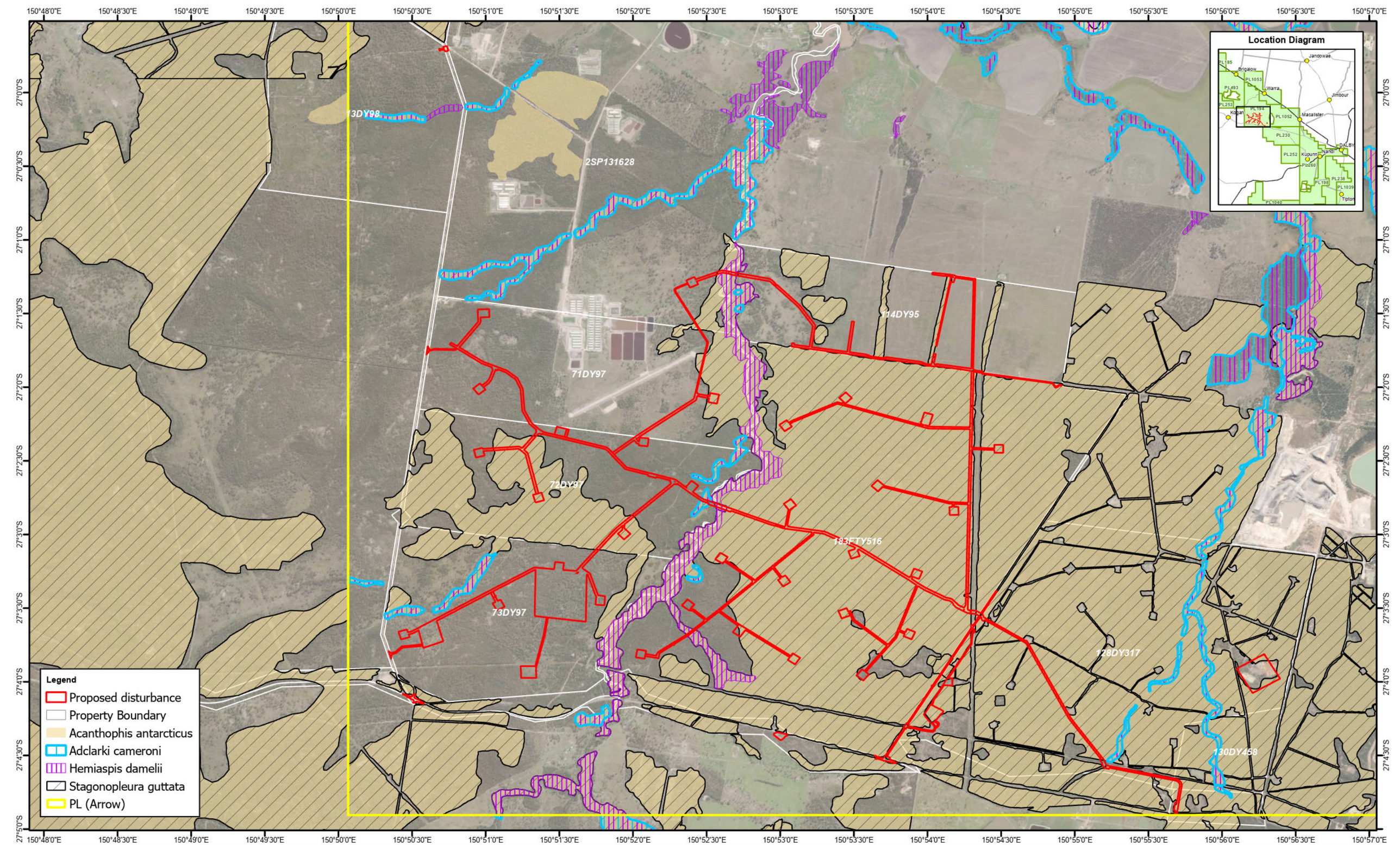

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Figure 2c
Prescribed Environmental Matters (PEMs) occurring within the project footprint

Uncontrolled (A)

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NOT FOR CONSTRUCTION

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3.2 Assessment of PEMs for Actual SRI

Review of Table 3 shows five PEMs with a potential for SRI (see Figures 1 and 2 for locations). Sections 3.2.1 to 3.2.5 provide a further assessment of these five matters. Table 4 provides a breakdown of each vegetation community that is impacted by the Project and the relevant PEM that is associated with each one.

