SUPPLEMENTARY TERRESTRIAL ECOLOGY TECHNICAL REPORT

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Bowen Gas Project SREIS

AUSTRALIA

Supplementary Terrestrial Ecology Technical Report

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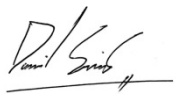
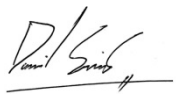
Checked by	Dan Simmons		15/04/2014	Senior Associate – Environmental Scientist
Approved by	Dan Simmons		15/04/2014	Senior Associate – Environmental Scientist

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ABBREVIATIONS

Abbreviation	Description
CGPF	central gas processing facility
DERM	Department of Environment and Resource Management (now Department of Environment and Heritage Protection)
E	endangered
EHP	Department of Environment and Heritage Protection (formerly DERM)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVNT	endangered, vulnerable or near threatened
FCF	field compression facility
ha	hectare
IPF	integrated processing facility
km	kilometre
km^2	square kilometre
LC	least concern
m	metre
m^2	square metre
NA	not applicable
NC	no concern
NC Act	*Nature Conservation Act 1992*
NCAP	no concern at present
OC	of concern
Project (the)	Bowen Gas Project
RE	regional ecosystem
SIS	Surface-in-Seam
VM Act	*Vegetation Management Act 1999*
WTF	water treatment facility

1 INTRODUCTION AND OVERVIEW

1.1 Objectives

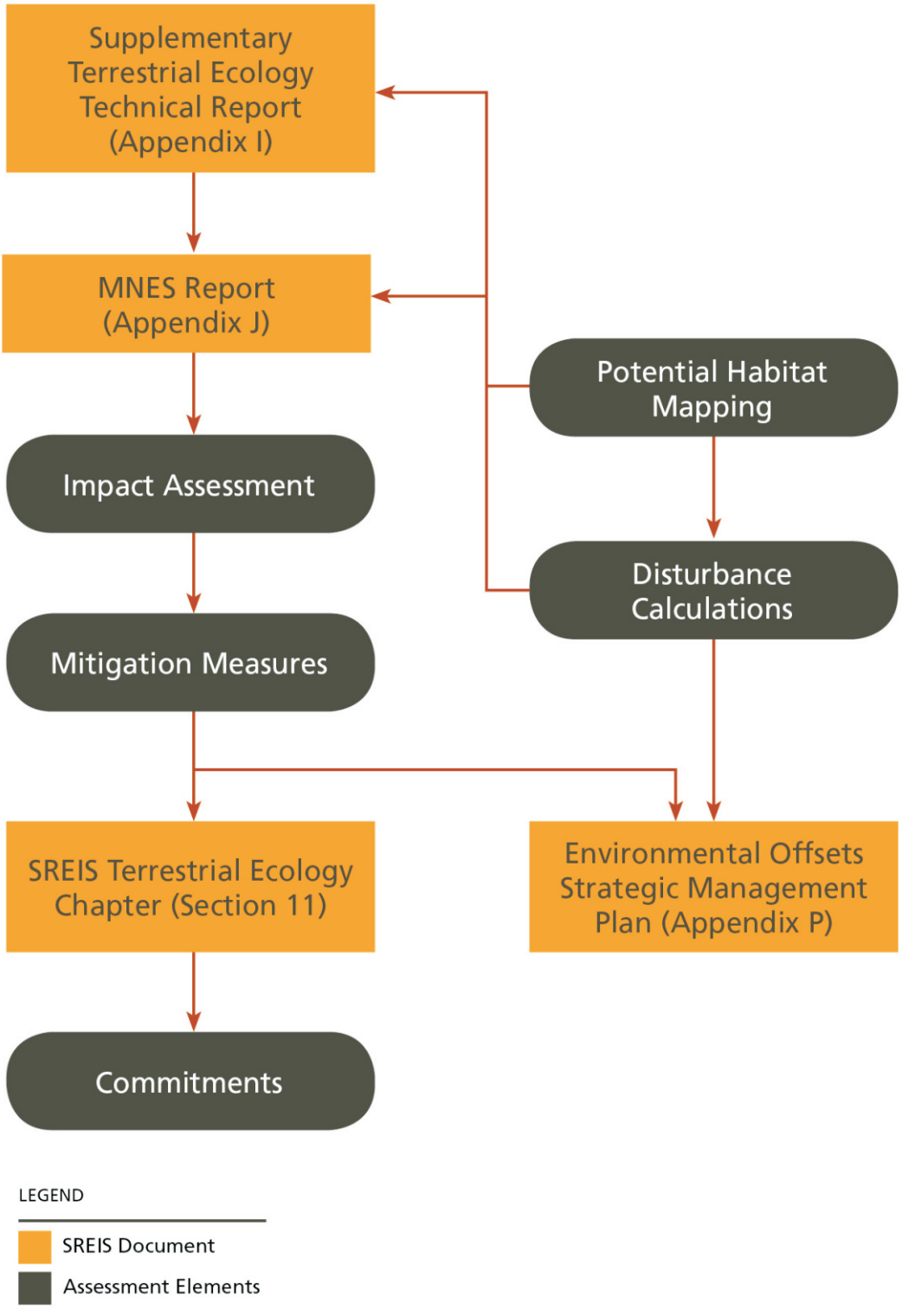
The objective of this supplementary report is to determine any revised potential impacts on terrestrial ecological values from Project activities arising from changes to the Arrow Bowen Gas Project (the Project) project description, and updates to relevant State or Commonwealth legislation subsequent to the Environmental Impact Statement (EIS). Additionally, this report addresses particular submissions made following the public consultation stage of the EIS.

This report aims to meet the following objectives:

- Summarise the ecological studies completed for the Project EIS;
- Review changes to the project description and review legislative changes relevant to terrestrial ecology;
- Undertake additional desktop investigations into ecological values within the Project area where necessary;
- Address public submissions;
- Assess the Project's potential impacts on any newly identified ecological values; and
- Identify mitigation measures where impacts have been revised or identified.

The ecological studies for the supplementary report to the EIS (SREIS) includes a number of supplementary and updated assessments. The relationship between the various elements of the updated supplementary assessments is illustrated below in Figure 1-1. The assessments include:

- **Supplementary Terrestrial Ecology Report (Appendix I) of the SREIS:** The Supplementary Terrestrial Ecology Technical Report of the SREIS is a standalone report that outlines the methodology and results of the supplementary assessment undertaken to meet the objective outlined above.
- **MNES Report (Appendix J) of the SREIS:** The Matters of National Environmental Significance (MNES) report of the SREIS is a standalone document to provide an update to, and supersede the previous MNES report provided in the EIS.
- **Terrestrial Ecology Chapter (Section 11) of the SREIS:** The Terrestrial Ecology chapter of the SREIS is a summary to the terrestrial ecology studies undertaken for the SREIS, and is to be read in conjunction with the EIS Terrestrial Ecology chapter.
- **Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS:** The Environmental Offsets Strategic Management Plan is a standalone report outlining the offset strategy for the Project in line with relevant State and Commonwealth legislation and policy.



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BOWEN GAS PROJECT SREIS

ECOLOGY ASSESSMENT SUMMARY

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TERRESTRIAL ECOLOGY TECHNICAL REPORT

Figure: **1-1**

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1.2 Summary of Terrestrial Ecology Studies Completed for the EIS

This section provides an overview of the terrestrial ecological impact assessment completed for the Project EIS and the main conclusions from that assessment.

The assessment identified and described terrestrial ecology values within the Project development area by desktop research and field surveys in selected areas.

The EIS desktop study included a review of relevant literature, database searches, and examination of aerial photography to inform the selection of sites to target during the field surveys. Sites for field surveys were selected to sample a range of ecosystems and validate their presence; to identify sensitive vegetation communities, and in particular, potential core habitat for flora and fauna species. Flora surveys were undertaken at 632 floristic survey sites across the Project development area comprising 102 secondary, 20 tertiary and 510 quaternary sites (3d Environmental & Ecosmart Ecology, 2012). In addition, 47 tertiary survey sites and 81 quaternary sites were assessed within the Project development area in studies undertaken by URS (2011a in 3d Environmental & Ecosmart Ecology, 2012). Fauna studies were conducted at 334 sites comprising 260 sites subject to active fauna searches, 39 sites featuring formalised trapping techniques and 35 sites where fauna observations were undertaken in recent associated studies (EMS, 2011 and URS, 2011b in 3d Environmental & Ecosmart Ecology, 2012).

Data from the desktop review and field based surveys for both flora and fauna was analysed and a list of threatened species, ecological communities and sensitive regional ecosystems (REs) considered relevant or potentially relevant to the Project development area was compiled. A 'likelihood of occurrence' assessment was undertaken based on available records, known species and habitat distribution, and habitat suitability.

1.2.1 Vegetation Communities

Three nationally significant threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were identified within the Project development area during the field surveys with an additional community considered as a 'Possible' occurrence.

A total of 78 REs (excluding RE sub-types) are mapped by EHP within the Project development area including representation of 18 'endangered' REs (biodiversity status) with 20 listed as 'of concern'. Two threshold REs (being those in danger of falling below 30% of their pre-clearing extent) are also recognised. No 'critically limited' REs are known to occur in the Project development area.

1.2.2 Flora Species

Sixty-three flora species listed as either endangered, vulnerable or near threatened (EVNT) under State and Commonwealth legislation were identified during EIS desktop searches as being potentially present within the Project development area. This included 17 species of national significance under the EPBC Act and 49 species of state significance under the *Nature Conservation Act 1992* (NC Act) (three species are listed under both the EPBC Act and the NC Act). Of these, 51 species are considered unlikely to occur in the Project development area due to low reliability of records and lack of suitable habitat. Consequently, 12 species listed as either 'endangered', 'vulnerable' or 'near threatened' under State and Commonwealth

legislation may potentially occur within the Project development area. Eleven NC Act listed species and four EPBC Act listed flora species are known to occur within the Project development area.

Potential impacts from Project activities (construction, operation and decommissioning) identified by the EIS terrestrial ecology impact assessment include:

- Habitat fragmentation and isolation of populations;
- Habitat loss or degradation and fauna mortality;
- Pest species invasion; and
- Edge effects.

Environmental protection for terrestrial ecology will be primarily achieved through design and site selection that results in avoidance and minimising disturbance of high-value environmental areas.

Commitments relating to minimising impacts to terrestrial ecology values were developed and outlined in the Terrestrial Ecology chapter (Section 17.5) and Draft Environmental Management Plan (Appendix Z, Section Z.4) of the EIS. The EIS outlines how the Project design and site selection of specific infrastructure will seek to avoid or minimise impacts to sites of high ecological value as the primary means by which protection for terrestrial ecology values will be achieved.

2 REGULATORY FRAMEWORK

The Terrestrial Ecology Technical Report (Appendix P) of the EIS detailed the State and Commonwealth legislation, policy and guidelines relevant to the Project. A review was conducted of the legislation, policy and guidelines cited to determine if any changes had been made subsequently that could affect approvals or environmental permitting for the Project.

2.1 Queensland Government

The following Queensland Acts and codes were reviewed as part of the EIS:

- *Environmental Protection Act 1994* (Qld);
- NC Act (Qld);
- *Vegetation Management Act 1999* (Qld) (VM Act);
- *Land Protection (Pest and Stock Route Management) Act 2002* (Qld); and
- *Draft Code of Environmental Compliance for Level 2 Petroleum Activities.*

No changes to these Acts or guidelines relevant to the Project were identified.

A number of species of wildlife were reclassified by the Scientific Technical Committee on 26 July 2012. Table 2-1 details the species and changes to classification made.

Table 2-1 Changes to NC Act-listed Wildlife Status since Publication of the EIS

Species	Common Name	NC Act status in EIS	Updated NC Act status in SREIS	Likelihood of occurrence in EIS
Dichanthium setosum	Bluegrass	Near threatened	Least concern	Known
Acacia gittinsii	-	Near threatened	Least concern	Unlikely
Choricarpia subargentea	Scrub ironwood	Near threatened	Least concern	Unlikely

Of the three species, only *Dichanthium setosum* is known to occur within the Project development area. As it is also listed under the EPBC Act, it is considered a species of conservation significance and will be managed according to the principles outlined in the EIS.

2.2 Commonwealth Government

Commonwealth legislation reviewed as part of the EIS was restricted to the EPBC Act. No changes to this Act relevant to the Project were identified as relevant to the terrestrial ecology aspects.

In May and December 2013 the Commonwealth Government changed the listing status to a number of EPBC Act-listed fauna and flora species. These are detailed in Table 2-2.

Table 2-2 Changes to EPBC Act-listed Wildlife Status Since Publication of the EIS

Species	Common Name	EPBC status in EIS	Updated EPBC status in SREIS	Likelihood of occurrence in EIS
Acacia ramiflora	-	Vulnerable	Not listed	Unlikely
Croton magneticus	-	Vulnerable	Not listed	Possible
Digitaria porrecta	Finger panic grass	Endangered	Not listed	Known
Leucopogon cuspidatus	-	Vulnerable	Not listed	Unlikely
Delma labialis	Stripe-tailed delma	Vulnerable	Not listed	Known
Paradelma orientalis	Brigalow scaly-foot	Vulnerable	Not listed	Known
Rostratula australis	Australian painted snipe	Vulnerable	Endangered	Unlikely

As shown in Table 2-2, *Delma labialis, Paradelma orientalis* and *Digitaria porrecta* are the only species known to occur within the Project development area that have been delisted. However, as they are still listed under the NC Act, they are considered as species of conservation significance and will be managed according to the principles outlined in the EIS. It should also be noted that holly-leaved graptophyllum (*Graptophyllum illicifolium*) was represented in the EIS as lacking a status under the EPBC Act. Holly-leaved graptophyllum is actually listed as 'Vulnerable' under the EPBC Act. As this species is unlikely to occur in the Project area (Section 11.5.1), this correction has no bearing on relevant matters in the SREIS.

2.3 Non-statutory Mechanisms

The following non-statutory mechanisms were reviewed as part of the EIS:

- Biodiversity Assessment and Mapping Methodology;
- *Nature Conservation (Protected Plants) Conservation Plan 2000*; and
- Weeds of National Significance.

No changes to these non-statutory mechanisms relevant to the Project were identified.

3 PROJECT DESCRIPTION CHANGES

As reported in the EIS, up to 6,625 production wells were to be drilled throughout the Project area over the approximate 40 year Project life. The current planning for a conceptual development footprint is for approximately 4,000 production wells to be drilled throughout the Project area over life of the Project. This entails a reduction in the order of 2,625 wells from the original estimate.

In addition to reducing the number of wells, by positioning multiple wells on one well pad, the number of well pads has been reduced. The updated Project Description chapter (Section 3) of the SREIS introduces the use of multi-well pads with up to 12 wells being constructed on a single pad.

The pad sizes and number of wells per pad has been standardised to facilitate construction. These standardised well configuration footprints are presented in Table 3-1 below. It presents the footprint of each well pad configuration during the drilling and construction phase, after which, the size of the well pad is reduced for operations. More detail on the well pad configurations is provided in Project Description chapter (Section 3) of the SREIS.

Table 3-1 SREIS Multi-Well Pad Disturbance Footprint

Well Pad	Disturbance Footprint
4 wells (2 vertical production + 2 deviated)	130 m x 175 m (22,750 m^2)
8 wells (4 production + 4 deviated)	130 m x 235 m (30,550 m^2)
12 wells (6 production + 6 deviated)	130 m x 295 m (38,350 m^2)

This reduction in well numbers and well pads translates to a decrease in the amount of land disturbed for wells and construction of associated linear infrastructure such as trunk lines, gathering lines and access tracks. As the multi-well pads consolidate a group of wells at one surface location, targeting multiple coal seams, they will typically result in:

- A reduction in the total number of well pad sites;
- A reduction in the individual pad area required per well;
- A significant reduction in the number of gathering lines, resulting in a significantly reduced construction and disturbance footprint; and
- Increase the average distance between any two well sites.

The Project design changes since the EIS to the conceptual development footprint have resulted in a decrease to the Project disturbance footprint as outlined below in Table 3-2.

Table 3-2 EIS vs SREIS Estimate Maximum Disturbance Areas of the Conceptual Footprint

Infrastructure	EIS		SREIS	
	Number	**Disturbance**	**Number**	**Disturbance**
Wells (production + deviated)	6,625	16,098 ha	4,000	5,977 ha
Linear Infrastructure	7,287.5 km*	18, 219 ha	3,494 km	8,734 ha
FCF	17	85 ha	33	251 ha
CGPF	5	75 ha	2	25 ha
IPF	3	320	NA	NA

* based on an estimated average length of gathering line and associated infrastructure per well.

Due to the nature of CSG development, the specific construction footprint for the life of the Project is still to be determined. A layout has been designed for Phase 1 of the Project which has been used to also estimate the potential disturbance limit for the life of the Project. The disturbance limits calculated are a conservative maximum disturbance estimate and it is highly anticipated that the likely actual disturbance during the Project will be lower than those impacts estimated. In addition to this built in conservatism to the maximum disturbance calculations, disturbance impacts are likely to be further reduced by the mitigation commitments for site scouting and avoidance of impacts where possible at the planning and pre-construction stages.

4 UPDATES TO EIS FINDINGS

4.1 Terrestrial Flora

4.1.1 Regional Ecosystems

4.1.1.1 EIS Data

Submissions received during the public consultation stage of the EIS raised queries regarding the accuracy and potential discrepancies in mapped areas of the regional ecosystems (REs) of the Project development area.

One issue questioned the accuracy of the existing regional ecosystem mapping. The proponent stated that 224 (or 35%) of the 632 floristic survey sites established within the Project area correspond with mapped REs in the certified data and as a result it was not clear in the EIS what the implications are for the project.

The second issue noted that “the remnant vegetation totals 306,371 ha (40% of the Project area), however, the summary of the ecosystems significant to impact assessment provided in Table 17-5 only accounts for 33,083 ha. This shows a major discrepancy of areas for all endangered and of concern regional ecosystems”.

The responses to these submissions are outlined in the submission response table in the Submission Responses chapter (Section 21) of the SREIS and in the text below.

In fieldwork conducted for the EIS, 632 floristic survey sites were recorded across the Project development area comprising 102 secondary, 20 tertiary and 510 quaternary sites with a large number of these sites collated from recent studies.

Survey sites were established within:

- Ecosystems within the Project development area where limited information on community condition or structure was available;
- Areas identified as containing, or potentially containing significant or sensitive vegetation, flora and vertebrate fauna species; and
- Sensitive vegetation communities or REs.

The detailed assessment was conducted in a study area where a mapping revision was undertaken utilising stereo-photographic images over an area approximating 800 km^2 at a spatial scale of 1:40,000. Polygons were delineated down to 0.5 ha, particularly where EPBC Act-listed communities were confirmed to be present. Outside the detailed study area, regional ecosystem mapping at a scale of 1:100,000 (DERM, 2009a in 3d Environmental & Ecosmart Ecology, 2012) was utilised as a basis for biodiversity assessment and preliminary sensitivity assessment.

Based on certified RE mapping (DERM, 2009a in 3d Environmental & Ecosmart Ecology, 2012), remnant vegetation totalled 306,371 ha (40% of the Project development area). This comprises 32,071 ha of remnant RE with a biodiversity status of ‘endangered’, 95,186 ha with a biodiversity status of ‘of concern’ and 178,276 ha with a biodiversity status of ‘no concern at present’. The remaining 461,021 ha of non-remnant vegetation comprises mostly cleared pastoral and grazing land. A total of 78

4 Updates to EIS Findings

REs (excluding RE sub-types) are mapped within the Project development area including 18 'endangered' REs (biodiversity status) with 20 listed as 'of concern'. Two threshold REs (those that could fall below 30% of their pre-clearing extent) are also recognised.

REs mapped by EHP present or potentially present within the Project development area are identified in Table 4-1.

Table 4-1 Regional Ecosystems within the Project Area

RE	Biodiversity Status (VM Act)	VM Act Status	EPBC Act Status	EPBC Comm.*	Project development area (EHP) (ha)
11.3.1	E	E	E	1	4,061
11.3.11	E	E	E	3	24
11.3.21	E	E	E	2	461
11.4.1	E	E	E	3	24
11.4.7	E	E	E	1	4
11.4.8	E	E	E	1	1,822
11.4.9	E	E	E	1	9,083
11.4.13	E	LC	NA	NA	3,996
11.5.15**	E	LC	E	3	1,193
11.5.16	E	E	E	1	190
11.5.17	E	E	NA	NA	72
11.8.13	E	E	E	3	2,211
11.8.15	E	E	NA	NA	370
11.9.1	E	E	E	1	1,360
11.9.4	E	E	E	3	686
11.9.5	E	E	E	1	5,236
11.9.10	E	OC	NA	NA	1,235
11.11.18	E	E	E	3	43
11.3.2	OC	OC	NA	NA	25,114
11.3.3	OC	OC	NA	NA	1,983
11.3.4	OC	OC	NA	NA	7,445
11.3.6	OC	LC	NA	NA	496
11.3.7	OC	LC	NA	NA	2,718
11.3.25	OC	LC	NA	NA	14,904
11.3.27	OC	LC	NA	NA	946
11.3.36	OC	OC	NA	NA	97
11.4.2	OC	OC	NA	NA	3,641
11.4.4	OC	LC	E	2	1,642

4 Updates to EIS Findings

RE	Biodiversity Status (VM Act)	VM Act Status	EPBC Act Status	EPBC Comm.*	Project development area (EHP) (ha)
11.4.11**	OC	OC	E	2	<1
11.5.18	OC	OC	NA	NA	243
11.7.1	OC	LC	NA	NA	312
11.8.3**	OC	OC	E	3	1,033
11.8.11	OC	OC	E	2	13,827
11.8.14	OC	OC	NA	NA	40
11.9.3	NCAP	LC	E	2	2,103
11.9.7	OC	OC	NA	NA	18,873
11.9.13	OC	OC	NA	NA	1,215
11.10.8	OC	OC	NA	NA	656
11.11.13	OC	OC	NA	NA	0
11.11.16	OC	OC	NA	NA	0
11.3.9	NCAP	LC	NA	NA	0
11.3.10	NCAP	LC	NA	NA	53
11.3.12	NCAP	LC	NA	NA	3
11.3.35	NCAP	LC	NA	NA	263
11.3.37	NCAP	LC	NA	NA	69
11.5.2	NCAP	LC	NA	NA	2,053
11.5.3	NCAP	LC	NA	NA	52,085
11.5.8	NCAP	LC	NA	NA	1,457
11.5.9	NCAP	LC	NA	NA	6,808
11.5.12	NCAP	LC	NA	NA	1,203
11.7.2	NCAP	LC	NA	NA	11,743
11.7.3	NCAP	LC	NA	NA	1,128
11.7.4	NCAP	LC	NA	NA	775
11.7.5	NCAP	LC	NA	NA	4
11.7.6	NCAP	LC	NA	NA	0
11.8.4	NCAP	LC	NA	NA	426
11.8.5	NCAP	LC	NA	NA	21,046
11.9.2	NCAP	LC	NA	NA	18,415
11.9.3	NCAP	LC	NA	NA	2,104
11.9.9	NCAP	LC	NA	NA	19,705
11.10.1	NCAP	LC	NA	NA	2,255
11.10.3	NCAP	LC	NA	NA	3,569
11.10.4	NCAP	LC	NA	NA	12,375
11.10.5	NCAP	LC	NA	NA	70

4 Updates to EIS Findings

RE	Biodiversity Status (VM Act)	VM Act Status	EPBC Act Status	EPBC Comm.*	Project development area (EHP) (ha)
11.10.7	NCAP	LC	NA	NA	8,564
11.10.12	NCAP	LC	NA	NA	4,032
11.10.13	NCAP	LC	NA	NA	0
11.11.1	NCAP	LC	NA	NA	5,245
11.11.9	NCAP	LC	NA	NA	353
11.12.1	NCAP	LC	NA	NA	1,592
11.12.2	NCAP	LC	NA	NA	25
11.12.3	NCAP	LC	NA	NA	705
11.12.4	NCAP	LC	NA	NA	151

* EPBC Threatened Ecological Community analogous RE.

** Threshold REs.

DERM – Department of Environment and Resource Management (now Department of Environment and Heritage Protection); E – endangered; OC – of concern; NC – no concern; LC - least concern; NCAP – no concern at present; NA - not applicable.

In lieu of comprehensive ground-truthed vegetation mapping over the entire tenement areas, Arrow proposes a range of measures to ensure vegetation communities are adequately assessed and managed. These are detailed in Section 4.1.1.2.