Table 4 Summary of Impacted Prescribed Environmental Matters (PEMs) including areas (ha), vegetation communities and co-locations

Vegetation Community	Area (ha)	Regulated Vegetation			Protected Wildlife Habitat (ha) – endangered or vulnerable wildlife										Protected Wildlife Habitat (ha) – special least concern wildlife	Waterway providing for fish passage (ha)
		RE within the defined distance of defining banks of a watercourse	Essential habitat for endangered wildlife		Koala	Greater Glider	Yellow-bellied Glider	South-eastern Long-eared Bat[1]	Diamond Firetail	South-eastern Glossy Black-cockatoo	Common Death Adder	Dunmall's Snake[1]	Grey Snake	Brigalow Woodland Snail	Short-beaked Echidna	Fish passage (not in an urban area)
			Spotted-tailed Quoll*	Koala												
11.3.14	0.554	0.501		0.167	0.554	0.554		0.554	0.554		0.554		0.554		0.554	0.043
11.3.18	0.408	0.256	0.023	0.216	0.408			0.408	0.408		0.408	0.408	0.408		0.064	0.008
11.3.25	0.303				0.303	0.303	0.303		0.303		0.303		0.303	0.303	0.303	
11.5.1	51.494	0.408		6.352	51.494	51.494	51.494	51.494	51.494		51.494	51.494			28.072	0.070
11.7.4	5.971				5.971	5.971	5.971	5.971	5.971	5.971	5.971	5.971				
11.7.7	13.453	0.574		1.369	13.453	13.453	13.453	13.453	13.453		13.453	13.453			10.994	0.048
Regrowth (11.5.1)	49.609		2.289	7.205	49.609										7.797	0.071
Regrowth (11.7.4)	23.172				23.172					23.172						
Cleared land	54.595														5.935	0.006
Total	**199.559**	**1.739**	**2.312**	**15.309**	**144.965**	**71.776**	**71.221**	**71.880**	**72.184**	**29.143**	**72.184**	**71.326**	**1.265**	**0.303**	**53.720**	**0.245**

([1]) Instances where the PEM corresponds to a MNES assessed under EPBC Act Approval (EPBC 2010/5344).

3.2.1 Regulated vegetation – Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse.

Table 4 shows that eight (8) vegetation communities will be impacted by the Project, Regrowth REs 11.5.1 and 11.7.4, and Remnant REs 11.3.14, 11.3.18, 11.3.25, 11.5.1, 11.7.4, and 11.7.7. Of the remnant communities 0.501 ha of RE 11.3.14, 0.256 ha of RE 11.3.18, 0.408 ha of RE 11.5.1 and 0.574 ha of RE 11.7.7 occur within the defined distance from the defining banks of a relevant watercourse. These four REs are listed as 'Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map' within the PL 194 EA with sufficient allowable impact areas.

As shown in Table 4 these RE polygons also provide habitat for protected wildlife, most of which are also listed protected species under the EPBC Act. It is Arrow's consideration that under such circumstances the biodiversity offset associated with this PEM would therefore be managed under the EPBC Act approval (EPBC 2010/5344) and associated Offset Strategy for the SGP Stage 1. However, The Department of Environment and Science (DES) considers regulated vegetation within the defined distance from a watercourse as a substantially different matter to habitat for protected species. Given the time-critical nature of the approval for this SRI report, Arrow will include a total area of 1.739 ha within the Notice of Election for biodiversity offset (both under this PEM and for the overlapping protected wildlife habitat as shown in Table 4, see also Section 3.2.3). It is noted that Arrow will further investigate options to avoid this sort of duplication of offset requirements in the future.

3.2.2 Regulated vegetation – Essential habitat (not in an urban area) for endangered or vulnerable wildlife.

As shown in Tables 3 and 4 there is 15.309 ha of Queensland Government mapped essential habitat for the Koala (*Phascolarctos cinereus*) and an overlapping 2.312 ha for the Spotted-tailed Quoll (*Dasyurus maculatus maculatus*), both listed as endangered under the EPBC Act and the NC Act, to be impacted by the Project. In all situations, the specific area of habitat to be impacted for a listed species protected under the NC Act is also habitat to be impacted for a species protected under the EPBC Act, including habitat for the South-eastern Long-eared Bat and Dunmall's Snake. As noted in Section 3.2.1, Arrow will further investigate options to avoid this sort of duplication of offset requirements when State matters overlap with Federal matters for the same impact area.

Essential habitat for the Koala

Of the 15.309 ha of mapped essential habitat for the Koala, 7.205 ha is located within regrowth vegetation, and 8.104 ha is located within remnant vegetation. The entire 15.309 ha overlaps with protected wildlife habitat for the Koala (Table 4, Section 3.2.3). This PEM also overlaps with 1.365 ha of the REs within the defined distance from the defining banks of a relevant watercourse PEM (Table 4, Section 3.2.1).

Regulated vegetation is a prescribed regional ecosystem as defined in the EO Act and does not include regrowth vegetation. As such Arrow will include a total area of 8.104 ha within the Notice of Election for biodiversity offset for essential habitat for the endangered Koala, including:

- 0.167 ha within remnant RE 11.3.14
- 0.216 ha within remnant RE 11.3.18
- 6.352 ha within remnant RE 11.5.1
- 1.369 ha within remnant RE 11.7.7

Essential habitat for the Spotted-tailed Quoll

The purpose of this SRI assessment is to decide whether or not the Project will or is likely to have a significant residual impact on the MSES, Queensland Government mapped essential habitat for the Spotted-tailed Quoll. This SRI assessment was completed in accordance with the Queensland Environmental Offsets Policy Significant Residual Impact guideline (DEHP 2014). Of the 15.309 ha of essential habitat impacted by the Project, 2.312 ha is mapped as essential habitat for the Spotted-tailed Quoll. The majority (2.289 ha) is located within regrowth vegetation (RE 11.5.1) and the remaining 0.023 ha is within remnant RE 11.3.18. This area completely overlaps with protected wildlife habitat for the Koala and several other threatened species (Table 4). Koala and Spotted-tailed Quoll are in the same species functional group under the EO Act and as such offsets could be co-located for the two species (DES, 2022).