4.1.1.2 Current Field Development Planning

Field development planning has advanced since preparation of the EIS, with the overall Project development area now being separated into 33 smaller drainage areas. Each drainage area is generally a 6 km radius catchment area for gathering well production (gas and water) to surface production facilities located at or near the centre of the circle. Each of these centrally located surface production facilities is a field compression facility (FCF).

The application of the drainage area approach has allowed for a refined analysis of the REs potentially affected by the Project. The focus of development will occur within the drainage area, although there may be impacts beyond the drainage area boundary. Within each drainage area, a discrete set of REs can be ascertained and potential impacts can be determined in isolation or in combination with other drainage areas. Impact areas outside of the drainage areas will also be incorporated into the disturbance footprint when known.

Thirty-three drainage areas are located across the Project tenements. These have been scheduled for development across three distinct Phases 1, 2 and 3.

An analysis of the EHP RE data has been conducted for each drainage area. This is presented in Appendix A of this report. The analysis shows that 321,917.4 ha of vegetation is present within all of the drainage areas. Of this, 109,428.3 ha or 34% is classed as remnant vegetation.

4 Updates to EIS Findings

Potential Impacts to Regional Ecosystems

Based on the overall Project conceptual development footprint estimated maximum disturbance scenario, 11,543 ha will potentially be impacted, with 6,836 ha classed as remnant. The remainder (4,707 ha) comprises non-remnant vegetation (including regrowth communities) and cleared or disturbed areas such as tracks. The estimated maximum scenario for potential impacts to each RE within each individual drainage area is presented in Appendix B of this report.

Further breakdown of areas and impacts for other values such as 'endangered' or 'of concern' REs, Threatened Ecological Communities and listed fauna, flora and habitat are presented in the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

Preclearance Surveys and Refinement of Vegetation Mapping

To assist in mitigating impacts, pre-clearance surveys, coupled with refined vegetation mapping at an appropriate scale, will be undertaken prior to development to quantify the presence of EVNT species and habitats. Following further field survey and revised mapping, possible habitat may be revised to "habitat known" or can be revised to areas in which the absence of EVNT habitat is known. This is consistent with commitments B132 and B155 as presented in the EIS (refer to Table 5-1).

The methodology for undertaking these surveys will be implemented through Arrow's Ecological Impact Assessment Procedure (99-H-PR-0081), Fauna Survey Guideline (99-H-GDL-0061) and Ecological Survey Guideline (99-H-GDL-00091), as presented in Appendix C of this report.

4.1.2 Threshold Regional Ecosystems

A submission was received regarding threshold regional ecosystems: "Additional critically limited and threshold regional ecosystems (RE) are not included as part of the list of environmentally sensitive areas. The proximity of the Project to threshold regional ecosystems has not been identified nor does the EIS mention threshold regional ecosystems. In contrast, the technical terrestrial report does identify that there are 2 threshold RE's located in the project area".

In response, 'least concern' (VM Act) threshold REs are those that have the potential to fall below 30% pre-clearing extent i.e. becoming 'of concern' under the VM Act. Similarly, threshold REs listed as 'of concern' under the VM Act are likely to become 'endangered' (i.e. less than 10% pre-clearing extent). Threshold REs trigger additional offset requirements under the *Queensland Biodiversity Offset Policy, 2011*. Of the REs mapped within the Project area (Table 4-1) three are regarded as threshold communities:

- 11.5.15 - Semi-evergreen vine thicket on Cainozoic sand plains-remnant;
- 11.4.11 - *Dichanthium sericeum, Astrebla* spp. and patchy *Acacia harpophylla*, *Eucalyptus coolabah* on Cainozoic clay plains; and

4 Updates to EIS Findings

- 11.8.3 - Semi-evergreen vine thicket on Cainozoic igneous rocks.

Both the EIS Terrestrial Ecology chapter (Section 17) and the Terrestrial Ecology Impact Assessment (Appendix P) of the EIS note that two threshold REs are found within the Project area, and that no critically limited REs are present (although 3 threshold REs are identified in Table 17–5 of the EIS Terrestrial Ecology chapter (Section 17) of the EIS.

4.1.3 Review of the Likelihood of Occurrence Assessment for Flora

Desktop analysis undertaken during the EIS identified 63 flora species listed under State and Commonwealth legislation that may occur within the Project area. This included 17 species of National significance (EPBC Act) and 49 species of State significance (NC Act).

Further analysis of literature and EIS field surveys indicated that 51 species are unlikely to occur in the Project area due to low precision records or lack of suitable habitat.

Public submissions and a third-party technical review recommended that a re-appraisal of the likelihood of occurrence assessments be undertaken for two listed flora species.

4.1.3.1 Holly-leaved graptophyllum (EPBC: V; NC: V)

It was highlighted in the public submissions that a flora species, holly-leaved graptophyllum (*Graptophyllum illicifolium*), is known to occur in the Project area.

Research into this species shows that is endemic to central coastal Queensland from the Mackay area with a disjunct population at Miriam Vale. The EPBC Act Species Profiles and Threats (SPRAT) database notes that it grows in tall to very tall mixed notophyll forest. This is a coastal rainforest community and does not exist within the project area. Current records of the species obtained from the Queensland Herbarium (2 April 2014) confirm that all specimens are located in coastal and subcoastal rainforest and vine thicket communities. No records are within or are in close proximity to the Project Development area with the closest record over 50 km away to the north-east of ATP749.

The Terrestrial Ecology Technical Report (Appendix P, Table 11) of the EIS notes the presence of *Graptophyllum illicifolium* as Unlikely. As tall to very tall mixed notophyll forest is not present in the Project development area, the likelihood of occurrence for this species has been retained as Unlikely.

4.1.3.2 Omphalea celata (EPBC: V; NC: V)

Submissions identified that the occurrence assessment for *Omphalea celata* should be reviewed against new information. The Terrestrial Ecology Technical Report (Appendix P) of the EIS noted the likelihood of occurrence for *Omphalea celata* as Unlikely.

4 Updates to EIS Findings

Omphalea celata is known from three sites in central east Queensland. Locations include Hazlewood Gorge, near Eungella; Gloucester Island, near Bowen; and Cooper Creek in the Homevale Station area, north-west of Nebo (TSSC, 2008).

At Hazlewood Gorge, *Omphalea celata* grows in fragmented semi-evergreen vine thicket along a watercourse on weathered metamorphics in a steep-sided gorge at an altitude of 560 m (Forster, 1995). At Cooper Creek, plants grow in the creek bed and adjacent bank (TSSC, 2008). Prime potential habitat is present approximately 10 km east of the Project development area in the Hazelwood Gorge area which features rocky riparian open forests supporting vine thicket communities.

Additional to the above, the distribution of *Omphalea celata* is not known to overlap with any EPBC TEC community. *Omphalea celata* was not detected during flora field surveys undertaken as part of the EIS, however the closest records are located outside the north eastern margin of the Project area (300 m) within suitable habitat in Homevale National Park.

It is considered that potential exists for this species to occur further along Cooper Creek within the Project area. However this part of the creek is confined to Homevale National Park which is designated as a “no go” area in the Project’s constraint’s mapping (Appendix CC of the EIS) and will be excluded from potential Impacts.

Despite the proximity of this record, the preferred habitat for the species is extremely uncommon across the Project development area, and is only likely to be found along Cooper Creek within Homevale National Pak. As such, the remainder of the Project area (outside Homevale National Park) is unlikely to support this species. *Omphalea celata* is considered to have an overall low likely of occurrence within the Project area, with the exception of Cooper Creek where there is a moderate likely hood of occurrence. Given that this species has a low likelihood of occurrence within the Project area (excluding the restricted Homevale National Park area where it’s a moderate occurrence along Cooper Creek) no further impact assessment or habitat mapping has been undertaken for this species.

4.2 Terrestrial Fauna

4.2.1 Review of the Likelihood of Occurrence Assessment for Fauna

The Terrestrial Ecology Technical Report (Appendix P) of the EIS notes that a total of 33 EVNT fauna species under the NC Act and/or the EPBC Act have been recorded from the study area. This includes one amphibian, four reptiles, 19 birds and eight mammals. The relevance of EVNT species to the Project development area was evaluated based on the number of records, record date, species habits (e.g. highly mobile / nomadic), their habitat requirements and known ranges, to produce a list of Known, Possible or Unlikely species.

Public submissions and a third-party technical review recommended that a re-appraisal of the likelihood of occurrence assessments for a number of listed fauna species be undertaken.

4 Updates to EIS Findings

4.2.1.1 Red goshawk (EPBC: V; NC: E)

A third-party technical review of the Terrestrial Ecology Technical Report (Appendix P) of the EIS recommended an amendment to the likelihood of occurrence assessment for the red goshawk (*Erythrotriorchis radiatus*). The Terrestrial Ecology Technical Report (Appendix P, Table 15) of the EIS noted the likelihood of occurrence for the red goshawk as Unlikely. This was based on habitat for this species within the Project development being marginal and that very few known records suggesting it is not a regular inhabitant of the area.

A review of habitat, distribution and historical data suggests suitable nesting and feeding habitat (including forest and woodland with a mosaic of vegetation types, large prey populations (birds), and permanent water) is minimal within the Project area. However, the proximity of the Project tenements to large tracts of vegetation in conjunction with the consideration of historical distribution has led to a precautionary upgrade of occurrence to Possible (Table 4-2).

It should be noted that within the MNES Report (Appendix J) of the SREIS, the likelihood of occurrence assessment for EPBC-listed species uses five criteria: Very Low, Low, Moderate, High and Recorded. The red goshawk has been accorded a rating of Moderate in the MNES Report.

As a result of the upgraded likelihood of occurrence of Possible for the red goshawk, potentially habitat mapping and a species profile is included the MNES Report (Appendix J) of the SREIS and potentially impacted habitat is considered as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

4.2.1.2 Yakka skink (EPBC: V; NC: V)

A third-party technical review of the draft Terrestrial Ecology Technical Report (Appendix P) of the EIS recommended an amendment to the likelihood of occurrence assessment for the yakka skink (*Egernia rugosa*). The Terrestrial Ecology Technical Report (Appendix P, Table 15) of the EIS noted the likelihood of occurrence for the yakka skink as Unlikely. This was based on a lack of known nearby records which suggested the species does not inhabit the area.

Further research on the yakka skink shows that it does not occur within or in close proximity to the northern Project gas field. However, two records occur in proximity to the southern gas field. As it is considered that marginal habitat (including open dry sclerophyll forest, woodland and scrub) may exist in Project tenements, the likelihood of occurrence for the yakka skink has been amended to Possible (Table 4-2).

It should be noted that within the MNES Report (Appendix J of the SREIS) the likelihood of occurrence assessment for EPBC-listed species uses five criteria: Very Low, Low, Moderate, High and Recorded. The yakka skink has been accorded a rating of Moderate in the MNES Report.

As a result of the upgraded likelihood of occurrence of Possible for the yakka skink, potential habitat mapping and a species profile is included the MNES Report (Appendix

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J) of the SREIS and potentially impacted habitat is considered as part of the Environmental Offsets Strategic Management Plan (Appendix P of the SREIS).

4.2.1.3 Black-chinned honeyeater (NC: NT)

Public submissions identified that the occurrence assessment for the black-chinned honeyeater (*Melithreptus gularis*) be reviewed against new information.

The black-chinned honeyeater was included in the Terrestrial Ecology Technical Report of the EIS (Appendix P, Table 15), with a likelihood of occurrence of 'possible'. Table 18 of the same report states it is 'known to occur' within the Project development area.

Given that records for the black-chinned honeyeater exist from the Project development area, the likelihood of occurrence table for fauna has been upgraded to reflect the known presence of black-chinned honeyeater (Table 4-2).

There will be no material change to the impact assessment or mitigation measures for this species as a species profile and impact assessment was undertaken within Appendix P of the EIS on the basis that the black-chinned honeyeater was included on a 'Possible' likelihood of occurrence.

4.2.1.4 Glossy-black cockatoo (NC: V)

A third-party technical review of the Terrestrial Ecology Technical Report (Appendix P) of the EIS recommended an amendment to the likelihood of occurrence assessment for the glossy-black cockatoo (*Calyptorhynchus lathami*). The Terrestrial Ecology Technical Report (Appendix P, Table 15) of the EIS noted the likelihood of occurrence for the glossy-black cockatoo as Unlikely. This was based on the lack of records away from Blackdown Tableland National Park which suggested that occurrence outside this area was very irregular.

Whilst the Atlas of Living Australia provides only two records of glossy-black cockatoo within the Project tenements (dating from 1845), a number of recent records from Blackdown Tablelands National Park bordering the southern tenements exist. Given that belah (*Casuarina cristata*) and other species of *Casuarina and Allocasuarina*, noted food trees, are found throughout the Project tenements, the likelihood of occurrence for the glossy-black cockatoo has been amended to Possible (Table 4-2).

As a result of the upgraded likelihood of occurrence of Possible for the glossy-black cockatoo, potentially impacted habitat will be included as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

4.2.1.5 Grey goshawk (NC: NT)

A third-party technical review of the Terrestrial Ecology Technical Report (Appendix P) of the EIS recommended an amendment to the likelihood of occurrence assessment for the grey goshawk (*Accipiter novaehollandiae*). The Terrestrial Ecology Technical Report

4 Updates to EIS Findings

for the EIS (Appendix P, Table 15) noted the likelihood of occurrence for the grey goshawk as Unlikely based upon the presence of marginal habitat and lack of records.

No records for the grey goshawk are present within the Project tenements (Atlas of Living Australia, 2013). However, two records are found in proximity to the tenements (both approximately 10 km away) and a cluster of records is present near Eungella approximately 20 km to the north-east of ATP749. Based on these records, and the suitability of habitat within the Project tenements (especially in the north-east and south-east), the likelihood of occurrence for the grey goshawk has been amended to Possible (Table 4-2).

As a result of the upgraded likelihood of occurrence of Possible for the grey goshawk, potentially impacted habitat will be included as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

4.2.1.6 Square-tailed kite (NC: NT)

A third-party technical review of the Terrestrial Ecology Technical Report (Appendix P) or the EIS recommended an amendment to the likelihood of occurrence assessment for the square-tailed kite (*Lophoictinia isura*). The Terrestrial Ecology Technical Report (Appendix P, Table 15) of the EIS noted the likelihood of occurrence for the square-tailed kite as Unlikely as although dispersing individuals may be found sporadically within the Project development area, individuals are unlikely to inhabit the area. Further research has indicated that the square-tailed kite may utilise suitable habitat within the Project area and as such its likelihood of occurrence has been amended to Possible (Table 4-2).

As a result of the upgraded likelihood of occurrence of Possible for the square-tailed kite, potentially impacted habitat will be included as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

Table 4-2 Summary of EVNT Fauna Likelihood of Occurrence in Project Development Areas based on Database Searches

Status	Known	Possible	Unlikely
EPBC Act			
Presumed Extinct			*Psephotus pulcherrimus* paradise parrot
Endangered		*Dasyurus hallucatus* northern quoll	*Anthochaera phrygia* regent honeyeater *Poephila cincta* black-throated finch *Lathamus discolor* swift parrot *Bettongia tropica* northern bettong
Vulnerable	*Denisonia maculata*	*Nyctophilus corbeni*	*Pedionomus torquatus*

4 Updates to EIS Findings

Status	Known	Possible	Unlikely
	ornamental snake *Paradelma orientalis* brigalow scaly-foot *Delma labialis* stripe-tailed delma *Geophaps scripta scripta* squatter pigeon *Phascolarctos cinereus* koala	south-eastern long-eared bat *Egernia rugosa* yakka skink *Erythrotriorchis radiatus* red goshawk	plains wanderer *Rostratula australis*** Australian painted snipe *Turnix melanogaster* black-breasted button-quail *Dasyurus geoffroii* western quoll *Onychogalea fraenata* bridled nailtail wallaby
NC Act			
Presumed Extinct/ Extinct			*Psephotus pulcherrimus* paradise parrot *Dasyurus geoffroii geoffroii* western quoll
Endangered		*Erythrotriorchis radiatus* red goshawk	*Anthochaera phrygia* regent honeyeater *Poephila cincta* black-throated finch *Lathamus discolor* swift parrot
Vulnerable	*Denisonia maculata* ornamental snake *Paradelma orientalis* brigalow scaly-foot *Delma labialis* stripe-tailed delma *Geophaps scripta scripta* squatter pigeon	*Jalmenus eubulus* pale imperial hairsteak *Nyctophilus corbeni* south-eastern long-eared bat *Calyptorhynchus lathami* glossy black-cockatoo *Egernia rugosa* yakka skink	*Pedionomus torquatus* plains wanderer *Turnix melanogaster* black-breasted button-quail *Rostratula australis* Australian painted snipe *Ninox strenua* powerful owl

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Status	Known	Possible	Unlikely
Near Threatened	*Acanthophis antarcticus* common death adder *Nettapus coromandelianus* cotton pygmy-goose *Ephippiorhynchus asiaticus* black-necked stork *Chalinolobus picatus* little pied bat *Melithreptus gularis* black-chinned honeyeater	*Accipiter novaehollandiae* grey goshawk *Lophoictinia isura* square-tailed kite	*Cyclorana verrucosa* rough collared frog *Lerista allanae* greater robust fine-lined slider *Strophurus taenicauda* golden-tailed gecko *Neophema pulchella* turquoise parrot *Tadorna radjah* radjah shelduck *Aerodramus terrareginae* Australian swiftlet *Turnix melanogaster* black-breasted button-quail *Bettongia tropica* northern bettong *Kerivoula papuensis* golden-tipped bat

As a result of the change of likelihood of occurrence for the reviewed species, the summary of EPBC Act and NC Act species Known, Possible or Unlikely to occur within the Project development area has been amended:

EPBC Act

- Five Known (five vulnerable);
- Four Possible (one endangered, three vulnerable); and
- Ten Unlikely (four endangered, five vulnerable, and one presumed extinct).

NC Act

- Nine Known (four vulnerable, five near threatened);
- Seven Possible (one endangered, four vulnerable, two near threatened); and
- Eighteen Unlikely (three endangered, four vulnerable, 9 near threatened and two presumed extinct / extinct).

4.3 Potential Impacts

4.3.1 Key Project Components

The following key Project components have been identified as having potentially significant surface area impacts. As placement will be driven in part by the site's ecological values, surface area impacts do not necessarily equate to impacts on vegetation communities, habitat or EVNT species.

4.3.2 Central Gas Processing Facilities

EIS Project development planning featured integrated processing facilities (IPFs) (this term is no longer used) in addition to the central gas processing facilities (CGPFs). The total area for each IPF was estimated at 120 ha. The CGPFs (without water treatment facilities (WTFs)) at the EIS stage were 15 ha in size.

Current Project development has CGPFs (with WTFs) replacing IPFs. Current Project planning has each CGPF at up to 72.5 ha (including 60 ha for a WTF).

This equates to an approximate decrease of 62.5 ha due to the combination of a WTF and CGPF for each facility.

The changes to the number of CGPFs as presented in the EIS base case versus the updated SREIS project description are shown in Table 3-2.

4.3.3 Field Compression Facilities

Due to the low wellhead pressures in the Bowen Basin, FCFs will be installed to boost the gas pressure to enable the transportation of the gas over longer distances. FCFs will also include a water transfer station to facilitate transfer of water from FCF to FCF en route to a CGPF.

EIS planning estimated that each FCF was to be 200 m by 250 m, or 5 ha. Current Project planning has the largest FCFs at 200 m by 380 m or 7.6 ha. This equates to an increase of 2.6 ha for the largest of the FCF facilities.

Changes to the number of FCFs as presented in the EIS and SREIS are shown in Table 3-2.

4.3.4 Wells

4.3.4.1 Well Numbers

The EIS reported that up to 6,625 production wells were expected to be drilled throughout the Project area over the approximate 40 year Project life. The current planning is for approximately 4,000 production wells to be drilled throughout the Project area over the life of the Project as a maximum disturbance scenario, reducing the well estimate by approximately 2,625 wells. This translates to an overall decrease in the amount of land disturbed for well pads and construction of associated infrastructure such as access tracks and gathering lines.

4.3.4.2 *Pad Sizes and Overall Disturbance Area*

EIS Conceptual Design

On a nominal 800 m grid pattern, an indicative density of one producer well per 65 to 130 ha was typically expected. During the drilling phase, each well pad was to occupy an area of 8,100 m^2 (90 m by 90 m) such that for each SIS dual-lateral producer, the required collective well pad area (for the three separate pads) was to be approximately 24,300 m^2.

Once the well is installed, the footprint was to be reduced to approximately 10 m by 10 m such that for each SIS dual-lateral producer, the required collective well pad operational area (for the three separate pads) would be approximately 17 m by 17 m.

As noted in Section 4.3.4, above, approximately 6,625 production wells were expected to be drilled throughout the Project area. At 24,300 m^2 each, this would equate to an approximate maximum disturbance area of 16,098 ha. Following installation this area would be reduced with the surrounding disturbed area rehabilitated.

SREIS Conceptual Design

The Project has been updated so that during the drilling phase, the estimated multi-well pad area will be:

- 130 m by 175 m for a 4 well pad;
- 130 m by 235 m for an 8 well pad; and
- 130 m by 295 m for a 12 well pad.

For the whole of the Project area the distribution of each well pad configuration is anticipated to be as follows:

- wells per pad used in approximately 71% of the development;
- 8 wells per pad used in approximately 21.5% of the development; and
- 12 wells per pad used in approximately 7.5% of the development.

Based on the assumption that approximately 4,000 production wells will be drilled throughout the Project area:

- well pads will disturb approximately 6,461 ha;
- 8 well pads will disturb approximately 2,627 ha; and
- 12 well pads will disturb approximately 1,150 ha.

The total approximate disturbance to land from well development using the SREIS multi-well pad approach is 10,238 ha. This is an approximate reduction of 5,860 ha from the estimate in the EIS development plan. These estimates do not necessarily equate to disturbance to ecological values, which will only occur where clearing is undertaken in previously uncleared areas. An estimate of the potential maximum clearing of REs for each drainage area is presented in Appendix B of this report. Potential impacts to additional ecological values are presented in the Environmental Offsets Strategic Management Plan (Appendix P) of the

SREIS. A directory to the location of respective disturbance calculations in the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS is presented in Table 4-4.

As detailed in Table 4-3, below, the area required for drilling is only temporary. Post drilling, the site will be rehabilitated to a smaller footprint required for operational activities. This estimated operational footprint includes erosion and sediment control and may be reduced further between return rig visits for well intervention / well maintenance, dependent on individual well access requirements.

Table 4-3 SREIS Well Configurations

Well Pad	Drilling Footprint	Operational Footprint
4 wells (2 vertical production conduit + 2 lateral wells)	130 m x 175 m (22,750 m^2)	100 m x 155 m (15,500 m^2)
8 wells (4 vertical + 4 lateral)	130 m x 235 m (30,550 m^2)	100 m x 215 m (21,500 m^2)
12 wells (6 vertical + 6 lateral)	130 m x 295 m (38,350 m^2)	100 m x 275 m (27,500 m^2)

4.3.5 Gathering Systems

The change from single-well lease pads to multi-well lease pads has allowed a significant reduction in the disturbance caused by the Project. By reducing the number of well pads, not only has the total area for required well pads been reduced, the number and length of gathering lines has also been significantly reduced.

4.4 Potential Impacts on Ecological Values

The inherent nature of CSG development has resulted in the approach adopted for this Project being the identification of constraints to development and the establishment of environmental management controls that should apply to Project activities in constrained areas. Known as the environmental framework, this approach is a process developed by Arrow for managing impacts in the planning phase and in the construction and operation phases through the application of environmental controls that reflect the sensitivity or vulnerability of environmental values. The following sections describe the process used to identify potential constraints to development.

Potential impacts on ecological values are presented in the Terrestrial Ecology chapter (Section 17) and Terrestrial Ecology Technical Report (Appendix P) of the EIS. As the actual well locations and specific disturbance footprint have not been finalised, it is not possible to ascertain the precise impacts to ecological values. However, potential areas of disturbance for REs, TECs and species of conservation significance have been estimated as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS. The estimates have been developed using a two-step process involving the mapping of potential habitat in conjunction with a calculation of disturbance. The process used is detailed below in Section 4.5 and 4.5.1.