Species overview:

Dasyurus maculatus maculatus is the southern subspecies of Spotted-tailed Quoll, occurring on the eastern Australian coastline from southeast Queensland through to eastern NSW, Victoria and Tasmania (DAWE, 2022). The subspecies is broken up into two populations, one on the mainland and one in Tasmania.

D. m. maculatus is a nocturnal carnivorous marsupial which can be distinguished by its reddish-brown fur with white spots on both its body and tail (DAWE, 2022). The species is the approximate size of the domestic cat, weighing about 5 kg, with a body and tail length of approximately 500 mm and 450 mm respectively (Queensland Museum, 1995). The species feeds primarily on medium-sized mammals (500–5000 g), however it is opportunistic and known to feed on anything from insects to small wallabies (Dawson, 2007).

D. m. maculatus breeds in winter, usually giving birth between late July and mid-August (Meyer-Gleaves, 2010). The young are inside the mother's pouch for approximately seven weeks, and do not reach independence until they are 17 to 19 weeks of age, spending the majority of lives up until this point inside a den relying on their mothers for food (Meyer-Gleaves, 2010). The species have a rather low reproductive output, with some females breeding only once or twice in their lifetimes (DotE, 2016). Female members of this species tend to have a home range of 200-1000 ha, and males have a much larger range of up to 500-2500 ha (Fitzgibbon, 2020). Female home ranges tend to overlap more frequently than those of males, however both sexes are highly solitary, and distributions are usually sparse (Meyer-Gleaves, 2010; Fitzgibbon, 2020). The species travel on average 3-5 km in 24 hours, however distances of over 7 km per night have been recorded (Fitzgibbon, 2020).

In southern Queensland, *D. m. maculatus* can be found on both sides of the Great Dividing Range in a range of habitats including rainforest, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, mangroves, on beaches and sometimes in grassland or pastoral areas adjacent to forested areas (DotE, 2016). The species is however

forest dependent, and its western distribution is limited by rainfall requirements, preferring to live in areas of consistent rainfall of over 600 mm per year (DotE, 2016; Belcher, 2004). The species relies on den sites for habitat, such as rock crevices, caves, hollow logs, burrows and tree hollows (DAWE, 2022).

The *D. m. maculatus* population is thought to have reduced by 50-90% since European settlement, and it now exists in fragmented populations (Meyer-Gleaves, 2010). The most significant threat to the species is habitat loss and fragmentation of forests that the species depends on for survival (Meyer-Gleaves, 2010). This has been caused by large-scale clearing and wildfires. Secondary to this are impacts from introduced species, both predators and prey. Introduced species such as cats (*Felis catus*), domestic dogs (*Canis familiaris*) and foxes (*Vulpes vulpes*) impact on *D. m. maculatus* through direct predation and competition for food (Meyer-Gleaves, 2010). The species may also be susceptible to baiting which is used to control these introduced predators (DotE, 2016). Though no studies have conclusively linked cane toad (*Rhinella marina*) poisoning to declines in Spotted-tail Quoll populations, modelling studies have predicted that this poisoning could put the southern subspecies at a moderate risk of population decline (DotE, 2016). Research into population decline due to cane toad poisoning is an action proposed in Australian Government Department of the Environment's National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus* (DotE, 2016).

Assessment of significance of impacts:

The Project will involve the drilling and completion of coal seam gas wells, along with the construction of supporting wellsite and gathering infrastructure. This infrastructure will deliver gas to the Kogan and Daandine gas processing facilities. Arrow's first priority during planning for this Project was to avoid the clearing of native vegetation, however because of the location of the proposed Project within Dalby State Forest and surrounding freehold properties, some of which have retained significant areas of vegetation, some clearing of vegetation is necessary. The impact of this clearing will be minimised by clearing the narrowest corridors possible within forested areas, co-locating tracks and pipelines as far as practicable, and ensuring that rehabilitation of Right of Ways (ROWs) is conducted as soon as possible after construction.

This stage of the Project development will involve the clearing of one, 1 ha well pad along with an associated access track and gathering within an area mapped as essential habitat for Spotted-tailed Quoll (*D. m. maculatus*). This clearing will occur entirely within Dalby State Forest. Wildlife online database searches were undertaken on 10 February 2022, showing all protected species recorded since 1980 within 50 km of the proposed infrastructure. The essential habitat mapping is based on one record from May 1980, which is the only individual recorded within 50 km of the proposed infrastructure. The record is unconfirmed and located immediately south of Dalby Kogan Road on the edge of a fragmented patch of ground-verified RE 11.5.1 surrounded by intensively farmed cropping land. Dalby State Forest to the north of the record is completely lacking in rock crevices and caves, a necessary requirement for quoll den sites. The species, if it existed on this property, would therefore rely heavily on hollow logs for den sites. These nesting sites were found to be quite sparse during field assessments because of historic clearing of large eucalypts in the state forest. The average yearly rainfall in the Dalby region is 676 mm, which exceeds the 600 mm minimum rainfall requirements of *D. m. maculatus* (BoM 2021a). This is however highly inconsistent between years, with 14 of the last 29 years having a yearly rainfall of under 600 mm (BoM 2021b).

It is extremely unlikely that any *D. m. maculatus* individuals could currently be found in this vicinity. In a recent likelihood of occurrence assessment, Mark Sanders who is a highly regarded fauna expert concluded that the species "will not occur" in the area (Ecosmart Ecology and 3D

Environmental, 2023). As per the assessment of significance in the table below, Arrow conclude that the Project activities are considered very unlikely to cause a significant residual impact to the species. As such Arrow will not be including any area (ha) within the Notice of Election for biodiversity offset for essential habitat for the endangered Spotted-tailed Quoll.

Significance criteria	**Assessment of significance**
An action is likely to have a significant impact on endangered and vulnerable wildlife if the impact on the habitat is likely to:	
Lead to a long-term decrease in the size of a local population	No populations of *D. m. maculatus* are known to exist in the area. The only record of the species within 50 km of the proposed activities was recorded over 40 years ago and is unconfirmed so it is unlikely to be accurate. It is therefore extremely unlikely that the proposed activities will lead to a long-term decrease in the size of a local population.
Reduce the extent of occurrence of the species	As stated above, *D. m. maculatus* is extremely unlikely to occur in this location because no reliable sightings have occurred within 50 km of the site in the last 40 years. The species is also unlikely to occur in this location because the annual rainfall does not consistently exceed 600 mm in the region, and the required den sites are not readily available. The proposed activities will therefore be located outside of the species' realistic extent of occurrence.
Fragment an existing population	As stated above, no existing populations are known or likely to occur in the area. After construction, the widest area that a *D. m. maculatus* individual would need to traverse would be approximately 70 m, and these areas will be rehabilitated swiftly after construction. The smallest average home ranges of *D. m. maculatus* are 200 ha, and the shortest average distance travelled by the species in 24 hours is 3 km. It is therefore extremely unlikely that clearing of the scale proposed would fragment populations of this species.
Result in genetically distinct populations forming as a result of habitat isolation	As stated above, no existing populations are known or likely to occur in the area. After construction, the widest area that a *D. m. maculatus* individual would need to traverse would be approximately 70 m, and these areas will be rehabilitated swiftly after construction. The smallest average home ranges of *D. m. maculatus* are 200 ha, and the shortest average distance travelled by the species in 24 hours is 3 km. It is therefore extremely unlikely that this activity will prevent the transfer of genetic material within a population.
Result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat	The invasive species that have the greatest effect on quoll populations are cats and foxes, which prey on and compete with the species. Cane toads also kill the species through poisoning when preyed upon. All three of these pest species are already established in the broader area. Arrow monitor for pest animals and plants under their Pest Management Procedure. Arrow has committed to ensuring that activities do not encourage or draw pest animals into areas with infrastructure (e.g. cats, foxes and wild dogs scavenging around camps or manned facilities). Where pest species are identified onsite, management techniques including euthanasia will be considered on a case-by-case basis. With these control measures, there will be no additional risk of invasive species that are harmful to *D. m. maculatus* becoming established in the area due to Arrow's activities.
Introduce disease that may cause the population to decline	Diseases in populations of threatened species including *D. m. maculatus* are often exacerbated by habitat fragmentation and increased population density. Arrow's activities will not fragment or isolate any known populations of the species, nor will it reduce the overall extent of occurrence of the species. There is no risk of disease becoming more prevalent or having a more significant impact on a population because of the clearing activities proposed for this project.
Interfere with the recovery of the species	As stated above, *D. m. maculatus* is extremely unlikely to occur in this location because no reliable sightings have occurred within 50 km of the site in the last 40 years. The activities will not fragment or reduce the extent of known habitat, nor will it increase the risk of pests or diseases that may impact the species. It is therefore extremely unlikely that the recovery of the species will be impacted.
Cause disruption to ecologically	Though the species may be found in areas outside of their ideal habitat, due to their relatively large home range, they are reliant on forested areas with den sites

Significance criteria	Assessment of significance
significant locations (breeding, feeding, nesting, migration or resting sites) of a species	and consistent rainfall of over 600 mm per year. Dalby State Forest does not meet this species requirements and is therefore not considered important habitat for the species. The proposed activities will be carried out in open woodland lacking in rock crevices and caves, with only sparse hollow logs and trees for den sites. Arrow records the locations of habitat trees and retains hollow-bearing trees and logs where possible during clearing activities. It is therefore unlikely that these activities will cause disruption to ecologically significant locations for the species.
Conclusion	Given that no *D. m. maculatus* populations are known to occur in the region, no important habitat is proposed to be cleared, and a large amount of remnant vegetation will remain in the area after construction activities occur, the proposed gas production infrastructure is considered very unlikely to cause a significant residual impact to the species.