4.5 Mapping of Potential Habitat

Mapping of potential habitat for MNES species and communities was undertaken as part of the MNES Report (Appendix J) of the SREIS. The aim of the potential habitat mapping was to identify MNES potential habitat across the entire Project. The potential habitat maps will be

used as a planning tool during the design and construction stage of the Project to assist in the placement of infrastructure. Where possible, areas of mapped potential habitat will be avoided during the design stage of the Project and changes to designs will be made with consideration given to the potential habitat. The mapping will also be used to determine the potential impact of the Project on MNES. Where applicable, this will determine the offset requirements for the Project.

Arrow has incorporated light detection and ranging (LIDAR) data to refine and improve the potential habitat mapping across the Project area. LIDAR data collected for the Project area was separated into layers of the classification values corresponding with ground, low vegetation, medium vegetation, and high vegetation, allowing a visual representation of each classification value. These classification layers were then able to be interrogated by GIS software to provide the following information:

- Canopy density of individual canopy height classes;
- Analysis of slope gradient;
- Identification and delineation of watercourse banks; and
- Identification of ground layer habitat features.

The information obtained from the LIDAR data was incorporated into the species potential habitat mapping, where appropriate. A full description of the process used is presented in the MNES Report (Appendix J) of the SREIS. This process was used in conjunction with the disturbance calculation method (Section 4.5.1, below) to estimate potential offsets for EPBC Act and NC Act-listed vegetation communities and species.

4.5.1 Disturbance Calculation

Due to the nature of CSG development, the construction footprint of the Project evolves over the life of the Project. In line with the framework approach, a conceptual development plan has been designed for Phase 1 of the Project that has been extrapolated to calculate the potential maximum disturbance area for the life of the Project. The disturbance limits calculated are a maximum disturbance and that the actual disturbance during the Project will be lower than that presented in the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

4.5.2 Estimates of Disturbance

Appendix B of this report details the maximum extent of potential impacts to each RE within each individual gas drainage area. This data is summarised in Section 4.1.1.

Estimates of disturbance for NC Act and EPBC Act values are presented in the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS. Table 4-4 below lists the tables in Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS within which the respective disturbance calculations are presented.

Table 4-4 Disturbance Data Presented in in the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS

Table	Values presented
Table 7-3	Endangered and Of concern REs
Table 7-4	Threatened Ecological Communities
Table 7-5	Threatened Fauna and Flora Species (EPBC Act and NC Act)
Table 7-6	State Significant Biodiversity Values (including HVR, Essential Habitat and Wetlands)

5 MITIGATION MEASURES

Mitigation measures for potential terrestrial ecology impacts were initially prescribed in the Project EIS. Subsequently, the infrastructure footprint was amended with footprint dimensions the key project description changes that will alter potential terrestrial ecology impacts. Mitigation measures stipulated in the EIS remain relevant to mitigation of impacts. These are presented in Table 5-1 below.

To further assist in mitigating impacts, preclearance surveys, coupled with refined vegetation mapping at an appropriate scale, will be undertaken prior to field development activities. The methodology for undertaking these surveys will be implemented through Arrow's Ecological Impact Assessment Procedure (99-H-PR-0081), Fauna Survey Guideline (99-H-GDL-0061) and Ecological Survey Guideline (99-H-GDL-00091), as presented in Appendix C of this report.

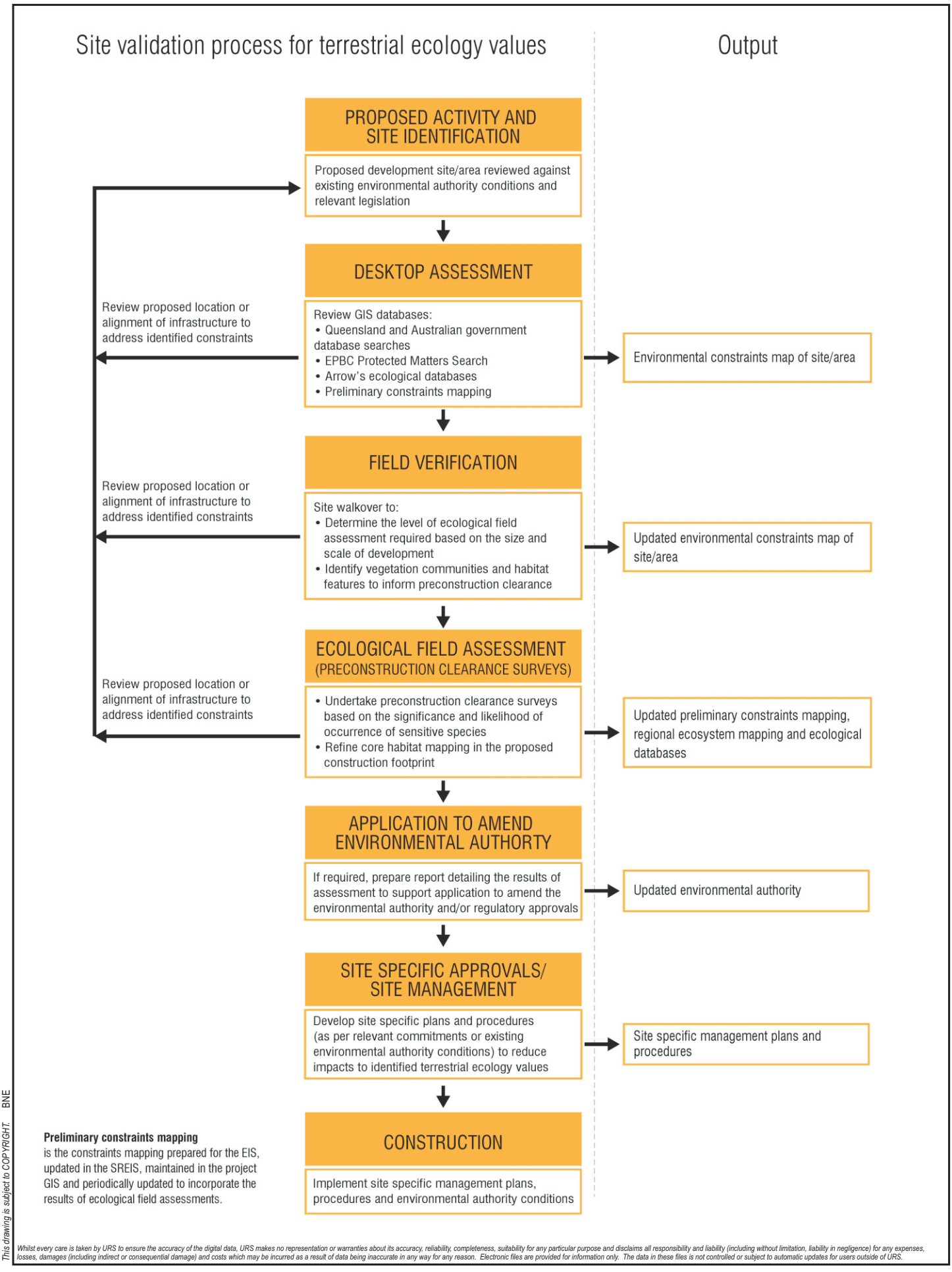
A flow chart outlining Arrow's process for ground truthing and site validation of ecological values is also provided below in Figure 5-1.

Table 5-1 Project Commitments to Avoid and Reduce Significance of Impacts to Terrestrial Ecology Values

No.	Commitment
B099	Design lighting in a manner that limits disruption on landscape character, views and visual amenity and direct lighting into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitat
B115	Use existing roads and designated access tracks, where practicable
B130	Avoid all disturbance within Homevale National Park (Category A ESAs)
B131	Aim to avoid disturbance within the following areas: • Endangered EPBC Act TECs: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (RE 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall Woodlands (REs 11.3.2 and 11.3.28); • Category B ESAs; • Category C ESAs including Arthur's Bluff State Forest and gazetted nature reserves; • Stock routes and state or regionally significant bioregional wildlife corridors; • Essential habitat; • Core habitat for EVNT species; • State forests and resource reserves; and • State-listed 'of concern' REs.
B132	Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum: • vegetation mapping at a scale suitable for site-specific planning; • identification of core habitats for EVNT species; and • identification of site-specific sensitive areas (e.g. Environmentally Sensitive Areas) that require avoidance or buffers).
B133	Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible.
B134	Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection.

No.	Commitment
B135	Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts.
B136	Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical.
B137	Retain habitat trees where practicable.
B138	Avoid removing riparian vegetation when directional drilling and reduction of right of ways where practical.
B139	Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values.
B140	Deviate access tracks and pipelines around sensitive vegetation where practicable.
B141	Avoid construction activities in waterbodies frequented by migratory species.
B142	Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable.
B143	Design creek crossings to ensure that existing flow regimes are maintained.
B144	Preparation of biodiversity offsets (DSEWPaC, 2011; DERM, 2011b) for Commonwealth and State significant biodiversity values.
B145	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 (outlined in Section 7 and detailed in Constraints Mapping (Appendix BB of the EIS).
B146	Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques.
B149	Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person.
B150	Fell trees away from existing vegetation not identified for removal where practicable.
B151	Avoid damaging trees (e.g. through scraping of tree trunk or breaking of limbs by equipment) not identified by removal where practicable.
B152	A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species.
B153	Suitably qualified animal handler or ecologist to capture injured wildlife, where possible. Injured wildlife resultant from land clearing will be taken to a qualified veterinary surgeon or carer where practical.
B154	Develop speed limits on Project controlled roads with due consideration to reduce the potential for vehicle collisions with wildlife.
B155	Undertake pre-clearing surveys to determine the likelihood of the species (including weeds) occurring.
B156	Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates.
B157	Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery.
B158	Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands).
B159	Trenches should be inspected and monitored as per the APIA *Code of Environmental Practice.*
B160	Install and maintain appropriate sediment and erosion control structures at work sites.

No.	Commitment
B161	Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt.
B162	Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be reinstated.
B163	Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete.
B164	Monitoring programs should focus on those sensitive ecological values at risk of a high to extremely high level of residual impact .
B165	Consider targeted monitoring effort conducted in co-operation with the proponents of overlapping Projects. Particularly suited species to such monitoring include ornamental snake (*Denisonia maculata*), koala (*Phascolarctos cinereus*) and brigalow scaly-foot (*Paradelma orientalis*).
B166	Ensure avoidance boundaries are clearly delineated prior to clearing.
B167	Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred.
B168	Reduce the impact of CSG water on soil structure and aquatic values, by designing and constructing wells in accordance with the *Code of Practice for Constructing and Abandoning CSG wells in Queensland* (NRM, 2013).
B169	Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans.
B170	Inspect food scrap bins and exclusion fences to ensure effectiveness.
B171	In accordance with the Pest Management Plan routinely inspect for pest flora and evidence of pest fauna within Project disturbed areas.
B172	Design washdown facilities to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas.
B173	Minimise the time a trench is left open. Construct exit points when construction is within 1 km of native vegetation, using appropriate material. Provide fauna refuges, such as sawdust-filled bags, regularly through areas of high fauna activity.



arrow energy go further

BOWEN GAS PROJECT SREIS

SITE VALIDATION PROCESS FOR TERRESTRIAL ECOLOGY VALUES

6 CONCLUSIONS

This Terrestrial Ecology supplementary report investigated potential impacts on terrestrial ecological values from Project activities arising from changes to the Arrow Bowen Gas Project Description, and updates to relevant State or Commonwealth legislation subsequent to the Project Environmental Impact Statement (EIS). Additionally, the report addressed particular submissions made following the public consultation stage of the Project EIS.

The status of three flora species listed under the NC Act potentially present were changed from near threatened to least concern. This resulted in no material impact to the findings of the EIS. Four flora and two fauna species listed under the EPBC Act that were potentially present were delisted. The Australian painted snipe (*Rostratula australis*) was upgraded from vulnerable to endangered. These changes resulted in no material impact to the findings of the EIS.

The Technical Report reviewed the likelihood of occurrence for two listed flora species and six listed fauna species presented in the EIS as Unlikely. This review resulted in the inclusion of one of the flora species (*Omphalea celata*) and six species of fauna (red goshawk; yakka skink; black-chinned honeyeater; glossy-black cockatoo, grey goshawk and square-tailed kite). Where relevant, for each of the species, additional potential habitat mapping and profiles were created within the MNES Report (Appendix J) of the SREIS and potentially impacted habitat is considered as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

Current Project development planning has enabled a clearer understanding of the area requirements for key project components such as central gas processing facilities, field compression facilities, wells and gathering systems. Overall, the physical impacts from infrastructure have been reduced as a result of refined development planning. Although actual well locations and the specific disturbance footprint have not been finalised, estimates of potential areas of disturbance for REs, TECs and species of conservation significance have been estimated as part of the Environmental Offsets Strategic Management Plan (Appendix P) of the SREIS.

Mitigation measures for potential terrestrial ecology impacts were initially prescribed in the Project EIS. Subsequently, the infrastructure footprint was amended with footprint dimensions the key project description changes that will alter potential terrestrial ecology impacts. Mitigation measures stipulated in the EIS remain relevant to mitigation of impacts.

To further assist in mitigating impacts, preclearance surveys, coupled with refined vegetation mapping at an appropriate scale, will be undertaken prior to field development activities. The methodology for undertaking these surveys will be implemented through Arrow's Ecological Impact Assessment Procedure (99-H-PR-0081), Fauna Survey Guideline (99-H-GDL-0061) and Ecological Survey Guideline (99-H-GDL-00091).

7 REFERENCES

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8 LIMITATIONS

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Arrow Energy Pty Ltd and only those third parties who have been authorised in writing by URS to rely on this Report.

It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this Report.

It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated January 2012.

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It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the site.

Any estimates of potential costs which have been provided are presented as estimates only as at the date of the Report. Any cost estimates that have been provided may therefore vary from actual costs at the time of expenditure.

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APPENDIX A AREAS OF REGIONAL ECOSYSTEMS PRESENT WITHIN DRAINAGE AREAS

Table A-1 Drainage Areas 1 to 20

RE	Total Disturbance (Includes all Drainage Areas)	Drainage Areas															
		1	2	3	4	6	8	9	11	12	13	14	15	16	18	19	20
11.10.1	1,591.30							296.3								1,255.60	39.4
11.10.3	97		97														
11.10.4a	2,688.30		24.2			68.4									475.7	1,887.30	162.4
11.10.7	143.8					143.8											
11.10.8	484.2							374.9									
11.11.1	1,749.90																
11.12.1	760.5																
11.3.1	1,094.70	10.5	80.4		0.1	0.1	12.7	51.5		226.6	12.2	35.5	244.5	0		29.1	32.9
11.3.10	15.5															7.3	8.2
11.3.1b	61.4									13.3							
11.3.2	7,204.90	263.8	872.1		199.8	1.2	64.2	534	41.4	1,702.00	232.5	85.1	129.2	0.2	337.6		
11.3.21	20.6												7.9				
11.3.25	5,271.00	236.2	531.5	180.8	80.5	333.7	29.6	351.1	63.9	297.7			323.6	260.9	190.2	145.3	345.8
11.3.27	6.9								0.4								
11.3.27b	213.4						9.4	34.7		57.1				2.4			
11.3.27f	231.1			68.1	2.5										130.3		
11.3.2b	21.2									20.4			0.8				
11.3.3	668.4									163	202.8		71.1				
11.3.35	37.1						29.5		7.6								
11.3.36	0.4							0.4									
11.3.37	64.9							1		0.7	29.3					16.9	
11.3.3c	17.1																
11.3.4	1,994.70	0.9	61.4	397.9		151.5					3.3				787.8		
11.3.6	411.7											195.3					
11.3.7	1,154.40							183.9		422.7						104.5	
11.4.13	2,053.20										249.5	510		0.1	5.4		
11.4.2	1,792.60	122.5										330			21.5		
11.4.4	194.6										0.6			1.4		61.2	
11.4.8	942.8	14.1	9.6				7	2.9		40.3	24.8	37.8		132.5			
11.4.9	4,202.10	361.7	36.7	333.7	53.6	26.4	74.9	103.1	227.5	142.6	164.2	271.2	1.9	173	35.7	288.7	
11.4.9a	147.2											60.1					
11.4.9b	11.7																
11.5.12	117.8								4.3							46.8	

RE	Total Disturbance (Includes all Drainage Areas)	Drainage Areas															
		1	2	3	4	6	8	9	11	12	13	14	15	16	18	19	20
11.5.15	665.8	13.9				284.5											16.4
11.5.16	115																115
11.5.17	34.7								4.1								
11.5.18	459.5															216.9	
11.5.2	56.3																32.9
11.5.2a	1																
11.5.3	24,294.20	185.6	610.2	3,061.60	461.9	3,726.00	396.9	1,278.60	293.2	2,214.80		26.7		72.7	1,079.90	768.2	
11.5.3b	5.7																
11.5.8c	1,227.80			327.8											900		
11.5.9b	994.7						184.3	216.5	155.2	4.6				0.3		216.9	
11.5.9c	2,632.70		489.3		807.9		52.2	35.5	1,152.10	6.9						3.7	81.4
11.7.1	54.9		16.5		38.4												
11.7.2	5,357.40		123.6	533.3	2,367.00	760.1									270	600.2	
11.7.3	904		12.9		891.1												
11.7.5	3.9																
11.8.11	9,836.10	2,235.50														29.6	
11.8.13	1,081.60	366.6															
11.8.14	16.5																
11.8.15	362	342.6															
11.8.3	-																
11.8.4	182.1																
11.8.5	9,041.60	328.7			56.1						24					47.1	2,523.30
11.9.1	149.1					12.9											116.5
11.9.10	710.7																479.4
11.9.13	696.5																178.3
11.9.2	4,607.00														234.6		865.2
11.9.3	399.2					189.2											
11.9.4a	138.9					62.1											70.5
11.9.5	1,261.70	69.8	59.8			95.3									115.4		230.4
11.9.7	0.3																
11.9.7a	4,276.10					47.3									1,403.20		
11.9.9	4,394.80														971.8		1,779.30
non-rem	212,489.10	6,039.40	6,234.70	4,368.20	3,059.10	3,829.40	9,692.50	7,032.60	9,359.70	5,725.60	10,123.10	7,920.00	9,478.20	9,584.10	1,339.00	6,156.30	2,363.20
Totals	**321,917.40**	**10,591.70**	**9,259.90**	**9,271.40**	**8,017.90**	**9,731.90**	**10,553.20**	**10,497.20**	**11,309.50**	**11,038.20**	**11,066.30**	**9,471.70**	**10,257.30**	**10,227.70**	**8,297.90**	**11,881.60**	**9,440.50**

Table A.2 **Drainage Areas 21 to 40**

RE	Drainage Areas																	
	21	22	23	25	27	28	29	30	31	32	33	34	35	36	38	39	40
11.10.1																	
11.10.3																	
11.10.4a		12.5		57.8													
11.10.7																	
11.10.8			109.3														
11.11.1			1,749.90														
11.12.1			760.5														
11.3.1		9.2			0.2	124.8	12.9	35.4	50.6	4.4	21.9	0			8.6	13.7	77
11.3.10																	
11.3.1b						48.1											
11.3.2	6	12.5		1.6	37.3	751.9	269.2	52.2	361.4			24		7.4	240.2	173.9	804.1
11.3.21						12.7											
11.3.25	34.8	90.8	119.7	190.1	98.3	235	156	68.3	33.8	16.8	27.8	32.3	30.5	226.8	278.1	29.8	231
11.3.27									6.5								
11.3.27b		0.8		25.9		67.7									13.2		2.3
11.3.27f				30.3													
11.3.2b						0											
11.3.3						18.2	49.5			25	33.5	69.3	24.4		11.4		
11.3.35																	
11.3.36																	
11.3.37						16.9											
11.3.3c										1	5.6	4.4	6.1				
11.3.4			206.3	385.6													
11.3.6									215.4	1							
11.3.7					5.5	243.5			89.8						104.5		
11.4.13				1,241.60			46.5										
11.4.2			43.1	821.1		13.6			439.1	1.6							
11.4.4					12.4	31.8	11.6		14.3						61.2		
11.4.8					1.6	44.3			173.9	1.5	18.9					25.8	407.8
11.4.9	343.2	150.6		18.3	198.9	73.4			21.7					15	288.7	341.9	455.6
11.4.9a										83.1		3.9					
11.4.9b											11.7						
11.5.12						3.3								16.6	46.8		
11.5.15	0.3													350.6			
11.5.16																	
11.5.17						30.5											
11.5.18		25.7													216.9		

RE	Drainage Areas																
	21	22	23	25	27	28	29	30	31	32	33	34	35	36	38	39	40
11.5.2									23.5								
11.5.2a									1								
11.5.3	65.4	1,091.00			665.5	44.1		1.8	490					2,007.10	768.2	1,269.00	3,715.80
11.5.3b					5.7												
11.5.8c																	
11.5.9b															216.9		
11.5.9c															3.7		
11.7.1																	
11.7.2		103													600.2		
11.7.3																	
11.7.5		3.9															
11.8.11	693	1,607.60			470.9									4,769.80	29.6		
11.8.13	362.3	236.3	64.4		2.7									49.3			
11.8.14			16.5														
11.8.15		19.4															
11.8.3																	
11.8.4			182.1														
11.8.5	768.9	1,717.00	1,639.10		718.8									1,171.60	47.1		
11.9.1									19.6								
11.9.10				231.2													
11.9.13			518.2														
11.9.2	0.3	1.2	277.8	1,021.30	1,610.70		0.6							66.2		529.1	
11.9.3					144.7											65.3	
11.9.4a			6.4														
11.9.5	244.6	124.4	25.5	124.3	88.1				1.6					82.7			
11.9.7							0.3										
11.9.7a			1,091.00	1,734.60													
11.9.9	107.7	130.4	201.3	879.5										324.8			
non-rem	8,683.10	5,973.10	1,277.20	3,051.30	3,958.80	9,549.50	9,103.50	6,201.70	7,618.50	8,747.70	8,781.30	10,405.30	11,001.10		6,156.30	5,875.90	3,799.70
Totals	**11,309.50**	**11,309.50**	**8,288.10**	**9,814.60**	**8,020.30**	**11,309.50**	**9,650.20**	**6,359.40**	**9,560.70**	**8,882.20**	**8,900.80**	**10,539.30**	**11,062.10**	**9,088.10**	**9,091.80**	**8,324.30**	**9,493.20**

APPENDIX B ESTIMATED MAXIMUM EXTENT OF REGIONAL ECOSYSTEMS POTENTIALLY IMPACTED FROM CONCEPTUAL DEVELOPMENT FOOTPRINT

Table B.1 Drainage Areas 1 to 20

RE	Total Disturbance (Includes all Drainage Areas)	Drainage Area																
		1	2	3	4	6	8	9	11	12	13	14	15	16	18	19	20
11.10.1	58.35							4.82								51.9	1.63
11.10.3	4.72		4.72														
11.10.4a	110.8		1.18			1.77									19.2	78.01	6.71
11.10.7	3.71					3.71											
11.10.8	10.45							6.1									
11.11.1	69.67																
11.12.1	30.28																
11.3.1	32.69	0.45	3.91		0	0	0.21	0.84		3.51	0.43	1.38	9.36	0		1.2	1.36
11.3.10	0.64															0.3	0.34
11.3.1b	0.93									0.21							
11.3.2	218.46	11.22	42.4		9.01	0.03	1.04	8.69	1.07	26.34	8.24	3.31	4.95	0.01	13.63		
11.3.21	0.5												0.3				
11.3.25	200.66	10.04	25.85	7.3	3.63	8.61	0.48	5.71	1.65	4.61			12.39	9.06	7.68	6.01	14.29
11.3.27	0.2								0.01								
11.3.27b	4.72						0.15	0.57		0.88				0.08			
11.3.27f	9.92			2.75	0.11										5.26		
11.3.2b	0.35									0.32			0.03				
11.3.3	19.43									2.52	7.19		2.72				
11.3.35	0.67						0.48		0.2								
11.3.36	0.01							0.01									
11.3.37	2.02							0.02		0.01	1.04					0.7	
11.3.3c	0.5																
11.3.4	86.04	0.04	2.99	16.06		3.91					0.12				31.8		
11.3.6	13.9											7.6					
11.3.7	23.02							2.99		6.54						4.32	
11.4.13	104.7										8.84	19.85		0	0.22		
11.4.2	82.48	5.21										12.84			0.87		
11.4.4	5.95										0.02			0.05		2.53	
11.4.8	34.92	0.6	0.47				0.11	0.05		0.62	0.88	1.47		4.6			
11.4.9	151.4	15.38	1.78	13.47	2.42	0.68	1.21	1.68	5.87	2.21	5.82	10.55	0.07	6.01	1.44	11.93	
11.4.9a	3.78											2.34					
11.4.9b	0.18																
11.5.12	5.06								0.11							1.93	

RE	Total Disturbance (Includes all Drainage Areas)	Drainage Area															
		1	2	3	4	6	8	9	11	12	13	14	15	16	18	19	20
11.5.15	45.74	0.59				7.34											0.68
11.5.16	4.75																4.75
11.5.17	0.57								0.11								
11.5.18	15.59															8.96	
11.5.2	2.04																1.36
11.5.2a	0.03																
11.5.3	958.16	7.89	29.67	123.58	20.82	96.17	6.42	20.81	7.57	34.28		1.04		2.52	43.59	31.75	
11.5.3b	0.17																
11.5.8c	49.56			13.23											36.33		
11.5.9b	25.16						2.98	3.52	4.01	0.07				0.01		8.96	
11.5.9c	95.08		23.79		36.41		0.85	0.58	29.74	0.11						0.15	3.36
11.7.1	2.53		0.8		1.73												
11.7.2	209.12		6.01	21.53	106.67	19.62									10.9	24.81	
11.7.3	40.79		0.63		40.16												
11.7.5	0.16																
11.8.11	707.71	95.03														1.22	
11.8.13	47.28	15.58															
11.8.14	0.66																
11.8.15	15.34	14.56															
11.8.3	-																
11.8.4	7.25																
11.8.5	434.82	13.97			2.53						0.85					1.95	104.29
11.9.1	5.72					0.33											4.82
11.9.10	33.56																19.82
11.9.13	28																7.37
11.9.2	191.42														9.47		35.76
11.9.3	11.56					4.88											
11.9.4a	4.77					1.6											2.91
11.9.5	57.07	2.97	2.91			2.46									4.66		9.52
11.9.7	0.01																
11.9.7a	204.38					1.22									56.64		
11.9.9	216.91														39.23		73.54
non-rem	6,836.06	256.73	303.16	176.33	137.86	98.84	156.89	114.45	241.58	88.61	358.83	308.23	362.83	332.75	54.05	254.46	97.68
Totals	**11,543.07**	**450.25**	**450.25**	**374.24**	**361.34**	**251.19**	**170.82**	**170.83**	**291.91**	**170.83**	**392.26**	**368.62**	**392.65**	**355.09**	**334.95**	**491.1**	**390.2**

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Table B.2 **Drainage Areas 21 to 40**

RE	Drainage Areas																
	21	22	23	25	27	28	29	30	31	32	33	34	35	36	38	39	40
11.10.1																	
11.10.3																	
11.10.4a		0.5		3.44													
11.10.7																	
11.10.8			4.35														
11.11.1			69.67														
11.12.1			30.28														
11.3.1		0.37			0.01	1.88	0.55	1.04	1.47	0.07	0.34	0			0.22	0.48	3.61
11.3.10																	
11.3.1b						0.73											
11.3.2	0.24	0.5		0.1	1.13	11.36	11.54	1.53	10.54			0.84		0.79	6.2	6.09	37.68
11.3.21						0.19											
11.3.25	1.39	3.61	4.77	11.29	2.98	3.55	6.69	2	0.99	0.26	0.44	1.13	1.22	24.01	7.18	1.04	10.82
11.3.27									0.19								
11.3.27b		0.03		1.54		1.02									0.34		0.11
11.3.27f				1.8													
11.3.2b						0											
11.3.3						0.28	2.12			0.39	0.52	2.42	0.97		0.3		
11.3.35																	
11.3.36																	
11.3.37						0.26											
11.3.3c										0.02	0.09	0.15	0.24				
11.3.4			8.21	22.92													
11.3.6									6.28	0.02							
11.3.7					0.17	3.68			2.62						2.7		
11.4.13				73.79			1.99										
11.4.2			1.72	48.8		0.21			12.81	0.03							
11.4.4					0.37	0.48	0.5		0.42						1.58		
11.4.8					0.05	0.67			5.07	0.02	0.3					0.9	19.11
11.4.9	13.66	5.99		1.09	6.03	1.11			0.63					1.59	7.45	11.97	21.35
11.4.9a										1.3		0.14					
11.4.9b											0.18						
11.5.12						0.05								1.76	1.21		
11.5.15	0.01													37.11			
11.5.16																	
11.5.17						0.46											
11.5.18		1.02													5.6		

RE	Drainage Areas																
	21	22	23	25	27	28	29	30	31	32	33	34	35	36	38	39	40
11.5.2									0.68								
11.5.2a									0.03								
11.5.3	2.6	43.44			20.18	0.67		0.05	14.3					212.43	19.83	44.43	174.13
11.5.3b					0.17												
11.5.8c																	
11.5.9b															5.6		
11.5.9c															0.1		
11.7.1																	
11.7.2		4.1													15.49		
11.7.3																	
11.7.5		0.16															
11.8.11	27.59	64			14.28									504.82	0.76		
11.8.13	14.42	9.41	2.57		0.08									5.22			
11.8.14			0.66														
11.8.15		0.77															
11.8.3																	
11.8.4			7.25														
11.8.5	30.61	68.36	65.26		21.79									124	1.22		
11.9.1									0.57								
11.9.10				13.74													
11.9.13			20.63														
11.9.2	0.01	0.05	11.06	60.69	48.83		0.03							7		18.52	
11.9.3					4.39											2.29	
11.9.4a			0.25														
11.9.5	9.74	4.95	1.01	7.39	2.67				0.05					8.76			
11.9.7							0.01										
11.9.7a			43.44	103.09													
11.9.9	4.29	5.19	8.01	52.27										34.38			
non-rem	345.69	237.81	50.85	181.34	120.01	144.24	390.24	181.69	222.28	136.76	137.28	362.47	439.45		158.9	205.72	178.06
Totals	**450.26**	**450.26**	**329.97**	**583.27**	**243.14**	**170.83**	**413.68**	**186.31**	**278.95**	**138.86**	**139.15**	**367.14**	**441.89**	**961.86**	**234.67**	**291.44**	**444.88**

APPENDIX C ARROW ECOLOGICAL IMPACT ASSESSMENT PROCEDURE AND SURVEY GUIDELINES

Purpose

The purpose of this procedure is to provide the processes to be used in assessing the ecological values of a site to:

- achieve consistency and efficiency with ecological data collection and management
- ensure compliance with environmental permits and legislative requirements
- minimise disturbance to sensitive environmental features such as threatened wildlife (flora and fauna) and communities on the site and in the surrounding area, and to areas of high biodiversity value
- provide a site assessment process that allows monitoring of progress against rehabilitation objectives and identify areas of a worksite that will require offsetting or other mitigation measures.

This procedure must be adhered to in order for Arrow to comply with the relevant Commonwealth and State legislation, regulations, policies and procedures. These include, but are not limited to, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC), *Nature Conservation Act 1992* (NCA) and the *Environmental Protection Act 1994*.

Scope

This procedure must be followed during the planning and approval phases of a project. Some operational activities may also require an ecological impact assessment:

- if there have been legislative changes (such as amendments to the Environmental Authority)
- if areas of high ecological value have been identified near the worksite
- where an ecological impact assessment has not previously been undertaken (generally work undertaken prior to June 2010).

Approval is required for any petroleum activity where flora and fauna may be disturbed. Activities requiring an Ecological Impact Assessment prior to a site specific environmental approval being issued may include:

- seismic and geotechnical surveys
- linear easements including pipelines, roads, powerlines, tracks
- infrastructure required during the construction phase of a project. This includes roads and tracks required to access a site, laydown areas for machinery, temporary offices, mulch piles, spoil piles, etc
- relocating pipelines or access routes
- constructing dams
- constructing borrow pits, gathering lines, compression and treatment facilities

watercourse / drainage crossings, including the installation of culverts

other associated activities and activities that have not previously been assessed

This procedure applies to all personnel at Arrow Energy controlled workplaces. It is the responsibility of the Ecology Team Leader to ensure, where required, additional documents are

developed to meet or exceed the requirements set within this procedure. Deviation from these requirements must be managed in accordance with the HSE Document Deviation Procedure.

Procedure

	Steps	Responsibility	When / Frequency
1	**Pre-LAR site assessments** Prior to receiving a Land Access Request (LAR), the Project Manager or Approvals Coordinator may request the Ecology team produce a constraints map for the entire footprint of the area proposed to be developed. The aim of the constraints map is to obtain a preliminary understanding at a broad scale of: ▪ the impact of locating infrastructure at a particular site ▪ whether it is permissible within the constraints of the current Environmental Authority, or other planning approvals ▪ whether the infrastructure is located on land protected under the Strategic Cropping Land Act 2011 ▪ the distance to buffer areas relating to environmentally sensitive areas and watercourses ▪ whether offsets will or are likely to be triggered at the proposed location. If the proposed location for development does not comply with the Environmental Authority or other relevant legislation, a compliant location , if possible, shall be recommended to the Project Manager or Approvals Coordinator for submission in the Land Access Request (LAR). The new location must, in order of preference, avoid, minimise or mitigate any impacts on areas of vegetation or other areas of ecological value. The proposed alternate location should not be placed in an area that will involve clearing vegetation or placing fill in a way that significantly isolates, fragments or dissects tracts of vegetation resulting in a reduction in the current level of ecosystem functioning, ecological connectivity (i.e. stepping stone or contiguous bioregional / local corridor networks) and / or results in an increase in threatening processes.	Ecologist	Upon Request from Project Manager / Approvals Coordinator
2	**LAR Submission** An LAR will be submitted to the Approvals Coordinator for distribution to Lands, Cultural Heritage and Ecology team for assessment. Upon receipt of the LAR, the Environmental Desktop Assessment can be undertaken.	Project Manager	As required

	Steps	Responsibility	When / Frequency
3	**Change Request if Required** Where any non-compliance is identified with the Environmental Authority (EA), NCA or other approval conditions, a revised location if possible shall be recommended to the Approvals Coordinator via an Exploration and Appraisal Change Control Form. This form is required to be signed by the Exploration/Appraisal Manager. Once the revised location has been approved by the Exploration/Appraisal Manager, a desktop assessment will be prepared.	Ecologist	When an activity requires relocation
4	**Desktop Assessment** The EDT report shall be completed using the form 99-H-FM-0074- Environmental Desktop Assessment. The following assessments are to be completed using the GIS data supplied by the Department of Environment and Heritage Protection (DEHP), which is updated and managed by Arrow's GIS department: ▪ The location and distance to environmental constraints, including the following: ▪ land features and infrastructure ▪ potential sensitive receptors ▪ topography ▪ acid sulphate soil potential ▪ soil profiles present ▪ Strategic Cropping Land ▪ watercourses, wetlands and springs ▪ HERBRECS records ▪ remnant and regrowth vegetation ▪ The location and distance to environmentally sensitive areas (ESA's) and their associated buffer zones. The following online database searches must be undertaken: ➢ EPBC Protected Matters Search for assessing Matters of National Environmental Significance. ➢ DEHP's Wildlife online. The results from these online searches are included within Threatened Species Tables (Tables 1 & 2) in the Desktop Assessment. ➢ An ESA search of the location utilising the DEHP ESA website search tool to verify all the Arrow GIS layers conform to DEHP's mapping. A high, medium or low rating will be provided for each criterion of the desktop assessment. The purpose of the rating is to indicate the level of risk identified to completing	Ecologist	Upon receipt of an LAR

	Steps	Responsibility	When / Frequency
	the project. Any high risk criterion of the assessment should be discussed in the summary section of the report.		
5	**Production of Environmental Constraints Map** An environmental constraints map will be prepared. The map will be incorporated into the Environmental Desktop Assessment report. It will highlight any high value regrowth, remnant vegetation, watercourses, wetlands and springs, ESA's and the associated buffers. This map should be at a scale sufficient to show features of the surrounding landscape.	Ecologist	During the EDT Assessment
6	**Desktop Assessment Completed** For large complex projects, the EDT report shall be provided to Project Managers to inform them of any issues identified. The Approvals Manager, project schedules and tracking programs (SPS) will be updated to indicate that the desktop assessment has been completed and the project site has passed this phase of the assessment.	Ecologist	After completion of the EDT
7	**Site Validation** For seismic surveys, linear infrastructure, dams and other large infrastructure projects, a site walkover will be conducted prior to the field assessment to validate features identified on the environmental constraints map. The walk over will be coordinated by a Land Liaison Officer, ensuring site access has been obtained. The site validation should be conducted using a GPS tablet or software that contains: • Satellite imagery with appropriate GIS layers • Kilometre Points (every 1km) for seismic lines and linear infrastructure • Cadastral layers • Infrastructure (fences, sheds, etc.) The location, boundaries and extent of Threatened Ecological Communities, ESA's, Regional Ecosystems, watercourses and wetlands shall be confirmed. The location of any fauna habitat features, including nests, dreys, burrows, hollows, logs, etc. should be identified and recorded. Information should be collected about the location of watercourses and wetlands with respect to their length,	Field Ecologist Ecologist	After completion of the EDT

	Steps	Responsibility	When / Frequency
	access to and options for crossing or navigating around them. For seismic lines, it should be noted where a break in the seismic line is recommended. If minor route alignments are required or recommended to reduce environmental impacts for seismic lines and linear infrastructure, possible options for alternate routes should be examined and enough data collected to provide to the Project Manager. Where the proposed area for a dam is unsuitable, potential new areas should be examined.		
8	**Complete Site Validation Report** The Site Validation Report, including recommendations for route or site changes, should provide a summary of the environmental features encountered within the development footprint. The report should be provided to the Project Manager.	Field Ecologist Ecologist	After completing Site Validation Assessment
9	**Ecological Field Assessment** Upon notifying the Approvals Coordinator that the EDT or Site Validation assessment has been completed, and that no issues with the proposed location were identified; access to the site should be organised with the relevant Land Liaison Officer and Field Ecology staff or consultant botanist to complete the field assessment. All ecologists must comply with the Land Access Conditions (Attachment 1) and have completed the appropriate inductions for the field location. A consultant botanist will be escorted on site. They may be shown or directed to the site by an Arrow Employee, if authorised by the Lands Department to be onsite unescorted by a Lands Liaison Officer. The field survey is based on collecting site and habitat information, as well as information relating to the vegetation structure condition, floristics, and groundcover data. Survey effort will vary depending on the vegetation formation and complexity, however, a team of two experienced field officers should complete each survey in 1-1.5 hours. Survey effort is dependant on a range of variables including: • Season and availability of plant identification material • Field officer experience with the particular vegetation	Field Ecologist Ecologist Consultant Ecologist	After completing EDT / Site Validation

	Steps	Responsibility	When / Frequency
	type and its constituent species • The overall species richness and structural complexity of the site • The density of woody vegetation within the site as this can affect the ease of making cover and abundance measurements. Where specimens are not known to field officers, they will need to be collected in the field for later identification in the office. Where they cannot be identified, specimens should be prepared and sent to specialists for identification. Figure 1 illustrates the standard assessment plot set-up for vegetation assessment. Once the site is located or established, marker posts are fixed at either end of a firmly tightened 100 metre tape (note: marker posts may be removed if the site is not to be permanently marked). Temporary markers are placed at the four corners of the 20x20m plot, and the two remaining corners of the 100x5m plot if woody vegetation is present on the site. Coordinates at each end of the transect are taken using a GPS and recorded on the form. Photos are taken facing North, East, South and West, and photo numbers corresponding with the direction of the photographs are recorded on the form (99-V-FM-0020). Plots should be located and oriented so that the entire plot remains in the same vegetation type and the same vegetation condition state. Normally plots should be oriented so that the long axis of the plot follows the contour. Where the standard plot cannot be located within the same vegetation type or condition state (often the case for riparian or other linear activities like roads activities), the plot shape should be modified but the overall assessment area (0.04 ha) needs to be maintained. The data collected is divided into a number of sections based on the type of data and the scale of the assessment. There are a range of different methods to be used including: 1. **A 20x20m quadrat for floristic abundance and cover**. All woody species and up to ten (10) species of groundcover are recorded, and their cover and abundance within the quadrat is estimated. 2. **A 100m long transect recording monitoring information**. At every 1m interval along the 100m tape the groundcover present is recorded. 3. **A 100x5m belt transect for recording woody species**. Each woody species (including trees and shrubs) within five metres of the transect tape are recorded and the number of each species found		

	Steps	Responsibility	When / Frequency

along the transect for each of the nominated height classes (T1, T2, shrubs, seedlings) is tallied.

4. **A timed random meander across the ESU**. This is done to gather data on flora species of conservation concern, incidental fauna records and any other noteworthy aspects. The minimum time for this meander is 0.5 hr per ESU.

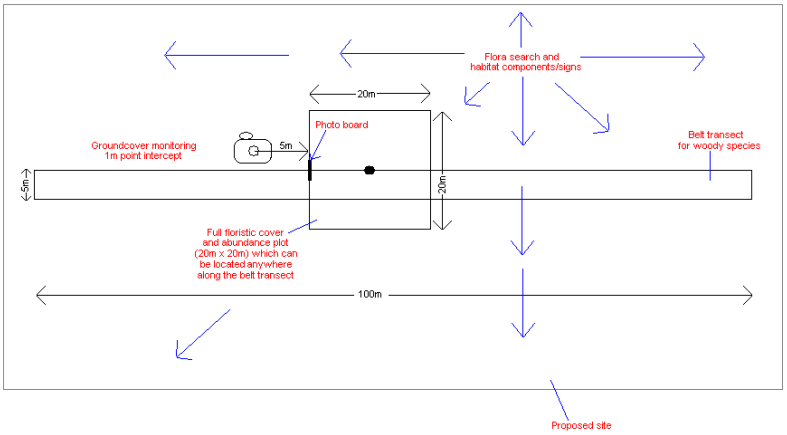

Figure 1. Plot layout

Any environmental features in the surrounding area that may constrain development should be noted. This may include declared weeds, NCA protected (Type A) plants or threatened plants and communities (EPBC or NCA) or habitat for threatened fauna, hollow bearing or stag trees, large trees requiring the installation of Tree Protection Zones (TPZ's), watercourses, drainage lines, eroded banks, ridges and escarpments, powerlines, existing infrastructure, sensitive receptors or habitat features.

The values of permanent and temporary water sources must be considered as possible breeding habitat for aquatic protected wildlife including platypus, turtles, frogs and fish.

For seismic lines and linear infrastructure, vegetation should be sampled within each regional ecosystem, or where variations should be recorded such as isolated communities that would not be mappable as a regional ecosystem (each on a separate Ecology Field Survey Form). The route of the easement should be walked, as much as practical, to search for threatened plants and other environmental features.

To properly assess a large complex site, it must be divided into homogeneous units of similar biophysical attributes. For vegetation related assessment, this separation is usually based on areas with the same vegetation type and condition status. To adequately survey the diversity across the area, at least one survey site would be situated within each ESU. Most small sites such as wells are likely to be one ESU but

	Steps	Responsibility	When / Frequency
	a larger site, such as a dam, may contain a number of ESUs. It is essential for ecologists to be experienced in botanical field surveys and vegetation condition assessment. Basic training in the assessment method can be undertaken in a day. It is highly desirable that an ecologist is familiar with the vegetation communities within the area of interest. In addition, if there is more than one survey team operating or different staff become involved in the survey work during the project, it is essential that the observers work closely together to ensure a high degree of observer calibration, their survey methods are consistent, and data fields recorded between observers are interpreted consistently. Pre-survey field calibration exercises aimed at reducing observer error are highly recommended. A typical field kit should contain the following equipment: • Global Positioning System (plus spare batteries) • Digital camera (plus spare batteries) • 1.5m fibreglass posts and post driver, flagging tape or wire pegs (check permit to work requirements) • Compass and clinometer (combined compass/clinometer is preferable) • 20m, and 100m fibreglass tapes (metres printed on both sides preferable) • Tree diameter tape (also known as DBH tapes (diameter at breast height)) • Flags and flagging tape • Photo-board and chalk (chalk board recommended) • Data sheets and clipboards • Hand lens, sample bags, plant press, plant identification books • Jewellery tags • Secateurs • 2x hand held radios (refer to the relevant SOP for use) • 2 methods of communication for the field location (SPOT, satellite phone if no mobile phone coverage is expected) • Mobile phone • PPE – steel capped boots, anti-static long sleeved shirt and pants, hard hat (for production areas) with sun protection, safety glasses, high visibility vest/shirt (production sites and as where required) • 10 litres water for vehicle, water supply for walking (camelbak or water bottle) • First aid kit, including bandages for snake bite • Gloves		

	Steps	Responsibility	When / Frequency
	• Esky (optional)		
10	**Complete Environmental Summary Report** When the field assessment has been completed, the Environmental Summary Report and threatened species assessment (Attachment 2) should be prepared. The results of the threatened species assessment should be analysed and collated in the Environmental Summary Report. Photographs should be stored in the project folder. Consultant reports should be saved unamended in the reports folder for consultants. The reports should also be saved in each project file and completed internally, where required.	Field Ecologist Ecologist Consultant Ecologist	After completing Ecological Field Assessment
11	**Ecology Registers** Arrow Energy's Ecology team, within the Environment Department maintains a number of data registers that document vegetation clearing activities for auditing purposes. These registers are: • Vegetation clearing register - records the estimated quantity cleared for each species for each infrastructure site, to comply with the *Nature Conservation Act 1992* exemption. • Rehabilitation Monitoring register - records species present from monitoring activities • Threatened species register – records the locations of threatened fauna, flora and vegetation communities • Breeding Places Register – records the location of breeding places tampered with or destroyed during works. Prior to submitting the internal approval document, an Ecology team member must ensure that each register has been updated with the site results.	Field Ecologist Ecologist	After completing Ecological Field Assessment
12	**Seek EA Amendment** If the proposed works cannot comply with the current environmental authority an EA amendment an application for an amendment may be justified. The field results and photographs should be collated in a request letter to DEHP to demonstrate why the activity should be allowed. The amendment process is managed by the Approvals Manager.	Field Ecologist Ecologist	As required

<table>
<tr><th></th><th>Steps</th><th>Responsibility</th><th>When / Frequency</th></tr>
<tr><td>13</td><td>

Seeking Approval from External Parties

There are several external approvals that may be required to clear or interfere with flora or fauna habitat on a particular site. These are listed in Table 1 below.