3.2.3 Protected wildlife habitat – habitat for an animal that is critically endangered, endangered or vulnerable.

As shown in Tables 3 and 4 there is habitat for ten (10) vulnerable and/or endangered species to be impacted by the Project. In all situations, the specific area of habitat to be impacted for a listed species protected under the NC Act is also habitat to be impacted for a species protected under the EPBC Act.

As noted in Section 3.2.1, Arrow will further investigate options to avoid this sort of duplication of offset requirements when State matters overlap with Federal matters for the same impact area. However, given the time-critical nature of the approval for this SRI report, Arrow will include the areas of impacted PEMs for protected wildlife habitat. This totals an area of 144.965 ha to be included in the Notice of Election for this Project. This offset area includes a combination of regulated vegetation and protected wildlife habitat for the Koala, Greater Glider, Yellow-bellied Glider, Diamond Firetail, Glossy Black-cockatoo, Common Death Adder, Grey Snake, and Brigalow Woodland Snail (refer to Table 4 for breakdown), including:

- 0.554 ha Remnant 11.3.14
- 0.408 ha Remnant 11.3.18
- 0.303 ha Remnant 11.3.25
- 51.494 ha Remnant 11.5.1
- 5.971 ha Remnant 11.7.4
- 13.453 ha Remnant 11.7.7
- 49.609 ha Regrowth 11.5.1
- 23.172 ha Regrowth 11.7.4

This PEM also overlaps completely with all other PEMs described in this SRI assessment report (Table 4).

3.2.4 Protected wildlife habitat – habitat for an animal that is special least concern.

As shown in Tables 3 and 4 there is 53.720 ha of protected wildlife habitat for the Short-beaked Echidna, listed as a special least concern species, to be impacted by the Project. Of the 53.720 ha, 5.935 ha has been ground verified as cleared land, leaving 47.785 ha of remnant and regrowth vegetation (REs 11.3.14, 11.3.18, 11.3.25, 11.5.1 and 11.7.7) (Tabel 4). This area completely

overlaps with protected wildlife habitat for the Koala and several other threatened species (Table 4). Koala and Short-beaked Echidna are in the same species functional group under the EO Act and as such offsets could be co-located for the two species (DES, 2022).

Under the SRI Assessment Guideline (DEHP, 2014), an action is likely to have a significant impact on special least concern (non-migratory) wildlife habitat if it is likely that it will result in:

- a long-term decrease in the size of a local population; or
- a reduced extent of occurrence of the species; or
- fragmentation of an existing population; or
- result in genetically distinct populations forming as a result of habitat isolation; or
- disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species.

The Short-beaked Echidna is a widespread and common mammal, occurring throughout all of mainland Australia. They are generalist in their habitat preference, occurring within alpine and cold-temperate areas to deserts and tropical regions. The Short-beaked Echidna appears to have no specific habitat requirements beyond a food supply of ants and termites.

As this species is widespread, highly mobile, non-territorial, and a generalist in habitat preference, the removal of 48 ha of potential habitat for the Short-beaked Echidna is not likely to lead to a long-term decrease in the size of a local population, or a reduced extent of occurrence of the species.

The nature of the clearing works for the Project does not involve broadscale clearing, with vegetation clearing comprising of narrow (< 40 meters wide) linear strips and well pads approximately 1 ha in size. This type of clearing footprint is not likely to result in fragmentation of an existing population as the nature of the clearing does not create a 'hard' barrier to dispersal (such as a permanent road or large building) and the species will move through disturbed and cleared areas such as access tracks. Therefore, the proposed action is unlikely to result in fragmentation of populations or result in genetically distinct populations forming as a result of habitat isolation.

Although no burrows or potential den sites have been specifically recorded within the Project area, Arrow's *Species management program for Tampering with Animal Breeding Places* (2023) (SMP) will be implemented prior to and during habitat disturbance. The SMP outlines specific controls and mitigation measures to be implemented if individual Echidnas, as well as potential or active burrows are found within the clearing area during pre-clearance surveys or clearing works. The Impact Minimisation Hierarchy ensures that avoiding disturbance during breeding season (July – November) is the highest priority in the hierarchy of controls, as well as additional measures including exclusion zones around individuals or burrows, and specific management by an experienced fauna spotter catcher. Therefore, the proposed action is unlikely to result in disruption to ecologically significant locations for the Short-beaked Echidna.

It is unlikely that the construction of the Project will result in a long-term decrease in the size of a local population or reduce the extent of occurrence of the Short-beaked Echidna, and is unlikely to result in population fragmentation or genetically distinct populations of Echidnas. Furthermore, it is unlikely that the construction works will result in a disruption to ecologically significant locations (breeding, feeding or nesting sites).

The results of this SRI assessment conclude that the construction and operation for the Project is unlikely to have a significant impact to the Short-beaked Echidna. A SRI for this PEM is not

considered likely and therefore this PEM will not be included in the Notice of Election for biodiversity offset for this Project.