Table 1: External Permits and Approvals that may be required

<table>
<tr><th>Permit or Approval Required</th><th>Administering Authority</th><th>When the Permit/Approval is Required</th></tr>
<tr><td>EPBC Act Referral under the Environment Protection and Biodiversity Conservation Act 1999.</td><td>Department of Sustainability, Environment, Water, Population and Communities</td><td>Referral to the Department must be undertaken when it is anticipated that the proposed works are likely have a significant impact on a Matter on National Environmental Significance.</td></tr>
<tr><td>SCL Compliance Certificate</td><td>Department of Environment and Heritage Protection</td><td>This permit is required when activities are located on confirmed SCL and are temporary and restorable.</td></tr>
<tr><td>Clearing Permit under the Nature Conservation Act 1992.</td><td>Department of Environment and Heritage Protection</td><td>This permit is required when the removal, destruction or damage of endangered, vulnerable or near threatened flora is required.
Please Note: Arrow has an exemption to clear least concern flora for an activity under an Environmental Authority only.</td></tr>
<tr><td>A Damage Mitigation Permit under the Nature Conservation Act 1992.</td><td>Department of Environment and Heritage Protection</td><td>This permit is required to take native fauna or tamper with the breeding places of native fauna.</td></tr>
<tr><td>Clearing Native Vegetation Permit under the Vegetation Management Act 1999.</td><td>Department of Environment and Heritage Protection</td><td>This permit is required when remnant vegetation is required to be removed, destroyed or damaged when not being undertaken as an authorised petroleum activity.</td></tr>
<tr><td>Guideline – Activities in a watercourse, lake or spring associated with mining operations. Endorsed 09/12/2010.</td><td>Department of Environment and Heritage Protection</td><td>Works within a watercourse must be undertaken in accordance with this guideline to demonstrate compliance with EA conditions.</td></tr>
<tr><td>Riverine Protection Permit under the Water Act 2000.</td><td>Department of Environment and Heritage Protection</td><td>This is required when disturbance (the destruction of vegetation, excavation or placing of fill) to the bed and banks of a watercourse outside a proposed petroleum authority is undertaken.</td></tr>
<tr><td>Pre-Works Advice Sheet in accordance with the Self Assessable Code for Minor Impact Works in a Declared Fish Habitat Area or Involving the Removal, Destruction or Damage of Marine Plants (MP06).</td><td>Queensland Boasting and Fisheries Patrol

Relevant Regional Fisheries Centre</td><td>This is required when the removal, destruction or damage to marine plants can be undertaken in accordance with the conditions in the self-assessable code (MP06).</td></tr>
</table>

</td><td>Ecologist

Biodiversity Coordinator

Approvals Manager</td><td>As required</td></tr>
</table>

<table>
<tr><th></th><th>Steps</th><th>Responsibility</th><th>When / Frequency</th></tr>
<tr><td></td><td>
<table>
<tr><td>An Operational Works Permit for the removal, destruction or damage of marine plants under the Fisheries Act 1994.</td><td>Department of Employment, Economic Development and Innovation</td><td>This permit is required when the removal, destruction or damage of marine plants cannot be undertaken in accordance with the condition in the self-assessable code (MP06).</td></tr>
<tr><td>Pre-Works Advice Sheet in accordance with the Self Assessable Code for Minor Waterway Barrier Works (WWBW01).</td><td>Queensland Boasting and Fisheries Patrol

Relevant Regional Fisheries Centre</td><td>This is required when the construction of waterway crossings, including culverts, can be undertaken in accordance with the conditions in the self assessable code (WWBW01).</td></tr>
<tr><td>Pre-Works Advice Sheet in accordance with the Self Assessable Code for Temporary Waterway Barrier Works (WWBW02)</td><td>Queensland Boasting and Fisheries Patrol

Relevant Regional Fisheries Centre</td><td>This is required when the construction of waterway crossings, including culverts, can be undertaken in accordance with the conditions in the self assessable code (WWBW02).</td></tr>
<tr><td>An Operational Works Permit for the construction of a waterway barrier under the Fisheries Act 1994.</td><td>Department of Employment, Economic Development and Innovation</td><td>This permit is required when the construction of waterway crossings, including culverts, cannot be undertaken in accordance with the conditions in the self assessable codes (WWBW01 and WWBW02).</td></tr>
<tr><td>Forest Products Permit under the Forestry Act 1959.</td><td>Department of Environment and Heritage Protection</td><td>A Forest Products permit may be required where loggable timber on state land (leasehold tenure) needs to be cleared.</td></tr>
<tr><td>Biodiversity Offset Area</td><td>Department of Environment and Heritage Protection</td><td>This may be required when residual impacts from a development on an area possessing State significant biodiversity values, cannot be avoided.</td></tr>
</table>

The permits must be approved by the external party, prior to approving the Environmental Authority to Proceed within the Access and Approval Conditions.</td><td></td><td></td></tr>
<tr><td>14</td><td>DEHP Map Change Request

Where the field assessment results indicate that the environmentally sensitive area is incorrectly mapped for a particular location, a map change request should be prepared by an Ecologist and submitted to DEHP. This process may take up to two months.</td><td>Field Ecologist

Ecologist

Approvals Manager</td><td>As required</td></tr>
<tr><td>15</td><td>Unmapped Ecological Communities or Threatened Species Found

The location of mapped ecological communities and threatened species should be provided to the GIS department to update the threatened species GIS layer.

A (Threatened) Species Management Plan (SMP) should be prepared to manage the threatened species or community during site works.

A register must be maintained for all breeding places</td><td>Field Ecologist

Ecologist

Biodiversity Coordinator</td><td>As required</td></tr>
</table>

	Steps	Responsibility	When / Frequency
	tampered with. For projects where the species management program applies, the register must record the number of obvious animal breeding places destroyed. Where the generic species management program does not apply, a specific SMP must be prepared and submitted to DEHP. The location of mappable regional ecosystems and threatened species should be provided to the Queensland Herbarium (DEHP).		
16	**Prepare Environmental Authority to Proceed within the Access and Approval Conditions** Once the Environmental Summary Report is completed and all other relevant permits have been obtained, the Environmental Authority to Proceed should be completed. An Ecology Map Request form should be submitted to the relevant GIS officer for processing. When the map has been finalised, the Access and Approvals Conditions document should be submitted to the Ecology Team Leader / Ecology Specialist for review and sign off.	Field Ecologist Ecologist	After completing Environmental Summary Report
17	**Review and signoff Environmental Authority to Proceed within the Access and Approval Conditions** The Environmental Authority to Proceed should be reviewed and approved by the Ecology Team Leader / Ecology Specialist, prior to submitting to the Approvals Coordinator. The Ecology Team Leader, the Ecology Specialist or their delegate can sign the Access and Approval conditions document.	Ecology Team Leader Ecology Specialist	As required
18	**Access and Approval Conditions provided to the Project Manager** The Approvals Coordinator provides the signed LAR with Access and Approval Conditions and any relevant documents to the Project Manager.	Approvals Coordinator	After completion of Access and Approval Conditions

Abbreviations

Abbreviation	Term
NCA	*Nature Conservation Act 1992*
DEM	Digital elevation model
DEHP	Department of Environment and Heritage Protection
EA	Environmental Authority

Abbreviation	Term
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ESU	Environmental Stratification Unit
ESA	Environmentally Sensitive Area
GIS	Geographic information system
HERBRECS	Herbarium Records collected by the Queensland DERM Herbarium
LAR	Land Access Request – internal approval process for site specific developments
MNES	Matters of National Environmental Significance
RE	Regional ecosystem- mapping system used to determine status of vegetation in Queensland
TPZ	Tree Protection Zone

References

Referenced Documents	
Reference	**Document Title**
1	99-H-PR-0015 – HSE Document Deviation Procedure
2	99-H-FM-0074 – Environmental Desktop Assessment
3	99-H-FM-0075 – Environmental Desktop Assessment (Linear)
4	99-V-FM-0020 - Ecology Field Survey Form
5	99-V-FM-0021 - Herbarium - Unknown Species Data Sheet
6	99-V-FM-0016 - Ecology Summary Report
7	Access and Approval Conditions
Supplementary Information Sources	

Document Control			
Revision	**Revision Date**	**Reviewer**	**Approver**
A		Ecology Team Leader	

Attachment 1- Arrow Energy's Land Access Rules

12 Land Access Rules

01

Only enter a property with the approval of your supervisor, who has cleared access with the landholder.

02

Only conduct activities that are approved within the access conditions.

03

Follow the directions of the landholders. Report any directions that are not within the access conditions.

04

Report landholder discussions, complaints or incidents to your supervisor or Land Liaison Officer.

05

Carry personal and vehicle identification showing that you are an employee or contractor of Arrow.

06

Keep sites tidy, ensure all rubbish is removed from site.

07

Do not interfere with the landholder's property, equipment or operations. Use approved tracks and laydown areas. Drive at less than 10kph within 200m of buildings. Leave gates as signed or found.

08

Do not take firearms, weapons, animals, illicit drugs or alcohol onto the property.

09

Do not light fires unless authorised. Smoking is only permitted in the designated locations.

10

Do not enter a site during or after wet weather without consent of the Land Liaison Officer (who has cleared access with the landholder) except in the case of a declared emergency.

11

Do not negotiate with landholders. Only Land Liaison Officers are permitted to negotiate activities and access conditions.

12

Do not threaten or pressure landholders or other people on the property.

Failure to comply with any Land Access Rules may result in disciplinary action.

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Attachment 2- Threatened Species Assessment

ACKNOWLEDGEMENTS
The outlined method is adapted from that developed by Ken Turner and Peter Smith in 1996 - *Guidelines for assessing the significance of native vegetation removal on threatened species, populations, or ecological communities, or their habitats* (NSW Department of Land and Water Conservation). Adaptation of these guidelines was largely undertaken by Wendy Hawes and Alan Ede, with inputs from Terry Mazzer, Phil Redpath, Darren Shelly and Ken Turner. This guideline is also based on specific consideration of the document *"The Assessment of Significance: Threatened Species Assessment Guidelines* (2006) prepared by DEC in conjunction with DPI.

TO ASSESS THE IMPACTS OF ARROW DEVELOPMENT PROPOSALS, THE METHOD IS BASED ON THE FOLLOWING PROCESS:

1. **Determining which threatened species are relevant** to the assessment, i.e. those present, or which have habitat present, in the subject;
2. **Considering the likely impacts of the proposed development** on each relevant threatened species and its habitat using a series of tables populated with field assessment and other data;
3. **Considering the overall significance** of the likely effects of the proposal on each threatened species and its habitat, based on the outcome for each table, and come to a conclusion;
4. **Considering whether the proposal's likely impacts can be reduced,** by reasonable, practical and appropriate mitigation measures, to prevent a likely significant impact.

1. DEFINITIONS

Subject site *means the area directly affected by the proposal.*

Study area *means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as required to take all potential impacts into account.*

Direct impacts *are those that directly affect habitat and individuals and include but are not limited to acute death through predation, trampling, poisoning of the animal/plant itself and the removal of suitable habitat. Consideration must be given to all likely direct impacts of the proposal.*

Indirect impacts *occur when proposal-related activities affect species or ecological communities in a manner other than direct loss. Indirect impacts can include loss of individuals through starvation, exposure, predation by domestic and/or feral animals, loss of breeding opportunities, loss of shade/shelter, deleterious changes in the water table, increased soil salinity, promotion of erosion, inhibition of nitrogen fixation, provision of suitable seed bed for exotic weed invasion, fertiliser drift, or increased human activity within or directly adjacent to sensitive habitat areas. As with direct impacts, consideration must be given to all the likely indirect impacts of the proposal.*

Gaps *are those areas which create unfavourable habitat for a species within an area of suitable habitat. How an individual flora or fauna species responds to a gap is completely dependent upon the life history of the species (e.g. mobility, habitat requirements, sensitivity to change, etc.) and the nature and width of the gap itself. Gaps are primarily artificial in creation (i.e. created by humans) although gaps may occur through natural means such as bushfire or cyclones.*

Available Habitat *means all areas within a 5 kilometre (km) radius of the boundary of the subject site (the study area) that appear to match the species known habitat requirements and are connected to the study area or are within the normal movement ability of the species.*

2. PROCESS OVERVIEW

- Identify all relevant threatened species and map suitable habitat for each (see below). Each threatened species present or with known habitat present in the **study area** must be considered within each table.
- The study area is considered to be that included within a 5 km radius from the boundary of the subject site.
- When undertaking the assessment process, if a proposed development has a significant impact on any threatened species, it may require either modification via conditions, the movement of the infrastructure or potentially an offset under the QLD biodiversity offset policy.
- Modification of a proposal to prevent or reduce likely impacts on threatened species and their habitats to below a significant level will generally involve one or more of the following;
  - exclusion of particular **areas** of habitat,
  - retention of particular **habitat components**, or
  - using **different methods** (e.g. specific equipment or techniques, changes to the activity timing).

  Which of these options is appropriate will depend on the species concerned and its 'essential habitat component' requirements. Following a precautionary approach, species with poorly known essential habitat components may require complete exclusion of areas of habitat to prevent significant impacts.
- After assessment of the likely impact on each threatened species, consider the overall likely impact of the proposal, **with appropriate impact mitigation conditions,** on each species. Advice on setting appropriate impact mitigation conditions is contained at the end of these guidelines.
- If it is not possible to set effective impact mitigation conditions for **any one or more** relevant species, **the proposal must be considered likely to have a significant impact on that/those species.**

3. IDENTIFY RELEVANT THREATENED SPECIES.

DATA REQUIREMENTS AND RESOURCES

- A description of the macro and microhabitat features present on the subject site (from field sheets) and macrohabitats of the study area.
- Profiles for the above species
- Relevant GIS mapping products (regional ecosystems, waterways, wetlands, etc)
- Imagery for the study area.

3.1 PROCEDURE

1. List any threatened species recorded or predicted (e.g. from field sheets and database searches) within the **study area** (including the subject site and areas within a 25km radius from its boundary).

2. Determine the broad macrohabitat types present in the study area using image interpretation and any available RE mapping.

3. Determine a final list of **relevant species** to be assessed, by comparing each species' known habitat requirements against microhabitat data from the field inspection. Species not containing any growing, feeding, roosting, breeding or movement habitat on the area can be culled from the list.

The resulting list contains those species that are **definitely present** and/or are considered to have **habitat** present in the study area, that is, **their known distributions and habitat preferences reasonably match the location and habitats in the study area.**
These are the relevant threatened species to be considered. Record this list in the Table.

NOTE: *For some species (e.g. perennial plants), if a reliable survey (including those conducted by Arrow staff) concludes that a species is absent from the study area, or will not periodically use habitats present in the study area, this is sufficient evidence a local population is not present. As a consequence this species would not need consideration. For other species (e.g. migratory/nomadic fauna, annual plants), surveys are often unreliable and if suitable habitat is present the species must be considered.*

3.2 MAP THREATENED SPECIES HABITAT

3.2.1 DATA REQUIREMENTS AND RESOURCES

- List of relevant threatened species for the study area
- Determinations, listing advice, profiles, conservation plans and other information for each species.
- GIS datasets and Imagery

3.2.2 PROCEDURE

1. Where possible, **group relevant threatened species** based on habitat use.
Flora and fauna species can be grouped based on their broad macrohabitat requirements, eg. forest or grassland dependent species. It may be appropriate to subdivide these groups further based on similar essential microhabitat requirements, e.g. forest dwelling bat species requiring tree hollows.
Some species may not fit readily into a group; these species should be assessed individually using the same procedure as outlined for a group.

2. **Map available habitat**

Map the habitat available to each of the species groups within the **study area**, using the groups determined in (1). This will require image interpretation, use of field data sheets and GIS mapping.
Habitat mapping should be macrohabitat types to the best achievable level. For example, it is difficult from imagery interpretation to determine understorey in forest communities, consequently, the habitat mapped will be the same for all species dependent upon forest overstorey structure independent of differences in species understorey requirements, ie. shrubby vs grassy.
It is not feasible to visit all patches within the broader study area to undertake an assessment. In most cases it will be necessary to extrapolate from field observations, RE mapping and imagery to make reasonable estimates of which other areas contain similar habitat to that in the subject site.

NOTE: *For migratory or nomadic species, and depending upon the size of the study area for sedentary species with high mobility and large home ranges, the area of available habitat will potentially be the whole of the study area.*

3. Determine the movement ability of each species or population.

Determine the movement ability of each flora and fauna species based on likely gap crossing ability.

4. Determine the area of interconnected habitat.

Consider the likely movement ability of each threatened species. Within each subgroup there may be species with different movement capabilities which, depending upon the configuration of vegetation within landscape will have more or less habitat available to them. For example; where their ranges overlap, the macrohabitat of the Golden-tailed Gecko (GTG) and Squatter Pigeon is the same woodland on poorer soils. However, the GTG has limited movement ability while the Squatter Pigeon is highly mobile. Consequently in fragmented landscapes, it is likely the area of woodland available to a local population of the GTG will be far less than that available to the Squatter Pigeon.
To determine the area of habitat available to the threatened species under assessment, further classify species within each group and/or subgroup according to the species' movement category. For species restricted to specialised microhabitat preferences (e.g. gully edges, soak areas, forest/grassland ecotone) within a macrohabitat, it may be necessary to estimate the proportion of the macrohabitat that contains these specific areas (from field inspection), and multiply the total area of the macrohabitat by this figure to estimate total area of suitable habitat.

5. Determine the local population.

Does the study area:

- form part of a larger patch of suitable habitat, or
- have a continuous connection of suitable habitat with other patches, or
- have other areas of suitable habitat that are within the species normal movement ability?

Review the habitat map created in (2). Consider the distribution of suitable habitat in the landscape for each species or species group. Specifically look for gaps between patches of habitat and determine those which are wider than the species movement ability and the type of gap created (i.e. roads, powerlines, development, etc). All habitat within a species' movement ability will be available to this species and is considered the area occupied by a **local population** of this species.
Calculate the area of a local population for each species.

6. For fauna species determine whether any of the species or populations are:

(i) Nomadic, migratory or sedentary species with high mobility ("no barriers to movement") and a low population density (<1 individual / 500ha).

4. UNDERTAKE THE ASSESSMENT

TABLE A – IMPACT ON A LOCAL POPULATION

In summary, the following assessment is seeking to determine for each relevant threatened species:

(i) The extent of the local population, and

(ii) The likely impact of the activity on the habitat components essential to the life cycle of the species.

This is judged via the following:

1. Determine the size and extent of the local population.

As population size cannot be measured directly, an indicator of likely size must be used, i.e. the area of suitable habitat available in the study area. For many species, a local population may not be restricted to the study area as it may *provide* only part of the suitable habitat available in the locality. This is particularly relevant for mobile species and for areas with connections to other suitable habitat. In order to estimate local population size, it is important to consider all **available habitat** in the local area.

An indication of significance then comes from comparing the total area of available habitat (surrogate for total local population size) to the size of the area under application (surrogate for affected part of local population). Significance will rise as the proportion of the local population affected by an activity increases. Additionally, if a population is very small, **any disturbance** is likely to result in a larger effect.

2. Determine the likely impacts of the proposal on the key habitat components essential to the life cycle of the species.

Each species has a set of habitat components or conditions essential to the continuation of its life cycle. Activities causing little disturbance to these components will result in a relatively small risk of harm. Thus an activity may occur over a large area of suitable habitat but have relatively little impact on a population because it does not affect the species essential habitat components. Activities which result in **any one (or more)** of these components being greatly reduced or removed, are likely to cause a major disruption to the life cycle of individuals in that area.

At present, a species' key habitat components will have to be inferred from known habitat preferences eg for fauna - current forest structure, tree hollows, particular food resources, water availability etc. Essential conditions for most flora species are likely to be more general and may include tree canopy >50% or minimising disturbance to the hydrological regime or groundcover.

Special Considerations under this Factor

(a) ***Nomadic and migratory fauna species***

Effects on a local population are an irrelevant consideration for most **nomadic** and **migratory** fauna species as a 'population' of these species may cover enormous areas and only use available habitat at a specific location briefly during the course of their migratory/nomadic behaviour. Given this large scale in relation to each study area, it is impossible to delineate a *local population* for these species. Therefore the proposal will be considered not significant for these species under this part of the assessment. However, consideration must be given to species which exhibit fidelity to a particular site over many years and which may contain an essential resource as any impact on the site may affect the entire population.

(b) **High-mobility, low population density, sedentary fauna species**

For sedentary species that are highly mobile (i.e. 'no barriers to movement') with low population densities (less than 1 individual per 500 ha, e.g. large raptors), the 5% threshold for fauna (in Table A) is also inappropriate for determining significant effects. Local populations of these species will also invariably range well beyond the study area.

For these species a proposal should be considered significant if it will cause major disruption to the species' life-cycle (i.e. modify/remove essential habitat components) over a total area of suitable habitat equivalent to 2 or more home ranges.

NOTE: *Proposals to disturb large areas but which retain **all** essential habitat components should be considered unlikely to place a local population of these species at risk of extinction.*

4.1 DATA REQUIREMENTS AND RESOURCES

- Maps of the extent of a local population generated in Section 3
- Area of suitable habitat proposed to be removed or modified on the subject site

4.2 ASSESSMENT PROCESS

FOR FAUNA

(a)1 Nomadic and migratory fauna

Is the species migratory or nomadic?

If NO - go to (a)2

If YES - the proposal is considered **unlikely** to significantly impact on a local population. To continue assessment for this species, go to Table B.

(a)2 Sedentary fauna with high mobility and low population densities

Is the species a sedentary fauna species with high mobility ('no barriers to movement') and low population density (eg many raptors)?

If NO - go to (a)3

If YES,

Will the proposal modify/remove essential habitat components for the species (ie cause major life cycle disruption to the species) over an area of habitat equivalent to 2 or more home ranges?

If NO - the proposal is considered **unlikely** to significantly impact on a local population. To continue assessment for this species, go to Table B

If YES - the proposal is considered **likely** to significantly impact on a local population.

(a)3 Special limits relate to very small local populations of medium to low-mobility species:

Is the species only able to cross medium gaps (eg up to 200m)?

If NO - species is able to cross larger gaps - go to (a)5

If YES -will the proposal reduce the total area of remaining available habitat to < 10 home ranges?

If NO - the proposal is considered **unlikely** to significantly impact on a local population. To continue assessment for this species, go to Table B.

If YES - the proposal is considered **likely** to significantly impact on a local population.

(a)4 For all other fauna species within the subject site.

(i) Determine the area of habitat where disturbance will occur but all of the species essential habitat components are maintained (by following suitable impact-mitigation conditions).

Area of habitat protected by mitigation conditions = ……..ha **(M)**

OR

Determine the area of currently suitable habitat which will undergo reduction or

removal of one or more essential habitat components.

Area of habitat to undergo reduction/removal = ...ha **(R)**

(ii) Compare the size of the disturbed area of habitat for this species in the subject site (M or R) with the total area of interconnected suitable habitat **(T)** calculated in Section 3

[disturbed area of habitat (ha) / total area of interconnected habitat (ha)] x 100 = ...% **(P)**
Assuming individuals of the species may be present throughout the total area of interconnected suitable habitat; this figure will give an indication of the proportion of the total local population likely to be affected by the proposed disturbance.
Record these calculations in the relevant column of Table A
Go to (a)5

(a)5 Determine the level of impact.
For each species, compare both the proportion of total habitat area to be affected (P), and the actual area to be affected (M or R) with the limits in Table 1:

Table 1: Fauna and Flora Species - Limits of significance for Table A

	Proposed activity type	
Measure	Activities which retain a species essential habitat components (eg. hollow tree retention) (M / T x 100)	Activities which reduce/remove a species essential habitat components (e.g. clearing) (R / T x 100)
% of total available habitat to be affected by this activity (P);	20%	5%

R: area of habitat to undergo major disruption; **M:** area of habitat protected by mitigation conditions;
T: total area of interconnected suitable habitat

Are figures for this proposal **greater than** the above limits?

If NO - the proposal is considered **unlikely** to significantly impact on a local population.

If YES - the proposal should be considered **likely** to significantly impact on a local population

FOR FLORA

(a)6 Special thresholds relate to very small local populations of flora species:

Is a local population of threatened plant species known and/or likely to be < 100 individuals?

If NO, go (a)7

If YES, the proposal is considered **likely** to significantly impact on a local population

(a)7 For all other flora species relevant to the subject site;

(i) Determine the area of habitat where disturbance will occur but all of the species' essential habitat components are maintained (by following suitable impact-mitigation conditions).

Area of habitat protected by mitigation conditions = ……..ha **(M)**

OR

(ii) Determine the area of currently suitable habitat which will undergo reduction or removal of one or more essential habitat components.

Area of habitat to undergo reduction/removal = ...ha **(R)**

(iii) Compare the size of the disturbed area of habitat for this species in the subject site (M or D) with the total area of interconnected suitable habitat **(T)** calculated in Section 3.

[disturbed area of habitat (ha) / total area of interconnected habitat (ha)] x 100 = ...% **(P)**
Assuming individuals of the species may be present throughout the total area of interconnected suitable habitat; this figure will give an indication of the proportion of the total local population likely to be affected by the proposed disturbance.
Record these calculations in the relevant column of the Table A.
Go to (a)8

(a)8 Determine the level of impact.
For each species, does the proposal exceed the significance limits in Table 1?

If NO - the proposal is considered **unlikely** to significantly impact on a local population
If YES (ie the proposed activity is **greater than either** of the significance limits) - the proposal is considered **likely** to significantly impact on a local population.

TABLE B - SIGNIFICANT AREA OF HABITAT
This consideration requires assessment of the significance of the area for any threatened species because of:

(a) its *size* relative to the average population density of the species and to the amount of similar habitat (type and quality) remaining in the surrounding locality,
(b) the *quality* of the habitat for each particular species it contains,
(c) its *landscape setting* - it may be part of a corridor, core area and/or large block,
(d) the presence of a *confirmed population,*
(e) its proximity to the *edge of the species' known distribution,* and
(f) the presence of a *disjunct population.*

The significance of the **size** of an area depends on the threatened species concerned and the amount of suitable habitat remaining. A 100 ha area of habitat may be significant for a plant or small mammal (with a density of 0.5 ha / individual), but relatively less significant for a wide-ranging bird (eg. a raptor that may cover 500 ha / individual). This must be combined with a consideration of the size of the area relative to the total amount of that habitat type remaining. If the raptor only has 1000 ha of known habitat left in a locality, the removal of 100 ha of habitat would be highly significant.

The **habitat quality** of an area also affects its importance. A proposal to disturb an area of high-quality habitat is more significant than one for an equal size and landscape position patch containing low-quality habitat. When combined with consideration of the local distribution of habitat, even a relatively small area may be significant if it contains high-quality habitat in a locality where most of the remaining habitat of that type is degraded. A valid assessment of this factor requires an understanding of the essential habitat requirements for all the threatened species being considered, and a reasonable knowledge of the amount and quality of each habitat type in a locality.
An area may also be significant because of its **landscape setting,** which include:

- *Large corridors*: Where a subject site lies between two separate large blocks of habitat, and potentially acts as a link allowing the movement of threatened species between these blocks, the area may be significant independent of its size. This value is additional to considerations under Table C and is detected at a broader scale. The proposal may not completely break a large corridor (so no isolation will result) but the value of the link may be greatly reduced by narrowing, the creation of bottlenecks, or the removal of an important habitat attribute for the species such as the shrub stratum.
- *Core areas*: A site may be highly significant if it is located in the centre or core of a large, relatively undisturbed block of suitable habitat. Core areas have higher habitat value because they are less subject to edge effects and invasion by exotic predators and weeds, and so contribute to the long-term viability of the entire habitat block. Some disturbance-sensitive fauna species in particular may rely on core areas.

- *Large blocks, disjunct populations, species at the edge of their range*: Relatively large, continuous blocks of habitat are generally more important for the long-term survival of a species than small, scattered patches. Any application to reduce the size of a large, continuous habitat patch to less than 100 home ranges (for fauna species) should be treated as significant. Proposals that greatly increase the edge to area ratio of a large block should also be treated as significant. '**Large**' is a relative term and must be judged relative to the amount of suitable habitat for the species remaining in a region. A 20 ha habitat block may be significant in a region that is 80% cleared but will be less so in a region that is 30% cleared. Disjunct populations and species at the edge of their range are considered important as a consequence of their vulnerability to stochastic events and genetic variability.

A final consideration for determining an important area is ***confirmed populations***. In most cases, assessments are dealing with a level of 'probability' that a threatened species and/or its habitat are present. Where a threatened species has **definitely been identified** on a subject or study area, it is considered important.

The above general principles have been used to develop the following assessment procedure:

(b)1 Has the presence of any threatened species been confirmed on the subject site?

If NO, go to (b)2

If YES, the subject site **is an important area of habitat**.

This level of certainty justifies the removal of these areas from the application or retention of the habitat components essential for the species to remain on the site.

(b)2 For each relevant species - use figures calculated in Section 4.
What percentage of the area of available habitat will be modified or removed?

(b)3 From imagery, vegetation mapping, RE mapping. Is the broad macrohabitat type for the species restricted within its distribution as a consequence of being either naturally rare or extensively cleared or modified?
The disturbance of a habitat type that has a restricted distribution or highly threatened is more significant than disturbance of the same amount of an extensive habitat type.

If NO, go to (b)4

If YES, the area **is important habitat** for the species under consideration.

(b)4 Are specific habitat requirements (e.g. tree hollows, food species) which occur on the subject site likely to be equally spread within the surrounding landscape?

If NO, go to (b)6

If YES, the proposal area is **not** considered important for the species under consideration.

(b)5 Is the quality of habitat in the subject site high (intact structure, hollow density etc) in relation to surrounding areas of this habitat type?
Disturbance of an area of high quality habitat is more significant than for the same amount of low quality habitat.

If NO, go to (b)6

If YES, the area **is important habitat** for the species under consideration.

(b)6 Is the subject site part of a landscape-scale corridor of similar habitat (mapping, satellite imagery)?

If NO, go to (b)8

If YES, go to (b)7

(b)7 Will the proposed activity reduce the width of a regional corridor to <500m at any point?

If NO, go to (b)8

If YES, the subject site **is considered important for the species under consideration**.

(b)8 Is the subject site located in the centre or core of a large continuous block of habitat?

If NO, go to (b)9

If YES, the subject site **is considered important habitat for the species**.

(b)9 Is the application area part of a large continuous block of habitat, and if so will the proposal reduce the area of this block to less than 100 home ranges (for a fauna species)?

If NO, go to (b)10

If YES, the subject site **is considered important habitat for the species**.

(b)10 Will the proposal

- increase the boundary to area ratio of a large block, or
- is the area part of a known disjunct population of the species, or
- is it at the edge of (<50km) a species known distribution?

Proposals with more than one of the above characteristics should be considered significant.

If NO, the subject site **is not considered important habitat** for the species**.**

If YES, the subject site **is considered important habitat** for the species.

TABLE C - ISOLATION POTENTIAL

This factor deals with the local connectivity value of an area, ie. whether it is currently contributing to the local movement patterns of any threatened species and if the proposal would significantly disrupt these patterns. Two or more areas of habitat for a threatened species should be considered currently contributing to the local movement patterns if individuals of the species could potentially move from one area to the other/s, i.e. the areas are either connected by continuous habitat or separated by gaps which are considered likely to be crossed by individuals.

(c)1 **Will the proposal cause a major reduction in any of the essential habitat components for the species?**

If NO, then **no area** of habitat is likely to become isolated from currently connected areas of habitat for this species.

If the proposal will not cause major changes to habitat structure or the habitat components required by this species, it can be assumed an individual that could move through the study area before the activity will be able to move through it afterwards.

If YES, go to (c)2

(c)2 From field inspection, and the habitat maps created in Section 3, consider the local landscape pattern:

i) Does vegetation on the study area lie in an area fragmented by previous clearing?

ii) Does the subject site form a stepping stone in a discontinuous corridor?

iii) Will the proposal create a gap between currently connected areas of habitat for any species?

iv) Will the proposal constrict a corridor or reduce a larger connection to corridor proportions?

If NO - to ALL of the above then it is considered no area of habitat is likely to become fragmented or isolated from other areas of habitat for a species.

If YES - go to (c)3

(c)3 I**s** the subject site part of a continuous patch of similar habitat for the species?

If NO - go to (c)6

If YES - go to (c)4

(c)4 Would a continuous connection of suitable habitat remain between the existing unaffected areas (i.e. will the proposal leave a habitat connection)?

If NO - go to (c)5

If YES - no habitat will become isolated for any species and this **consideration is not significant** [however, the width of the retained connection is important]

(c)5 Would the gap between the resulting patches be greater than the movement ability of the species?

If NO - the two currently connected areas are not isolated from each other. It is considered that individuals can still move between these areas. Although some negative impact on habitat connectivity is likely, this factor **would not be considered significant** for that species.

If YES - the proposal will create a gap which is greater than the movement ability of the species. The two areas of habitat **will become isolated** for that species - go to (c)7

(c)6 If the adjacent habitats are **not** the same as the study area, then assessment is complex. It is necessary to consider both species with habitat in the subject site and species with habitat in nearby patches that may use the subject site to move between these other patches. Will the gap between the resulting patches be greater than the movement ability of any species which may use the area?

If NO - the two currently connected areas are not likely to become isolated from each other. Individuals can still move between the areas and this consideration would **not be significant**.

If YES - the proposal will cut all connections and create a gap which is greater than the movement ability of the species, then two areas of habitat **will become isolated for that species** - go to (c)7

(c)7 **Determine the isolation significance for a species**.

The isolation of a currently connected patch of habitat is only significant if the patch has important value for the species; ie. if it could support a resident population of the species, or has the potential to act as a stepping stone to other resident patches.

i) **For fauna** – Is the area of habitat within the subject site large enough to support a resident population of two or more individuals (based on average population density)?

For flora - Is the area of habitat within the subject site > 0.5 ha?

AND

ii) Does the subject site provide individuals with a means of moving between other larger areas of suitable habitat?

If NO – to both conditions above, the likely fragmentation or isolation of habitat as a result of the proposal **is not considered significant.**

If YES – to both conditions above, the isolation and fragmentation of habitat which would result from the proposal **is significant** as the patches to be isolated are large enough to support resident populations, or allow individuals to move between other large patches in the landscape.

5.0 IMPACT MITIGATION CONDITIONS

5.1 WHAT ARE IMPACT MITIGATION CONDITIONS?

If the proposal leads to a positive response to any of the tables for any species, it may require modification through the use of impact mitigation conditions. The conditions applied to a proposal must prevent, or reduce the likely level of, impacts on all species to the limits outlined in this guideline. If impact reduction or prevention is not possible, the proposal is considered likely to have a significant impact.

5.2 WHEN ARE CONDITIONS APPROPRIATE?

Impact mitigation conditions are applied when a proposal exceeds a limit. If a proposal **cannot** be modified to prevent significant impacts, moving the site or entering into an offset arrangement are the only options.

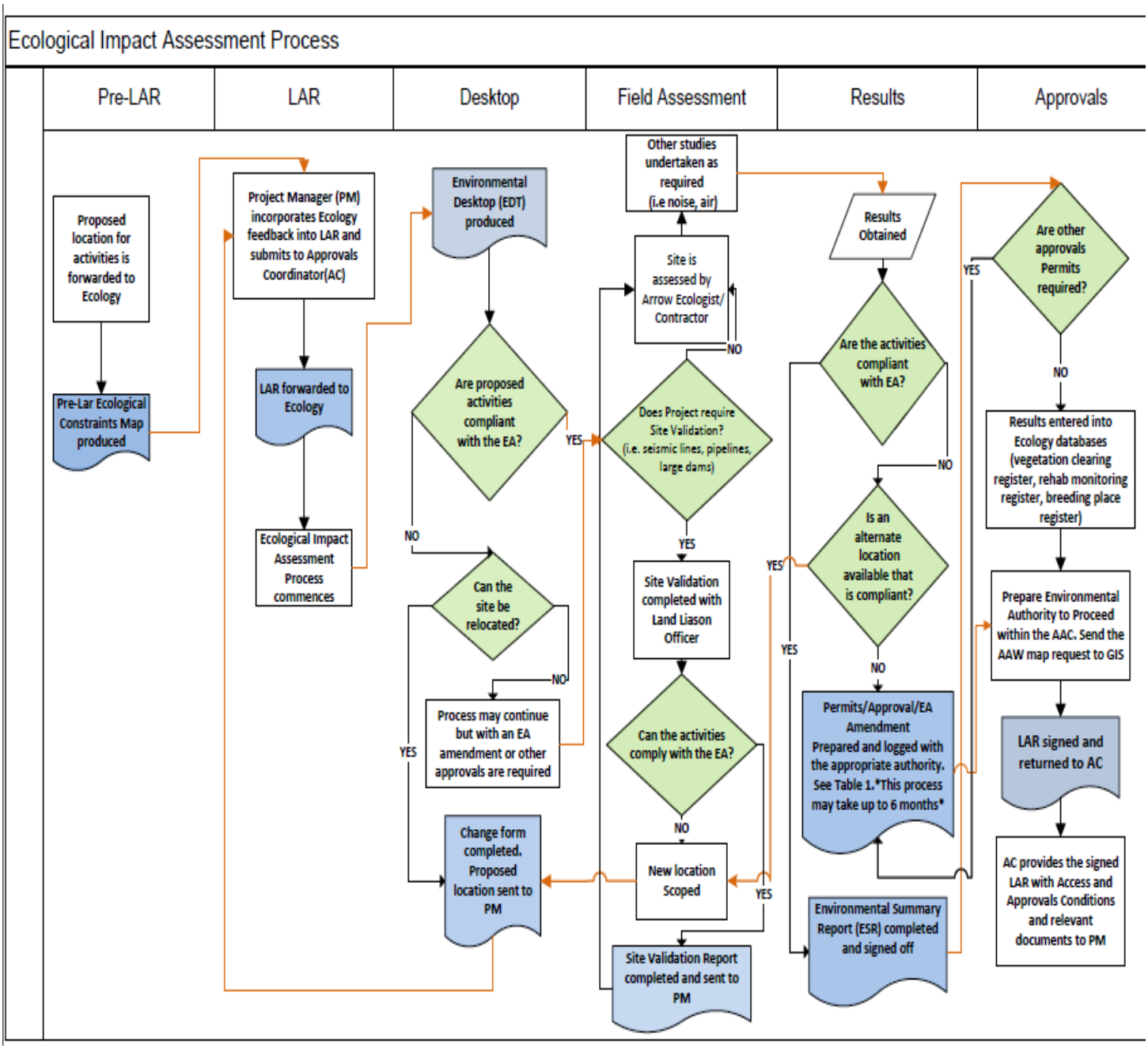
5.3 WHAT MUST CONDITIONS DO?

Each condition should be: specific, measurable, achievable, reasonable and time-specific. Conditions imposed to mitigate the impact of a development on a threatened species must be demonstrated as successful for that species under similar circumstances.
In addition, modifications or mitigation prescriptions relating to threatened species must achieve the following:

1. Reduce likely impacts to a level where essential habitat features will be excluded or not significantly impacted on, and
2. Reduce the area to be affected to below a significant level or exclude habitat from the proposal, and

Not result in conditions that will make the basic intent of the proposal impossible. For example, if the proposal is to construct a pipeline, then a condition to retain all mature trees along the route is incompatible with the development.

Attachment 3- Ecological Impact Assessment Flow Chart Process



Purpose

This guideline outlines how native terrestrial and freshwater fauna should be managed on Arrow Energy controlled work sites during site preparation, construction, operation and decommissioning activities. It establishes the minimum requirements to ensure compliance with applicable laws and regulations and the Arrow Energy Health, Safety and Environment Management System (HSEMS). This guideline has been prepared to support implementing the *Fauna Management Procedure*[1] and should be read in conjunction with this procedure. Additional documents are required to implement this guideline, including related guidelines, registers, templates and forms.

This guideline contains mitigation measures that are listed in the generic Species Management Program (SMP) issued to the company for tampering with animal breeding places for most least concern (ie. common) fauna species. The generic SMP is a requirement of the *Nature Conservation Act 1992 (Qld)* (NC Act) and section 332 of the *Nature Conservation (Wildlife Management) Regulation 2006* and therefore the measures described in this guideline are mandatory for Arrow employees and recommended for contractors who shall have equivalent guidelines. An additional SMP is also required to tamper with animal breeding places of conservation significant species.

Scope

This guideline aims to avoid, minimise and mitigate disturbance to native fauna and their habitats that will be impacted by constructing, operating and decommissioning coal seam gas (CSG) infrastructure. This guideline applies to all work sites where Arrow maintains principal responsibility.

This guideline does not apply in emergency situations where people and/or property are threatened; however, the relevant Arrow Ecologist in each region should be contacted to discuss options for fauna management in such situations, where possible.

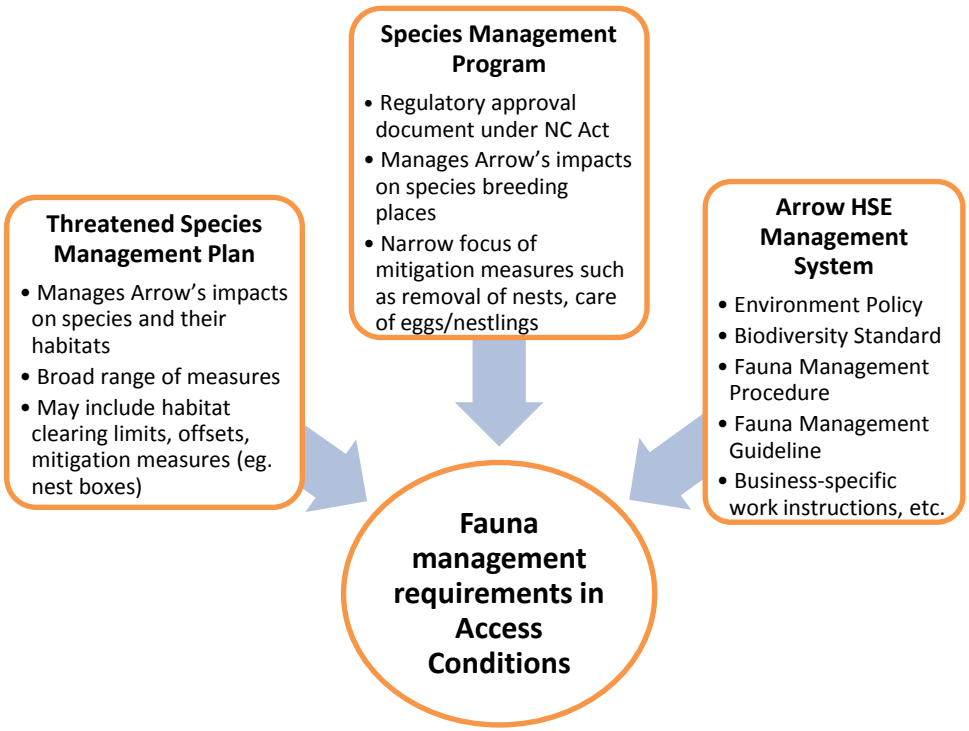
Responsibilities

Title	Responsibilities
Corporate Environment Manager	▪ Ensure systems are in place to avoid or minimise harm to fauna and fauna habitat features at Arrow Energy controlled work sites. ▪ Ensure adequate training is available to personnel who are tasked with implementing fauna management activities.
Corporate Environment Adviser – Biodiversity & Fauna	▪ When appropriate, consult with the regulator where breeding places of species that have heightened community interest have been identified on a site.
Asset Manager or nominated delegate	▪ Comply with fauna management conditions for the asset and tenements under their responsibility.
Project Manager	▪ Ensure the design and implementation of projects minimises impacts on fauna and fauna habitats.

	▪ When the Access Conditions (AC) include a requirement for a fauna spotter-catcher (FSC), ensure a FSC is booked and available for the works. ▪ Providing all resources required to manage fauna on their projects.
Site Supervisor	▪ Ensure all relevant staff and contractors are aware of the location of any habitat, significant fauna or micro-habitat features identified in the AC and the requirements of this guideline through project kickoff meetings and/or site inductions as appropriate. ▪ Manage and oversee activities conducted on the work site to ensure impacts to fauna and their micro-habitat features are avoided, minimised or mitigated according to the AC and other regulatory conditions. ▪ Check that the FSC has the required permit (i.e. holds a Rehabilitation Permit or signed authorisation from permit holder), certificates and safety documentation whilst on the work site. ▪ Comply with all reasonable directions of the FSC regarding minimising harm to fauna and fauna habitats. ▪ Ensure that the FSC signs onto the JSEA for clearing operations. ▪ Ensure all areas on or near the site, and features demarcated for protection, are clearly marked to indicate their protection status. ▪ Report all interactions with fauna in accordance with the *Incident Management Procedure*[2] and *Statutory Notification Guideline*[3].
Fauna spotter-catcher (FSC)	▪ The FSC shall be familiar with, and comply with, the *Australian code for the care and use of animals for scientific purposes* and the *Code of Practice: Care of Sick, Injured or Orphaned Protected Animals in Queensland*. ▪ Operate with valid permits for the location where the work is being conducted and the tasks involved. ▪ Identify and demarcate areas of fauna habitat features (eg. habitat trees, significant species / communities, rock piles, coarse woody debris, etc) in the field. ▪ Identify actual or potential breeding areas of fauna species and ensure adequate protection or relocate the species and their breeding place, where appropriate. ▪ Ensure animals requiring removal and relocation are protected during vegetation clearing and other site preparation activities. ▪ Identify the closest veterinary clinic and wildlife carer (if available in the locality) to the work site including after hours phone numbers. ▪ Comply with all safety directions given by the Site Supervisor and understand, sign on and comply with the requirements of the contractor's Safe Work Method Statement for clearing operations. The Job Safety and Environment Analysis (JSEA) must include communications protocols between the FSC and plant operator.
Ecologist (Arrow employee or contractor)	▪ Must be suitably qualified and experienced in fauna habitat assessments. ▪ Where appropriate, may direct and coordinate FSC scope of work on a work site. ▪ Undertake ecological impact assessments on a work site to establish whether fauna or their habitat will be impacted by a project. ▪ Populate the AC to record what mitigation and actions will be required on the site.

	▪ Populate the AC to include a list of all permits relevant to fauna required to undertake the works. ▪ Clearly articulate fauna management related conditions to site staff and contractors at project kickoff and/or site induction meetings. ▪ Provide advice on design aspects of construction to reduce impacts to fauna and fauna habitats. ▪ Provide site specific information regarding species of conservation significance to field staff. ▪ Remove and relocate reptiles under a Damage Mitigation Permit (DMP). ▪ Undertake investigations of fauna incidents reported on site when required.
Principal Ecologist	▪ Ensure that the company holds all licenses, permits, approvals and plans relevant to fauna management to comply with the NC Act, excluding individual site-based approvals and LNG project approvals.
Plant operator	▪ Comply with all reasonable directions of the FSC, including stop work requests.
All employees and contractors	▪ Implement site activities in accordance with this guideline. ▪ Comply with reasonable directions of the Arrow Ecologist, consultant ecologist or FSC with regards to fauna management. ▪ Shall not approach, attempt to capture or handle native fauna whilst on a work site unless directed to do so by the Arrow Ecologist, consultant ecologist or FSC. ▪ Report any unidentified fauna or habitat features that may be disturbed by the proposed activities to the Site Supervisor. ▪ Report damaged or inadequate fauna management controls (eg. grids, gates, fences, ramps, pit or pipe covers etc) to the Site Supervisor. ▪ Comply with the AC and relevant approval documents, guidelines, procedures and inductions. ▪ Ensure incidents involving fauna are reported to the Site Supervisor.

Process	Actions
Design and planning	▪ Impacts to fauna and habitats can be dramatically reduced by appropriate planning. To limit the impacts on fauna, infrastructure shall be preferentially sited away from important habitats such as: intact remnant vegetation (including native grasslands); habitat for conservation significant species; and watercourses and wetlands. ▪ Fragmenting habitat at a site should be avoided. Infrastructure, particularly linear projects, should be constructed away from patches of remnant and mature regrowth vegetation to limit fragmenting or isolating blocks of vegetation. ▪ To minimise impacts to fauna, selecting sites for infrastructure shall follow the hierarchy in **Attachment 1**. ▪ Minimal disturbance techniques shall be considered to minimise impacts to fauna habitat values, such as cracking soils. ▪ Some infrastructure used for CSG activities pose specific hazards to fauna as a consequence of their inherent qualities. Mitigating these hazards to reduce their impact on wildlife should be undertaken, where possible.

Process	Actions
	a) Fauna are attracted to natural waterbodies that may exist adjacent to infrastructure and artificial dams and water infrastructure. b) Lighting around infrastructure attracts insects; and thus microbats, nocturnal birds and amphibians. c) Open trenches may trap many different types of terrestrial fauna. d) Roads and tracks may create barriers to fauna movement. Roads also provide a hazard for nocturnal and diurnal species where they can be killed by moving traffic.
Project approvals and conditions	▪ The AC for each work site shall contain specific conditions for managing native fauna and may include, but are not limited to: a) avoiding significant habitat features b) identifying habitat trees to be retained and protected c) identifying hollows and hollow logs to be salvaged and relocated d) identifying nests, burrows or possum dreys to be avoided at certain times or relocated in accordance with an SMP e) other animal breeding places requiring mitigation in accordance with an SMP f) fencing or other mitigation measures. ▪ Any additional permits (such as approved plans, programs, permits or licenses) required to interfere with threatened fauna habitat or other species of conservation significance must be included with the AC document, attached to the Approvals Package (AP) and adhered to for the life of operating the site. **Figure 1** identifies the main sources of fauna management measures to be included on ACs.  **Figure 1 Sources of fauna management conditions included on ACs**
Training and awareness	▪ All employees and contractors shall be inducted onto the AC for the

Process	Actions
	work site, which will include fauna management conditions specific to the work site. ▪ Where required by the AC, the FSC and/or ecologist shall attend a pre-start toolbox meeting with the Site Supervisor and/or contractor representative and the plant operator to highlight site specific risks to fauna. The Site Supervisor, FSC and plant operator shall develop protocols for safe operating distances and communicating between the parties to ensure that clearing operations and fauna spotting activities are undertaken safely. Any JSEA's relevant to the works must reflect this information and are to be updated should any changes occur (this will include the FSC and plant operator JSEA's). ▪ All FSCs and ecologists engaging in fauna management activities on an Arrow work site shall be suitably qualified and experienced as defined in the *Fauna Management Procedure*.
Fauna management prior to site disturbance and vegetation clearing	▪ **Attachment 2** provides a process flow for management of fauna and fauna habitats prior to starting activities that may result in habitat disturbance. ▪ Pre-clear survey and walk-through assessment of a work site shall be completed by a suitably qualified and experienced person (i.e. Arrow Ecologist, consultant ecologist or FSC). ▪ A pre-clear survey shall be undertaken in accordance with the *Fauna Survey Guideline*[4] and must be completed at least the day before clearing commencing. ▪ The AC and Ecological Summary Report (and any maps and coordinates (in GDA94 datum)) shall be provided to the pre-clear surveyor, identifying habitat features to be removed or retained. Additional habitat features may be identified by the surveyor during the pre-clearing survey. ▪ Identified habitat features shall be marked on maps or construction drawings and in the field, where required (with tape, spray paint or similar). Features to be retained (such as habitat trees) shall be protected and demarcated (eg. using star pickets and construction flagging tape or other appropriate temporary barricades, where required). The location of the habitat features and specific methods to be employed shall be communicated to the Site Supervisor and plant operators. ▪ The FSC shall discuss an appropriate clearing strategy with the Site Supervisor and plant operator to manage fauna prior to and during clearing. ▪ Large mature trees (including dead trees) shall be identified and retained to provide fauna habitat (e.g. roosting, foraging and breeding opportunities) unless their removal is warranted for safety or maintenance reasons. Trees, particularly Eucalypt, Angophora and Corymbia species, often have hollows that are valuable habitat for glider, bird and bat species. ▪ If a tree has been identified for retention, but must be felled at a later date, documentation shall be prepared that shows adequate justification for removal of the tree (eg. record of site conversation). This documentation shall be provided to the Project Manager, who shall retain the information in the project file.