3.2.5 Waterway providing for fish passage – Fish passage (not in an urban area).

There are mapped watercourses intersecting the Project footprint associated with Braemar Creek and several other unnamed tributaries (Table 4, Figure 2). These waterways are categorised by DAF as having a mix of 'low', 'moderate', 'high', and 'major' risk of impact for fish passage. Waterway barrier works in a fish passage waterway will be undertaken in accordance with the DAF guideline "*Accepted development requirements for operational work that is constructing or raising waterway barrier works*" (DAF, 2018). The purpose of this section is to assess if the proposed pipeline crossing construction will have a SRI relating to the MSES 'Waterway providing for Fish Passage'.

Under the SRI Assessment Guideline (DEHP, 2014), an environmental offset may be required '*for any part of a waterway that provides for passage of fish (other than that part of a waterway within an urban area) if the construction, installation or modification of waterway barrier works carried out under an authority will limit the passage of fish along the waterway*'.

In accordance with DEHP (2014), the construction and operation of the pipeline for the Project is not likely to:

- result in the mortality or injury of fish; or
- result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fishes energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish; or
- reduce the extent, frequency or duration of fish passage previously found at a site; or
- substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish; or
- result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows; or
- lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species.

The focal watercourses are ephemeral in nature. Construction of the pipelines are proposed to be a standard open-cut (trenching) method. This technique is most suited to dry or low flow conditions and involves establishing a stable working platform either side of the watercourse and creating a trench using excavators, or similar. Tie-in points will be located on high ground, away from any water flow. Trench spoil removed from the watercourse will be positioned above the high bank. Welded pipe will be laid in the trench and spoil material returned to the trench. Trench and backfill activities will be undertaken to ensure that the bed and bank materials are stockpiled separately and returned to the trench to match original conditions to the greatest extent possible. Rock protection may be placed over the trench if required, to prevent potential scouring during high water flow conditions.

Pipeline construction will be undertaken outside of the wet season when the watercourses are not expected to be flowing. As such it is very unlikely that fish species will be present during

construction. Construction time for watercourse crossing is expected to be approximately 10 days. Construction methodology will not introduce any chemicals or solvents, alter water chemistry, or change flow regimes. All construction works will be undertaken and completed in accordance with IECA Best Practice Erosion & Sediment Control Guidelines (IECA, 2008). If water is present in the watercourse, erosion and sediment control (ESC) measures such as temporary coffer dams and silt curtains, as determined by a suitably qualified person, will be installed for the duration of instream works. These measures may temporarily restrict passage whilst in place. If required, water quality monitoring (such as, total dissolved solids (TDS), dissolved oxygen, pH, etc.) will be undertaken during instream construction works to ensure ESC measures and construction methodology is effective. Fauna spotter-catchers will regularly monitor the crossing for possible presence of aquatic species including fish. In the event that monitoring has indicated an impact then works will cease until such time as the issue is resolved in consultation with a suitably qualified person. The ESC measures will be removed once in-stream construction works are completed.

Following construction, the construction trench will be backfilled using spoil to match original conditions. All temporary construction materials and equipment will be removed from the crossing location prior to the onset of the following wet season. No permanent structure or water barrier will be left in-situ that will meaningfully change local hydrology. Following completion of construction activities, the disturbed area will be rehabilitated to reflect the pre-disturbance state and surrounding area.

Therefore, it is very unlikely that the construction of the pipeline will result in the direct mortality or injury of fish, or substantially increase risks to fish health and wellbeing through stranding, entrapment, or confined schooling behaviour. The extent, frequency or duration of fish passage is unlikely to be reduced. The construction and operation of the pipeline is unlikely to substantially modify, destroy or fragment areas of fish habitat necessary for the breeding and/or survival of fish. It is also very unlikely to result in a substantial and measurable change in the hydrological regime of the waterway or lead to significant changes in water quality.

The results of this SRI assessment conclude that the construction and operation of the pipeline for the Project is very unlikely to have a significant impact to a waterway providing for fish passage and will not limit the passage of fish along the waterway. A SRI for this PEM is not considered likely and therefore this PEM will not be included in the Notice of Election for biodiversity offset for this Project.

4. Conclusion

Arrow is yet to investigate options to avoid duplication in regard to biodiversity offsets for overlapping State and Federal matters for the same impact area. This, in combination with the time critical nature of the Project (Wari Djunben, SGP PL194) and this SRI assessment report approval, has led Arrow to identify a total of 144.965 ha of vegetation clearing to require an offset under the State process for three overlapping PEMs, including:

- Regulated vegetation (REs within the defined distance from the defining banks of a relevant watercourse),
- Regulated vegetation (essential habitat for endangered wildlife – Koala), and
- Protected wildlife habitat (habitat for Koala, Greater Glider, Yellow-bellied Glider, Diamond Firetail, Glossy Black-cockatoo, Common Death Adder, Grey Snake, and Brigalow Woodland Snail).