Process	Actions
Fauna management during construction	The following mitigation measures shall be undertaken to minimise impacting fauna during the construction phase of a project: ▪ Implementing all conditions specified in the AC for managing fauna, habitat retention or fencing. ▪ Ensuring a FSC is present as stipulated in the AC. ▪ The FSC shall conduct a search of the area proposed to be cleared of vegetation to remove residual fauna and to check occupancy of identified habitat features by fauna, immediately prior to vegetation clearing commencing (walk-through assessment). If animals are detected, the FSC shall assess the most appropriate method to avoid or minimise impacts to the individual. ▪ Where possible, all fauna must be allowed to move off the site on their own accord. If forced relocation is necessary, the FSC shall assess the most suitable method to capture and relocate the fauna. ▪ The following hierarchy to manage fauna and habitat features shall be employed from the most preferred option to least preferred option: a) **Avoid** – the habitat and/or feature containing the fauna species shall not be disturbed. In some circumstances the FSC may determine in consultation with an Arrow Ecologist and Project Manager that interfering with the habitat and/or feature would have unacceptable impacts to fauna. Such circumstances may include nests with young, where interference may result in nestlings being abandoned by their parents. b) **Minimise** – ▪ minimise interfering with the habitat feature until the fauna has moved away on its own. In most cases, the presence of adjacent working plant will provide a disturbance stimulus for fauna to move to adjacent habitat (i.e. birds and large terrestrial species). Habitat features known or suspected to contain fauna may be hit, stimulating the fauna to vacate the tree or log. This may involve gently bumping the tree or hollow log with a sledgehammer or plant equipment to move fauna. If the species is a koala (*Phascolarctos cinereus*) the tree where it is located shall not be felled until the animal has moved away. This may require the tree being left standing overnight. ▪ habitat features shall be preferentially cleared and relocated to minimise impacts to sheltering fauna species. This may involve pushing rather than cutting trees, felling trees on to previously felled timber to cushion the impact, and lifting hollow logs rather than rolling them. Hollow-bearing branches or logs shall be checked by the FSC prior to cutting. c) **Mitigate** – once the habitat feature has been cleared or relocated, the FSC shall inspect the habitat feature for any sheltering fauna. If fauna are discovered, then the FSC shall assess the most appropriate method to extract the fauna. This may involve cutting hollow limbs from the felled tree, gently breaking open hollow logs or carefully excavating soil cracks. The habitat feature may remain untouched if the FSC considers that the fauna is uninjured and

Process	Actions
	could move away on its own. ▪ Laydown areas, pits, dams, open trenches and stockpile areas should be fenced as soon as practicable. Temporary fencing to exclude small fauna, reptiles and amphibians around stockpiles may be used as an interim measure before permanent fencing is erected. Stockpiles should be located away from habitat such as remnant vegetation and preferentially on previously disturbed areas, if available. ▪ All personnel should scan laydown and stockpile areas and their surrounds for fauna before moving machinery or materials. Snakes and other reptiles may be found on warm exposed surfaces or sheltering below stacked materials. ▪ Fence and/or screen all construction sites as soon as possible to exclude and prevent the entrapment of fauna, and limit introducing or spreading pest fauna species. ▪ Minimise light spill from project activities to reduce disturbance to nocturnal fauna. **Watercourse Crossings and Wetlands** ▪ The value of permanent and temporary watercourses and wetlands as possible breeding habitat for aquatic fauna including platypus *(Ornithorhynchus anatinus*), turtles, frogs and fish must be considered. Where appropriate and practicably safe, an assessment must be undertaken of these values in view of impacts and mitigation strategies. Where the assessment identifies a high risk to conservation significant species or habitats, a management plan must be completed by a suitably qualified and experienced person who has demonstrated experience in the management of the target fauna species. ▪ Avoid construction activities in waterbodies frequented by an important population of a listed migratory species. ▪ Implement the conditions of waterway barrier works permit or disturbance of fish habitat permit, if required. ▪ Design flumes used to construct permanent watercourse crossings to a suitable size to maintain flows and enable fish passage. Protect the bed of the watercourse from scouring at the site of the downstream discharge of any flumes or pipes.
Felling large habitat trees	▪ When large habitat trees have been identified in an area to be cleared and avoidance is not practicable, the FSC should first check the habitat tree to determine the presence or otherwise of fauna. If fauna are observed then an elevated work platform or cherry-picker should be used in conjunction with a chainsaw operator and the FSC (or a FSC who holds a current training qualification in use of chainsaws). This step-by-step process is detailed below (modified from Nottidge 2013): a) The FSC (with chainsaw operator unless the FSC is a qualified chainsaw operator) will inspect each visible hollow or potential breeding place (e.g. nest) identified in each tree using the cherry-picker. This is usually carried out by simply looking into hollows and nests (with the assistance of a small torch); however, fibrescopes may also be useful for deep hollows. b) If fauna is located within a hollow, a piece of towel or rag should be firmly placed in the entrance to prevent the wildlife from escaping,

Process	Actions
	as arboreal fauna may attempt to flee the nesting/denning hollow due to a perceived threat. c) Once the hollow entrance has been secured the arborist will then remove the entire hollow limb off below the cavity where the branch remains solid. In circumstances where a hollow continues into the main stem of the tree, the arborist should carefully cut a small window into the hollow, allowing the FSC to plug the hollow above and below the window, then the hollow limb is removed and lowered to the ground in sections. d) When the fauna has been safely secured within its hollow, the entire limb will then be placed in the cherry-picker bucket or lowered to the ground using ropes (depending on the size of the limb). e) This limb will be placed in a cool, quiet location until translocation to the recipient habitat site, when at dusk of the same day the hollow entrance will be re-opened to allow the fauna to emerge of its own accord. Alternatively (and preferably) hollow limbs shall be erected and secured in appropriate recipient habitat in a similar orientation and slope to their original position.
Capturing, handling and release of fauna	▪ Only suitably qualified and experience people shall attempt to capture and handle fauna, and only when authorised under the relevant permits (ie. Damage Mitigation Permit, Rehabilitation Permit). Where it can be shown that engaging a suitably qualified and experienced person to capture injured fauna was not practical or would excessively delay treatment of the animal, then all employees and contractors may capture an animal if they are confident and competent and it is safe to do so. This is to ensure that an animal's welfare is provided for. ▪ Animals shall only be captured in the following circumstances: a) If it is at risk of injury or mortality due to planned disturbance of habitat for which approval has been given (eg. AC) b) If it has been injured, or suspected to have been injured, through disturbance of habitat c) If it has been injured through operation of vehicles, machinery, plant or structures (eg. dams) on Arrow work sites d) If it has been injured through an Arrow vehicle impact on public roads e) If it is a species that presents a risk to people or property (eg. snakes) ▪ An equipment and documentation list for capturers is provided in **Attachment 3**. ▪ The capture and handling of the animal shall not be attempted if the capture would put the capturer and/or bystanders at an unacceptable risk of injury. The capturer may ask bystanders to move away at least 20m from the animal being captured. A SLAM (Stop, Look, Assess, Manage) card should also be completed if the capture is not part of a usual activity (eg. spotter-catcher activities). ▪ The capture and/or handling of the animal shall be conducted in a way that minimises injury and stress to the animal. ▪ If an animal has been, or is likely to have been injured, then it should be captured and contained in a suitably sized container, hessian bag

Process	Actions

or pet carrier and transported to the nearest qualified veterinary surgeon for assessment. Methods to capture snakes are detailed below.

- In general, fauna shall not be contained for longer than two to four hours. If prolonged containment is necessary because it is difficult to access storage facilities (i.e. veterinary surgery, wildlife carer premises) or the animal must be released at a certain time (eg. nocturnal fauna), food and water shall be provided and requirements in **Table 1** will need to be complied with, as far as practicable.

Table 1: Approximate holding times for the short to medium term (4-24 hours) containment of adult animals (Hanger & Nottidge, 2008)

Species	Water (hours)	Food (hours)	Maximum time in bag	Maximum time in short-term enclosure (eg pet carrier, bag)
Macropod	4	12	4 (*)	4 (*)
Koala	4	4	2	4
Echidna	4	8	2	24
Bandicoot	4	8	2	24
Possum / glider	4	8	2	24
Rodent	4	8	2	24
Insectivorous bat	4	4	12 (**)	12
Dasyurid (quoll, planigale, dunnart)	4	4	2	24
Flying fox	4	8	2 (***)	12
Wombat	4	8	n/a	4
Snake	24	7 days	24	24
Lizard	24	2 days	24	24
Turtle	24	2 days	24	24
Frog	12 (#)	24	8 (#)	24

* With sedation/anaesthesia only
** Only if fed and watered every 4 hours
*** Calico bags containing flying foxes must be hung rather than laid down.
# Containers for frogs must prevent drying. Plastic boxes with ventilation are preferred.

- Once assessed and released by a veterinary surgeon, a suitably qualified and experienced person shall be responsible for transporting the fauna to a licensed wildlife carer, if it is to be rehabilitated. If the fauna is to be released into the wild, the suitably qualified and experienced person shall discuss possible release locations with an Arrow Ecologist and government wildlife officers, if it cannot be released at the site or immediate surroundings where it was collected. Suitable sites to relocate animals will be limited to those areas where Arrow has land access arrangements in place or publically accessible areas (eg. road reserves, stock routes).

Capturing snakes

- Capturing snakes shall only be conducted by competent people (ie. suitably qualified and experienced people who have had formal training in capturing and handling snakes) and only when it is safe to do so.
- Snakes shall only be caught using the following process:
  a) Using a snake hook and hoop bag, place the bag in front of the snake and coax into the bag using the hook.
  ****NOTE: Capture of snakes by grabbing the tail ("tailing") is not permitted on any Arrow work site**.**

Process	Actions
	b) Once the snake has been caught, seal the snake in the bag by holding the hook at the neck of the bag and twisting the handle several times. A 'U-shape' bend can then be made of the twisted bag and sealed with a thick rubber band. The bottom of the bag containing the snake can then be placed into the top of the bag ready for travel. For long distance travel, the bag should be removed from the hoop and placed in a sealable container ensuring that small holes have been pierced through the lid. c) At the release site, attached the bag back onto the hoop and remove the rubber bands, ensuring that the bottom of the bag is never in contact with your body. Let the bag untwist. d) Place the hoop edge on the ground and drop the handle away from yourself. Move around to the handle end, hold the bottom of the bag with the attached tabs and put your foot on the handle. Gently lift up the bag and hoop towards your body and back slowing away from the snake. e) Record details of the capture and release locations, including coordinates, facility/site, habitat type and species caught.
Managing breeding places and eggs	▪ The following fauna management practices will be considered, and where practicable, will be applied to all activities independently or together, to minimise disturbing breeding animals and/or their young (in order of preference): a) Option 1: Avoid the need to tamper with animals by assessing the site at the project's concept phase for animal breeding places and sympathetically considering them in planning and project design (including route location) b) Option 2: Avoid the need to tamper with animals by timing operations (avoiding breeding seasons to allow young to mature and leave breeding places, delaying operations if breeding identified) c) Option 3: Remove or relocate a breeding place without eggs or young d) Option 4: Remove or relocate a breeding place and place eggs/young with a wildlife carer/facility e) Option 5: Remove or relocate a breeding place and destroy/terminate eggs. ▪ If the breeding place is of species listed as threatened, near threatened or special least concern under state or Commonwealth legislation or is a colonial breeding species, then additional measures must be employed as detailed in an approved SMP. Some species-specific measures are included in **Attachment 4**. ▪ If the FSC decides that the breeding place must be removed, any eggs/young in the breeding place must be handed over to a licensed wildlife carer/facility. It is preferable to allow eggs to hatch and/or young to mature and move away from a breeding place. As a last resort, eggs may be destroyed. ▪ There are two acceptable methods for destroying or terminating eggs: a) quickly breaking an egg and crushing its contents, or b) reducing the temperature of the egg to less than 4°C for at least 4 hours.

Process	Actions
	▪ Where the destruction of a breeding structure will impact on the future breeding success of an animal (for instance, a breeding season will be foregone while a large nest is reconstructed, or no or limited potential breeding structures exist in the vicinity), and where a suitably qualified and experienced person deems it appropriate, the necessary support to allow for relocating the breeding structure must be provided. ▪ Removal and relocating breeding structures must be undertaken by suitably qualified and experienced persons and advice sought where necessary.
Managing threatened fauna species	▪ Additional measures must be implemented when fauna species listed as threatened (extinct in the wild, critically endangered, endangered or vulnerable) or near threatened under the NC Act and/or EPBC Act have been identified as known or likely occurrences on a work site. ▪ If a threatened species management plan does not exist for the site, one shall be prepared and implemented on the work site prior to works commencing for each identified threatened or near threatened species. ▪ The threatened species management plan must include any conditions of approval, commitments or obligations for managing that species. ▪ Breeding places of threatened and near threatened species shall be managed according to the measures listed in **Attachment 4**.
Calling stop-work on operating plant	▪ If required, the FSC shall inform the plant operator, Site Supervisor or their representative to stop work because fauna needs to be managed by capturing and assessment. All operating plant within the immediate vicinity of the fauna incident (ie. plant that poses a risk of injury to the FSC) must stop operating until the incident has been appropriately investigated and managed in consultation with the FSC and Site Supervisor or Project Manager, if required.
Fauna management during pipeline construction	**Trenching** ▪ Stage activities to minimise the time a trench is open. The length of open trenches should be kept to a minimum as far as practicable. Laying and burying pipes should occur as soon as possible. ▪ The FSC must inspect open trenches daily, preferably within 2 hours of sunrise, for trapped fauna and remove and relocate fauna as required. ▪ Relocating fauna may be the most practical method to reduce animal mortality during right of way clearing, right of way access track construction and trenching. ▪ Temporary barriers or fences to restrict fauna access should be erected around open excavations (including trenches), wherever practicable. Open trenches must be checked by a FSC prior to laying pipes or backfilling. ▪ Exit points for fauna should be placed along the trench at regular intervals (every 250m or at one end of each trench if shorter in length) when within 1km of identified habitat areas. Exit points may be created by digging a sloped (less than 50% grade) ramp approximately 0.5m – 1m wide. Barrier mesh or branches may also be placed on the ramp to facilitate escape. ▪ Hessian sacks (or similar) filled with sawdust and wetted should be placed within the trench, in between the ramps. **Stringing and welding**

Process	Actions
	▪ Pipes should be capped and fauna crossing points should be provided at the close of each day. ▪ Daily scanning on or around the pipes and their surrounds for fauna should be undertaken by all personnel, particularly for snakes. ▪ Any fauna should be allowed to move off on their own accord, if possible. Where this does not occur, the FSC should relocate the animal. **Laying pipe and backfilling** ▪ Prior to conducting any works, all pipes, trenches and surrounds should be checked for fauna. **Decommissioning** ▪ Right of ways are to be rehabilitated according to the relevant approval conditions (eg. EA or otherwise) to allow unhindered fauna crossings.
Fauna management for dams	**Construction and operation** ▪ Fauna exclusion fencing must be installed around all new dams (**Attachment 5a**). ▪ Dams must be designed to have an escape point for fauna and measures to facilitate escape (eg. critter mats, floating items). ▪ Other measures to prevent injury or death to fauna must be considered at the design stage. **Decommissioning** ▪ Where a dam is proposed to be drained, an aquatic ecological assessment of the dam must be completed by a suitably qualified and experienced aquatic ecologist. The results of the assessment will determine whether a specific management plan to manage aquatic species (eg. fish, turtles, invertebrates) is required. ▪ The management plan should details the methods to extract fish and aquatic fauna from the dam and how the fauna will be managed ethically and humanely. Methods may include capture and relocation (eg. for native turtles), euthanasia (eg. for exotic and native fish) or other end points.
Fauna management for facilities	**Facilities (eg. operating plant, offices, camps, warehouses, etc)** ▪ Facilities should be designed and operated to avoid causing injury or fatality to fauna. This may include: a) Ensuring all food scraps and waste are contained within appropriately sized skips or bins with lids. Storage devices must be emptied regularly in a manner that does not involve disposal to on-site trenches or waste dumps. b) Doors are kept closed to prevent ingress of fauna, wherever possible. c) Install fauna exclusion fencing around facilities. d) Install fauna signage along access roads and tracks where fauna may be present, ie. '*Slow Down – Wildlife Crossing*'. Minimise light spill from facilities to reduce disturbance to nocturnal fauna
General mitigation measures	▪ Fauna-friendly and fauna exclusion fencing specifications are provided in **Attachments 5a** and **5b**.

Process	Actions
	▪ Implement speed limits on Arrow controlled roads and tracks to reduce the potential for vehicle collisions with fauna.
Emergency situations	▪ In an emergency situation, public and staff safety considerations will take precedence. Where possible, Arrow will discuss options with government wildlife officers on a case-by-case basis. The approved entity will notify in writing (via email) the relevant government wildlife officer(s) of actions taken under this clause within 48 hours.
Monitoring and reporting	▪ The *Fauna Incident Process Map*[9] should be used to determine the reporting requirements for any interaction with native fauna by Arrow personnel and contractors. ▪ During vegetation clearing, information on fauna and obvious fauna breeding places impacted by clearing works (i.e. incidents that have involved the FSC) shall be provided on a regular basis to the Arrow Ecologist and staff involved in the project. ▪ If a fauna species listed as threatened or conservation significant under state or Commonwealth legislation is identified on a work site and had not been considered at the ecological impact assessment stage, the FSC will contact the Site Supervisor and Arrow Ecologist as soon as practicable. The FSC, in conjunction with the Arrow Ecologist will complete an assessment of the potential impacts of continued clearing on the species and its habitat and will determine whether mitigation measures should be implemented. ▪ Photos of fauna and habitat features from the work areas should be provided to site personnel and/or displayed around the site to help staff with fauna identification. ▪ On completion of the work, the FSC will provide a report within two weeks outlining: a) any fauna sighted, relocated or injured b) any obvious fauna breeding places tampered with c) any notable actions arising. ▪ The report will also include completion of the following: *a) Fauna Observations and Incidents Register*[8] b) *Breeding Places Register*[9].

References

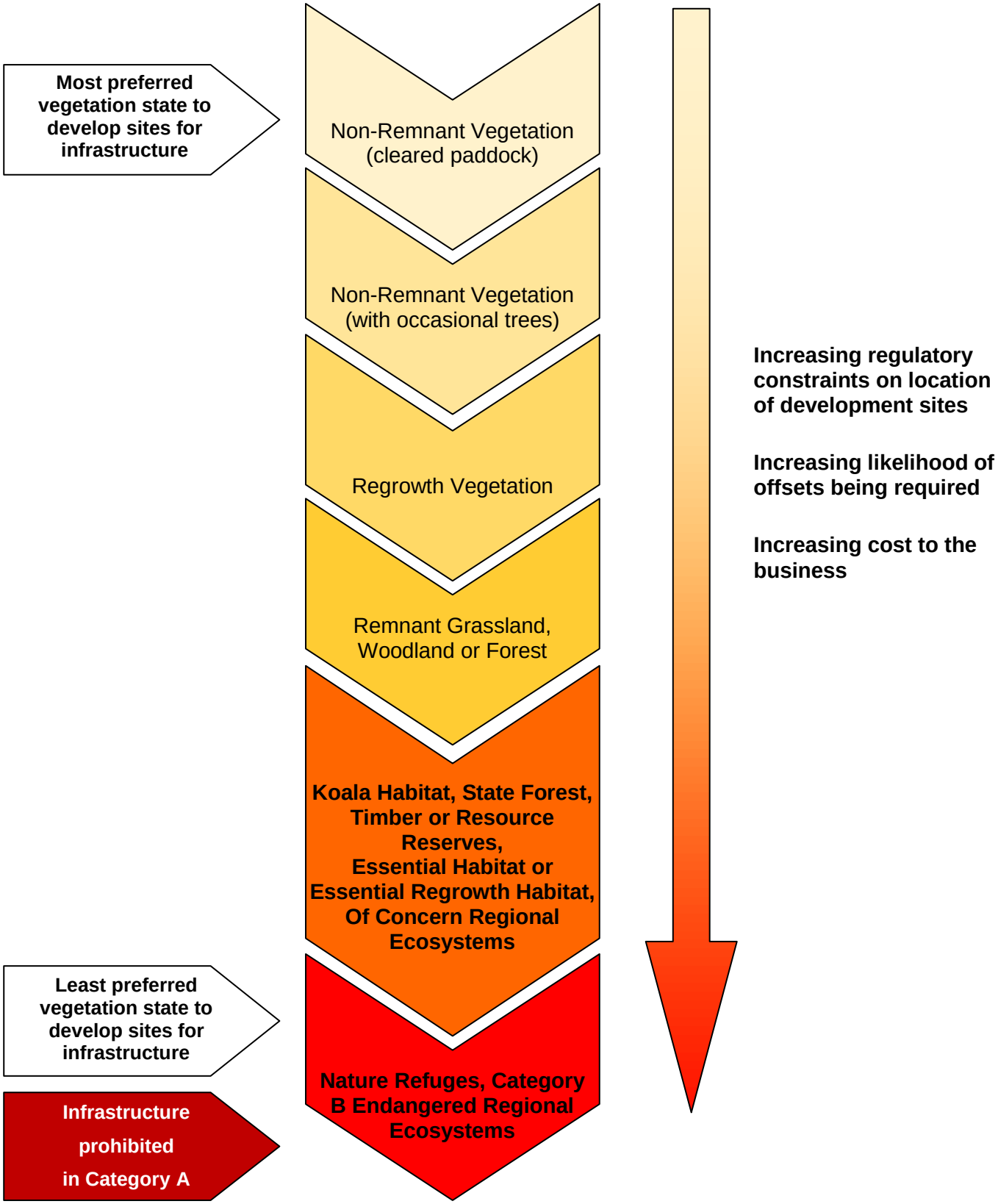
Referenced Documents	
Reference	**Document Title**
1	99-H-PR-0075 Fauna Management Procedure
2	99-H-PR-0112 Incident Management Procedure
3	99-H-GDL-0029 Statutory Notification Guideline
4	99-H-GDL-0061 Fauna Survey Guideline
5	99-H-GDL-00102 Site Preparation and Vegetation Clearing Guideline
6	99-H-PR-0010 Incident Reporting and Recording and Investigation Procedure
7	Fauna Observations and Incident Register
8	Breeding Place Register
9	Fauna Incident Process Map

Supplementary Information Sources

- *Australian code for the care and use of animals for scientific purposes* (National Health and Medical Research Council, 8th Edition, 2013)
- *Code of Practice: Care of Sick, Injured or Orphaned Protected Animals in Queensland* (Department of Environment and Heritage Protection, 2013)
- Nottidge, B. 2012. *Vegetation Clearing Procedure*. Greenleaf Ecology, May 2012.
- Hanger, J. & Nottidge, B. 2009. *Code of Practice for the Welfare of Wild Animals Affected by Land-Clearing and other Habitat Impacts and Wildlife Spotter/catchers*. Draft

Document Control			
Revision	**Revision Date**	**Reviewers**	**Approver**
1	31/10/2013	H. Wood	J. Flint

Attachment 1 Preferred Vegetation States for Locating Development Sites



Biodiversity offsets must be provided for unavoidable losses of biodiversity values where required under legislative or Environmental Authority obligations (refer to the Environmental Offsets Assessment Guideline).