This includes:

- 0.554 ha Remnant 11.3.14
- 0.408 ha Remnant 11.3.18
- 0.303 ha Remnant 11.3.25
- 51.494 ha Remnant 11.5.1
- 5.971 ha Remnant 11.7.4
- 13.453 ha Remnant 11.7.7
- 49.609 ha Regrowth 11.5.1
- 23.172 ha Regrowth 11.7.4

As noted above, Arrow will further investigate options to avoid this sort of duplication of offset requirements when State matters overlap with Federal matters for the same impact area.

Table 5 shows the SRIs for PEMs impacted by the current Project (Wari Djunben, SGP PL194) reconciled with the PL 194 EA Table 3 (Biodiversity 11). All matters, both MSES and MNES, identified as present and to be disturbed trigger a SRI. For the current Project this includes Dunmall's Snake and South-eastern Long-eared Bat for which offsets will be managed under the EPBC Act Stage 1 Offset Strategy for the SGP.

Table 5 Significant Residual Impacts (SRIs) to Prescribed Environmental Matters (PEMs) reconciled with the Environmental Authority (EA) Table 3 (Biodiversity 11) for SGP PL194 Wari Djunben

PEM	Total area (ha) authorised in EA	Total area (ha) from SGP PL194 Wari Djunben	Estimated area (ha) remaining
REGULATED VEGETATION			
Regional ecosystems (not within an urban area) within the defined distance from the defining banks of a relevant watercourse on the vegetation management watercourse map			
RE 11.3.14	0.6	0.6	0
RE 11.3.18	0.3	0.3	0
RE 11.5.1	0.5	0.5	0
RE 11.7.7	0.6	0.6	0
Essential habitat (not in an urban area) on the essential habitat map for endangered wildlife			
Phascolarctos cinereus (Koala)	8.7	8.7	0
Dasyurus maculatus (Spotted-tailed Quoll)	2.4 (no SRI)	2.4	0
PROTECTED WILDLIFE HABITAT			
Habitat for an animal that is endangered wildlife			
Hemiaspis damelii (Grey Snake)	1.3	1.3	0
Phascolarctos cinereus (Koala)	145.7	145.7	0
Petauroides volans (Greater Glider)	71.8	71.8	0
Habitat for an animal that is vulnerable wildlife			
Acanthophis antarcticus (Common Death Adder)	72.2	72.2	0
Adclarkia cameroni (Brigalow Woodland Snail)	0.4	0.4	0
Petaurus australis (Yellow-bellied Glider)	71.3	71.3	0
Nyctophilus corbeni (South-eastern Long-eared Bat)[1]	71.9 (MNES)	71.9	0
Glyphodon (Furina) dunmalli (Dunmall's Snake)[1]	71.4 (MNES)	71.4	0

PEM	Total area (ha) authorised in EA	Total area (ha) from SGP PL194 Wari Djunben	Estimated area (ha) remaining
Stagonopleura guttata (Diamond Firetail)	72.2	72.2	0
Calyptorhynchus lathami (Glossy Black Cockatoo)	29.2	29.2	0
Habitat for an animal that is special least concern wildlife			
Tachyglossus aculeatus (Echidna)	53.8 (no SRI)	53.8	0
WATERWAY PROVIDING FOR FISH PASSAGE			
Fish passage (not in an urban area)	0.3 (no SRI)	0.3	0

([1]) = Instances where the PEM corresponds to a MNES assessed under EPBC Act Approval (EPBC 2010/5344).

4.1 Distinct Matter Area (DMA) Grouping Justification for Financial Offsets

If this SRI assessment is approved by DES a corresponding Notice of Election (NoE) submission will be made as a Financial Offsets Calculation. Several matters have been grouped together in the same Distinct Matter Area (DMA) (Table 6), due to colocation of habitat.

The purpose of this Section is to provide supporting justification that demonstrates why it is appropriate to group these matters in the same DMA, in relation to their required habitat requirements and rehabilitation management actions.

Table 6 Distinct Matter Area (DMA) Groupings for Financial Offsets Calculation

DMA	Matter Groups	Impact Area (ha)
1.1	1.1.1: Regional ecosystem—11.3.14 (*Eucalyptus spp*., *Angophora spp*., *Callitris spp*. woodland on alluvial plains) [including 0.167 ha remnant essential habitat for the Koala, and 0.501 ha RE within the defined distance of defining banks of a watercourse] 1.1.2: Threatened animals— *Phascolarctos cinereus* (Koala)	0.6
1.2	1.2.1: Regional ecosystem—11.3.18 (*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium) [including 0.216 ha remnant essential habitat for the Koala, and 0.256 ha RE within the defined distance of defining banks of a watercourse] 1.2.2: Threatened animals— *Phascolarctos cinereus* (Koala)	0. 3
1.3	1.3.1: Regional ecosystem—11.5.1 (*Eucalyptus crebra* and/or *E. populnea, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains and/or remnant surfaces) [including 6.352 ha remnant essential habitat for the Koala, and 0.408 ha RE within the defined distance of defining banks of a watercourse] 1.3.2: Threatened animals— *Phascolarctos cinereus* (Koala)	6.4
1.4	1.4.1: Regional ecosystem—11.7.7 (*Eucalyptus fibrosa* subsp. *nubilis* +/- *Corymbia* spp. +/- *Eucalyptus* spp. woodland on Cainozoic lateritic duricrust) [including 1.369 ha remnant essential habitat for the Koala, and 0.574 ha RE within the defined distance of defining banks of a watercourse] 1.4.2: Threatened animals— *Phascolarctos cinereus* (Koala)	1.4
1.5	1.5.1: Threatened animals— *Phascolarctos cinereus* (Koala) [habitat is within remnant REs 11.3.14, 11.3.18, 11.3.25, 11.5.1, 11.7.4 and 11.7.7, and regrowth REs 11.5.1 and 11.7.4]	137.0
1.6	1.6.1: Threatened animals— *Petauroides volans* (Greater Glider) [habitat is within remnant REs 11.3.14, 11.3.25, 11.5.1, 11.7.4 and 11.7.7]	71.8
1.7	1.7.1: Threatened animals— *Petaurus australis* (Yellow-bellied Glider) [habitat is within remnant REs 11.3.25, 11.5.1, 11.7.4 and 11.7.7]	71.3

DMA	Matter Groups	Impact Area (ha)
1.8	1.8.1: Threatened animals— *Stagonopleura guttata* (Diamond Firetail) [habitat is within remnant REs 11.3.14, 11.3.18, 11.3.25, 11.5.1, 11.7.4 and 11.7.7]	72.2
1.9	1.9.1: Threatened animals— *Calyptorhynchus lathami* (South-eastern Glossy Black-cockatoo) [habitat is within remnant and regrowth RE 11.7.4]	29.2
1.10	1.10.1: Threatened animals— *Acanthophis antarcticus* (Common Death Adder) [habitat is within remnant REs 11.3.14, 11.3.18, 11.3.25, 11.5.1, 11.7.4 and 11.7.7]	72.2
1.11	1.11.1: Threatened animals— *Hemiaspis damelii* (Grey Snake) [habitat is within remnant REs 11.3.14,11.3.18 and11.3.25]	1.3
1.12	1.12.1: Threatened animals— *Adclarkia cameroni* (Brigalow Woodland Snail) [habitat is within remnant RE 11.3.25]	0.4

Koalas occur in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas. Koalas near the western edge of their range are often associated with watercourses though are not restricted to them. Koalas feed on eucalyptus trees but show dietary preference based on geographical region and the types of tree species present. In the Brigalow Belt Koalas have at least 24 species of Eucalyptus upon which they preferentially forage, of these the following have been recorded within the SGP: *Corymbia tessellaris*, *C. citriodora*, *Eucalyptus camaldulensis*, *E. chloroclada*, *E. coolabah*, *E. crebra*, *E. exserta*, *E. fibrosa*, *E. melanophloia*, *E. moluccana*, *E. ochrophloia*, *E. populnea*, and *E. tereticornis* (Ecosmart Ecology and 3D Environmental, 2023). Given this description, the habitat mapping rules provided in the SGP ecology report identifies all remnant and regrowth REs except 11.9.5 as 'Core Habitat Possible' with respect to Koala habitat (Ecosmart Ecology and 3D Environmental, 2023).

Therefore, the patches of REs 11.3.14, 11.3.18, 11.5.1 and 11.7.7 within the SGP PL194 Project (Wari Djunben) area constitute 'Core Habitat Possible' for the Koala and as such, the implementation of management actions relating to the rehabilitation of these REs will apply to the rehabilitation of habitat for the Koala.

Appendix 6 of the Queensland Environmental Offsets (EO) Policy (v1.13) (DES, 2022) outlines several examples of direct management actions that can achieve a conservation outcome. The implementation of such management actions when applied to rehabilitated areas of REs 11.3.14, 11.3.18, 11.5.1 and 11.7.7 can lead to an improvement in the extent and quality of available habitat for the Koala.

Based on the habitat mapping rules for Koala (Ecosmart Ecology and 3D Environmental, 2023), management actions intended to restore disturbed and/or degraded areas of REs 11.3.14, 11.3.18, 11.5.1 and 11.7.7 will simultaneously result in an improvement in the shelter and foraging habitat for this species. Therefore, grouping REs 11.3.14, 11.3.18, 11.5.1 and 11.7.7 and Koala habitat in

the same DMA for the purposes of calculating the financial offset liability for SGP PL194 Project (Wari Djunben) is appropriate.

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6 Document Administration

Revision history

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Acceptance and release

Author

Position	Incumbent	Release Date
Principal Ecologist	*Paul Finn*	*21/09/2023*
Principal Ecologist	*Paul Finn*	*02/11/2023*

Stakeholders and reviewers

Position	Incumbent	Review Date
Access & Approvals Manager	*Tom Casey*	*25/09/2023*
Team Lead Regulatory Approvals	*Tyson Croll*	*26/09/2023*
Regulatory Approvals Specialist	*John Earley*	*26/09/2023*
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