Attachment 2 Process Flow for Assessment and Identification of Conservation Significant Fauna and Fauna Habitat

Ecological Impact Assessment

- Completed according to the Ecological Impact Assessment Procedure (99-H-PR-0081).
- Involves desktop assessment, field verification (if required) and field assessment ("pegging party") to identify ecological constraints on a proposed development site.

Threatened Species Survey

- Completed if there is a high likelihood of a threatened or conservation significant fauna species presence on a site.
- An appropriate level of survey effort is completed according to the Guideline - Fauna Survey (99-H-GDL-0061).

Pre-clear Survey

- Surveys to identify the presence of constraints and sensitive areas within a proposed clearing footprint and vicinity. These surveys can be undertaken to identify and mark potential breeding places and habitat trees, and may include fauna trapping for fauna load reduction. They are generally more detailed at the local level than the more broadscale threatened species surveys.
- Undertaken at least 24 hours prior to clearing.

Walk-through Assessment

- Assessments undertaken immediately prior to clearing, to identify whether fauna is present that needs to be avoided or relocated, whether habitat trees or breeding places are being utilised, or other features need to be retained.
- Undertaken on the morning of the scheduled vegetation clearing date.

Spotter-catching Activities

- FSC continues searching for fauna and breeding places missed in walkthrough assessment.
- Rescue of animals injured during clearing activities.
- Relocation of habitat features (eg. hollow logs, etc.).

Attachment 3 Equipment List for Capturing Fauna

The following equipment and documentation is considered mandatory for persons capturing fauna on Arrow work sites:

- Copy of approved Rehabilitation Permit or signed authorisation from permit holder
- Copy of all relevant induction cards: GIQ Coal Surface Generic induction, Arrow Energy CSG induction, Land Access induction, Queensland Construction induction ("white card")
- A site specific JSEA for any site conditions not identified in the *99-H-PL-0013 Arrow Field Work Safety Management Plan* or contractor's Safety Management Plan
- Minimum Personal Protective Equipment – hard hat with brim, long-sleeved high visibility shirt (or vest), long pants, steel-capped boots, gloves, safety glasses and veil
- Portable UHF radio (two-way)
- Mobile phone and/or satellite phone if poor mobile coverage
- Binoculars
- Torch / spotlight
- Pet carry cages and bedding
- Wrecking bar
- Hessian bags
- Snake hook, hoop bag and thick rubber bands
- Drinking water
- First aid kit, including compression bandages for snake bites
- Spray paint or flagging tape or various colours
- Driver competencies and four wheel drive vehicle outfitted to specifications as described in *99-H-PR-0043 Journey Management and Driver Safety*.

The following equipment is considered desirable, although is mandatory under some Species Management Programs:

- Fibrescope on pole.

Attachment 4 Conservation Significant Species and Breeding Place Management Measures (Surat species only)

	Conservation Significant Species and Breeding Place Management Measures							
Species Name	Avoid disturbance in areas known or assessed to be suitable habitat during breeding season.	If breeding activity is observed, an exclusion zone (30m radius) should be enforced until the breeding place is vacated	If breeding activity is observed, an exclusion zone (50m radius) should be enforced until the breeding place is vacated.	If breeding activity is observed, an exclusion zone (100m radius) should be enforced until the breeding place is vacated.	As a last resort, eggs or young may be removed and placed with a licenced wildlife carer/facility for incubation of eggs and/or raising of the young for subsequent release.	All clutches of reptile eggs encountered during pre-clear surveys and clearing, which could be EVNT reptile eggs, should be collected and placed with a suitably qualified and licensed wildlife carer/facility for incubation and release of hatched offspring.	Where relocation of animals in tree hollows is required, the management actions for felling hollow-bearing trees (Section 3.2.3) will be followed.	Species-specific measures
EVNT								
Invertebrates								
pale imperial hairstreak *Jalmenus eubulus*	Yes		Yes, including where larvae are found					Where disturbance is proposed within larger (over 100m across) patches of undisturbed old-growth brigalow within the range of the pale imperial hairstreak, a preconstruction clearance survey will be conducted utilising a butterfly specialist, including survey for larvae.
bulloak jewel butterfly *Hypochrysops piceata*	Yes		Yes					Should Arrow seek to work within suitable habitat in Bendidee State Forest, a preconstruction clearance survey of the forest will be conducted utilising a butterfly specialist, including survey for larvae.
Amphibians								

	Conservation Significant Species and Breeding Place Management Measures							
rough collared frog *Cyclorana verrucosa*	Spring-summer, but may respond to rainfall	Yes.						Egg clumps or tadpoles encountered during pre-clear surveys and clearing, that are assessed as likely to be those of rough collared frog, should be collected and placed with a suitably qualified and licensed wildlife carer/facility for incubation and release of metamorph frogs. As a last resort, eggs or young (including larvae and tadpoles) may be removed.
Reptiles								
five-clawed worm-skink *Anomalopus mackayi*	Spring-summer	Yes				Yes		
collared delma *Delma torquata*	Dec-Mar	Yes				Yes		
yakka skink *Egernia rugosa*	Yes		Yes					As a last resort, colony translocation may be employed (if approved). An artificial colony shelter site should be established using a dense pile of natural hollow-bearing logs in a nearby area of suitable habitat. Individual skinks will be captured and relocated to the artificial shelter prior to commencing clearing.
Dunmall's snake *Furina dunmalli*	Oct-Feb	Yes				Yes		
brigalow scaly-foot *Paradelma orientalis*	Sept-Feb	Yes				Yes		
grey snake *Hemiaspis damelii*	Oct-Mar	Yes						

	Conservation Significant Species and Breeding Place Management Measures							
Darling Downs earless dragon *Tympanocryptis* cf. *tetraporophora*	Nov-Feb	Yes				Yes		
common death adder *Acanthophis antarcticus*	Oct-Apr	Yes						
golden-tailed gecko *Strophurus taenicauda*	Oct-Apr	Yes				Yes		
Birds								
regent honeyeater *Anthochaera phrygia*	Aug-Feb			Yes				
Australian painted snipe *Rostratula australis*	Oct-Dec			Yes				
squatter pigeon (southern) *Geophaps scripta scripta*	Varies - early dry season		Yes		Yes			
glossy black-cockatoo *Calyptorhynchus lathami*	Jan-Aug			Yes	Yes, also must relocate tree hollow		Yes	
painted honeyeater *Grantiella picta*	Aug-Feb		Yes		Yes			
grey goshawk *Accipiter novaehollandiae*	Aug-Dec			Yes	Yes			

	Conservation Significant Species and Breeding Place Management Measures							
black-chinned honeyeater *Melithreptus gularis*	Jul-Dec		Yes		Yes			
black-necked stork *Ephippiorhynchus asiaticus*	Aug-Feb			Yes	Yes			
cotton pygmy-goose *Nettapus coromandelianus*	Dec-Apr		Yes		Yes, also must relocate tree hollow		Yes	
freckled duck *Stictonetta naevosa*	Aug-Dec		Yes		Yes			
Lewin's rail *Lewinia pectoralis*	Spring-summer		Yes		Yes			
square-tailed kite *Lophoictinia isura*	Aug-Dec			Yes	Yes			
turquoise parrot *Neophema pulchella*	Aug-Dec		Yes		Yes, also must relocate tree hollow		Yes	
Mammals								
south-eastern long-eared bat *Nyctophilus corbeni*		Yes					Yes	
little pied bat *Chalinolobus picatus*		Yes					Yes	
Migratory								
cattle egret *Ardea ibis*	Nov-Jan			Yes	Yes			

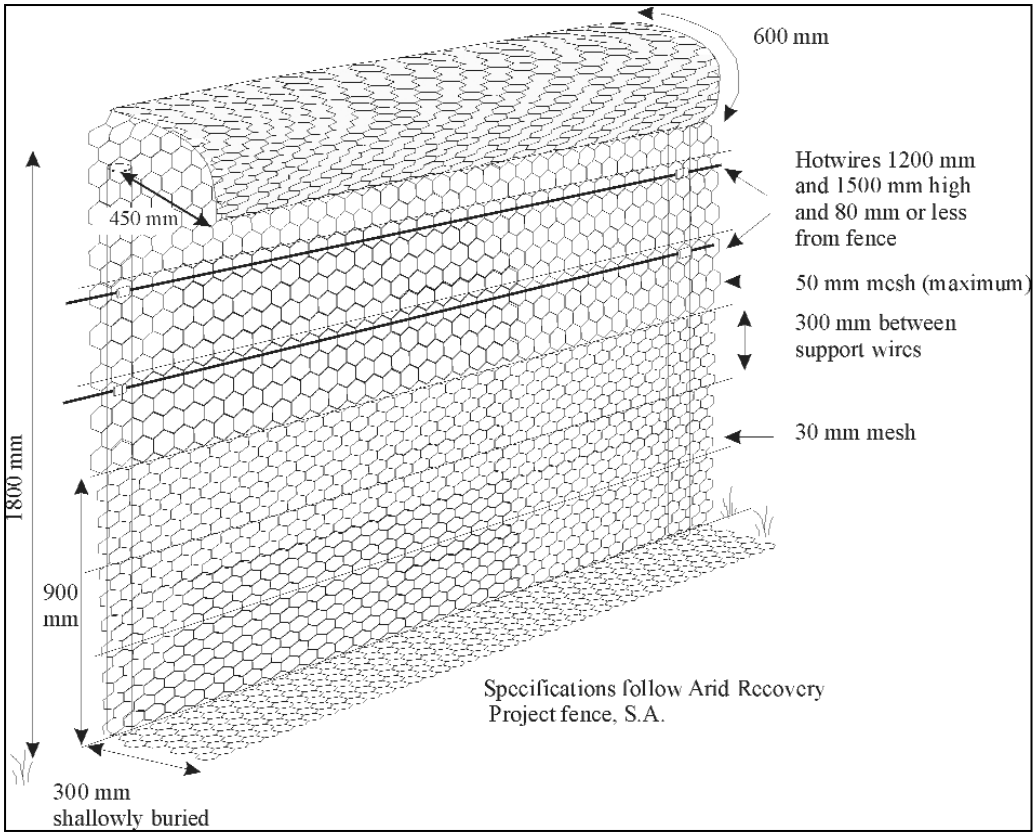
	Conservation Significant Species and Breeding Place Management Measures							
eastern great egret *Ardea modesta*	Dec-Jan			Yes	Yes			
glossy ibis *Plegadis falcinellus*	Oct-Apr, but also after rain and flooding			Yes	Yes			
rainbow bee-eater *Merops ornatus*	Aug-Jan	Yes			Yes			
satin flycatcher *Myiagra cyanoleuca*	Nov-Jan	Yes			Yes			
white-bellied sea-eagle *Haliaeetus leucogaster*	May-Sept			Yes	Yes			
black-faced monarch *Monarcha melanopsis*	Sep-Feb	Yes			Yes			
rufous fantail *Rhipidura rufifrons*	Oct-Jan	Yes			Yes			
Australian reed warbler *Acrocephalus australis*	Sep-Feb			Yes	Yes			
Special Least Concern								
short-beaked echidna *Tachyglossus aculeatus*	Jul-Nov	Yes			Yes			

	Conservation Significant Species and Breeding Place Management Measures							
koala *Phascolarctos cinereus*								If a female with young is observed, a minimum exclusion zone of 100m radius will be enforced until the female has moved on of its own accord. No vehicles may enter the exclusion zone at any time. Vehicle operators will be made aware of the koala's presence, and a reduced speed limit will be established in the surrounding area
Colonial breeding species								
Colonial-breeding waterfowl	Varies, includes following rain and flooding			Yes	Yes			
Colonial breeding microbats	Varies		Yes				Yes	

Attachment 5 Fauna considerations for fence designs

Attachment 5.1 Fauna exclusion fence designs

(Left) Floppy bottom fence at Punchbowl Pilot Dam with barbed wire top



(Above) Diagram of floppy top and bottom fence (hotwires not required for Arrow projects)

Attachment 5.2 Fauna friendly fence designs

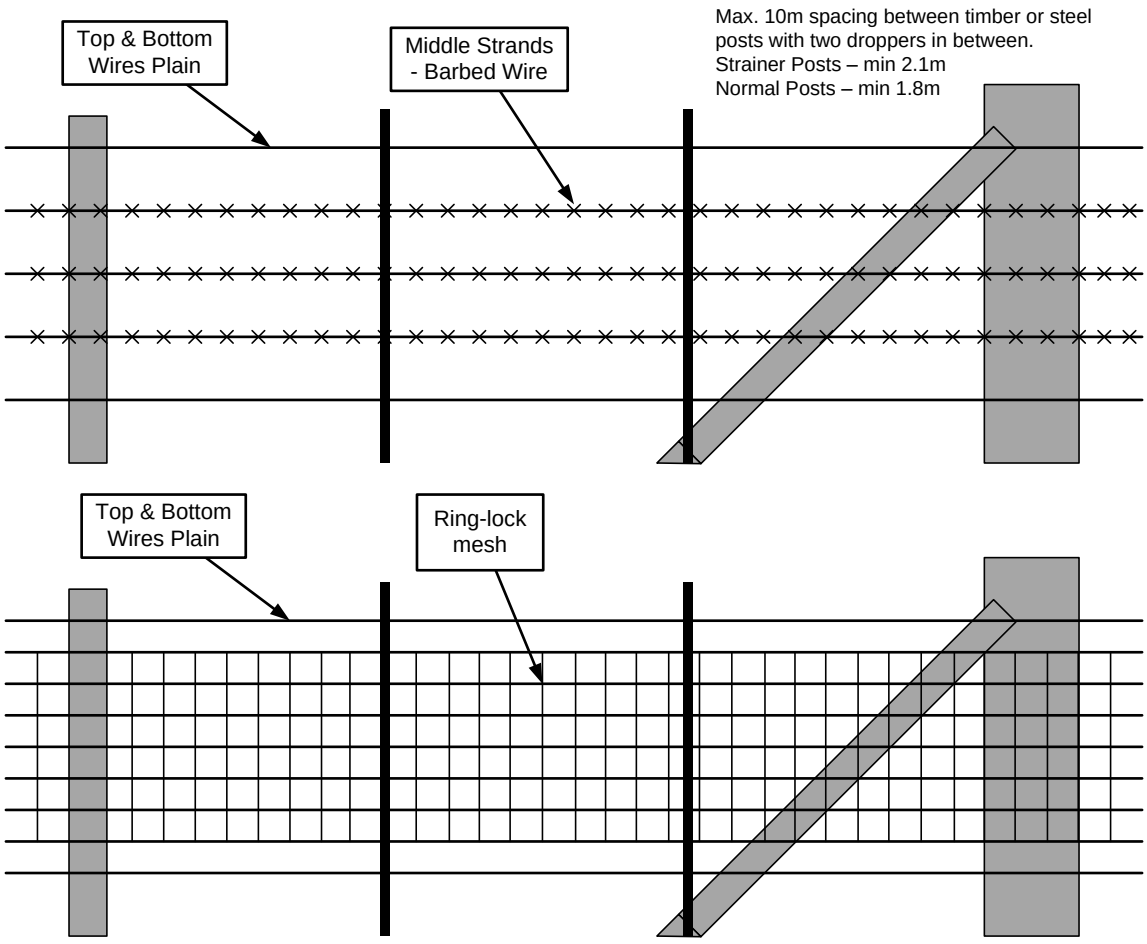


Figure 4 – Fence Wiring Configurations

Figure 5 – Electric Fence – Dual hot tape

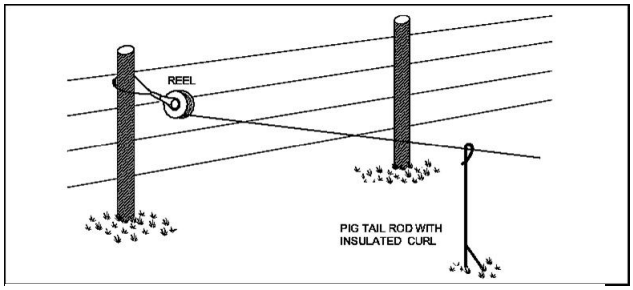


Figure 6 – Electric Fence – Single strand hot tape or wire

Purpose

The purpose of this guideline is to provide a clear and consistent process for completing ecological surveys required by the *Ecological Impact Assessment Procedure*[1]. Ecological surveys are required to identify, assess and record the vegetation characteristics (context, structure and floristics) and fauna habitat values at proposed infrastructure sites, and landscape characteristics in the immediate surroundings. Ecological surveys are required to collect baseline data to measure:

- regional ecosystem (RE) status and confirmation
- remnant and mature regrowth status of vegetation
- flora species present in the tree, shrub and ground layers to address rehabilitation criteria and maintain exemptions from clearing permits
- Environmentally Sensitive Areas (ESA) status and buffers
- presence of threatened flora and fauna species
- condition of vegetation to address final rehabilitation criteria
- presence of fauna habitat and animal breeding places
- confirm environmental offsets will be triggered.

The ecological survey is a condition of the Environmental Authorities (EA) under which Arrow Energy (Arrow) legally operates on its tenements.

Scope

This guideline applies to all Arrow controlled sites where there will be disturbance to land that has not been previously disturbed by Arrow's activities. Specifically, this will be where a Land Access Request (LAR) process has been initiated on new or old sites, involving vegetation being disturbed, and where an ecological impact assessment has not previously been undertaken (generally work undertaken prior to June 2010).

Therefore, this guideline is mandatory for Arrow employees and contractors (consultant ecologists/botanists) working on LARs.

The ecological survey incorporates elements of both the BioCondition (Eyre, *et al* 2011) and CORVEG (Neldner, *et al* 2012*)* assessment methods in use in Queensland and will collect data with the same or similar attributes. The *Ecological Impact Assessment Procedure*[1] and its associated field assessment methods are designed to assess site condition to address the company's obligations relating to ecological State and Federal legislative requirements, extending beyond EA conditions.

Additional survey methods may be required specifically for fauna management, offsets, regional ecosystem validation.

Responsibilities

Title	Responsibilities
Corporate Environment Manager	Ensuring that this guideline meets or exceeds the current regulatory framework such as EA conditions. Identifying whether additional guidelines, forms, templates, registers or other documentation is required to support the ecological survey process.
Senior Ecologist	Directing Ecologists to complete ecological surveys for LARs. Escalating field verified site constraints to the Project Manager.
Ecologist	Completing ecological surveys using the appropriate forms and other resources. Completing registers and databases that store ecological survey data. Updating the project schedules and tracking program (SPS) upon completion of ecological surveys.

Process	Actions
Training	▪ It is essential for Ecologists to be experienced in botanical field surveys and ecological condition assessment. Basic training in the assessment method can be undertaken in a day. It is highly desirable that an Ecologist is familiar with the vegetation communities within the area of interest. In addition, if there is more than one survey team operating or different employees or consultants become involved in the survey work, it is essential that the observers work closely together to ensure a high degree of observer calibration, consistency in survey methods, and consistency between observers recording. Pre-survey field calibration exercises aimed at reducing observer error are highly recommended.
Survey preparation	▪ The Ecologist shall review the Environmental Desktop Assessment Report completed for the site prior to conducting the ecological survey.
Site validation	▪ A site validation assessment (ie. 'walkover) shall be completed for large infrastructure projects such as seismic surveys, linear infrastructure, dams and facilities. ▪ The site validation should be conducted using a Global Positioning System (GPS) enabled device and preferably software that contains: o Satellite imagery with appropriate GIS layers o Development boundaries or kilometre points (every 1km) for seismic lines and linear infrastructure o Cadastral layers o Existing infrastructure (fences, sheds, etc.) ▪ The location, boundaries and extent of Threatened Ecological Communities (TECs), ESAs, REs, watercourses and wetlands shall be confirmed. ▪ The location of any obvious fauna habitat and/or features, including nests, dreys, burrows, hollows, logs, etc. should be identified and recorded. ▪ Information should be collected about the location of watercourses and wetlands with respect to their length/size, distance to proposed infrastructure, access to and options for crossing or navigating around

Process	Actions
	them. ▪ For seismic lines, it should be noted where a break in the seismic line is recommended. ▪ If minor route alignments are required or recommended to reduce environmental impacts for seismic lines and linear infrastructure, possible options for alternate routes should be examined and adequate data collected to provide to the Project Manager. ▪ Where the proposed area for a dam is unsuitable due to ecological constraints, potential new areas should be examined. ▪ The walkover may also be used to stratify (divide the site into assessment units and is discussed further below) the site and immediate surrounds to determine the number of vegetation survey transects and level of fauna survey (refer to *Fauna Survey Guideline*[2]) that may be required to adequately assess the site.
Complete site validation report	▪ The site validation report, including recommendations for route or site changes, shall be prepared to provide a summary of the environmental features encountered within and immediately adjacent to the site, where it will assist reporting. The report may be provided to the Project Manager to assist with their decision making.
Field survey preparation	▪ Ecologists must comply with all conditions to access properties and have completed the appropriate inductions for the field location. A consultant botanist/ecologist may be escorted on site by a Land Liaison Officer (LLO) or an Ecologist, if authorised by the LLO. ▪ The field survey is based on collecting vegetation and habitat information (and fauna survey as specified), as well as information relating to the vegetation structure, condition, floristics, and groundcover data. ▪ A typical field kit should contain, as a minimum, the equipment listed in **Attachment 1**. ▪ For large sites (generally greater than one hectare), stratification of the vegetation communities within the site will be required to adequately survey each community and/or disturbance regime. A transect can then be completed within each of these Environmental Stratification Units (ESU) depending upon the size and the land use of the area that each ESU occupies. ▪ In most cases, an ESU will correspond to a mapped RE comprising either remnant or regrowth vegetation according to the 50/70 rule (refer to Neldner, *et al* 2012 to determine remnant status of REs). However, additional ESU's should be created for all vegetated areas within a site such as cropping, derived native grasslands, exotic pastures, forestry, etc to ensure all land uses and disturbances are captured. For further information on ESU construction, refer to **Attachment 2** and how to set up assessment units in Eyre, *et al* (2011) and Neldner, *et al* (2012).
Vegetation survey method overview	▪ Survey effort will vary depending on the vegetation formations and complexity, however, an experienced Ecologist should complete each survey in less than one hour. ▪ Survey effort is dependent on a range of variables including: o Season and availability of plant identification material o Ecologists' experience with the particular vegetation type and its constituent species

Process	Actions
	o The overall species richness and structural complexity of the site. ▪ The results of the vegetation survey shall be recorded on the *Ecological Field Survey Form*[3]. ▪ The field survey is divided into three assessment units at different spatial scales: o Broad assessment of landform features within 500m of the site or as far as can be seen o Assessment of physiography variables, disturbance and vegetation structure and context within an ESU or 100m x 100m area, including searches for conservation significant flora species and declared and regionally significant weed species o Vegetation floristics and ground cover within a 50m x 10m transect
Vegetation survey method: – within 500m – landscape attributes	▪ General landform information is to be recorded within an approximate 500m radius around the transect or as far as can be seen. ▪ Photos may be taken as needed to show the context of the site in the landscape. ▪ Any environmental features in the surrounding area that may constrain development or require management should be noted. This may include declared weeds, conservation significant plants (threatened or Type A species) and communities or habitat for threatened fauna, hollow bearing and stag trees, large trees requiring the installation of Tree Protection Zones (TPZ's), watercourses, drainage lines, eroded banks, ridges and escarpments, powerlines, existing infrastructure or other habitat features. ▪ The values of permanent and temporary water sources must be considered as possible breeding habitat for semi-aquatic protected species including platypus (*Ornithorhynchus anatinus*), water rat (*Hydromys chrysogaster*), turtles and frogs and threatened fish species. ▪ For seismic lines and linear infrastructure, vegetation should be sampled within each RE, or where variations should be recorded such as isolated communities that would not be mappable as a RE. The route should be walked, as much as practical, to search for conservation significant plants and other environmental features.
Vegetation survey method: – within ESU or 100mx100m area – Physiography – Disturbance – Vegetation structure & context – Significant species	▪ Physiographic information is to be recorded from within an ESU or general 100m x 100m area around the transect to provide immediate context of the transect. Variables include: o Macrohabitat type (**Attachment 3**) o Slope o Aspect o Soil colour o Soil texture grade (method in **Attachment 4**) o Presence of erosion and erosion type. ▪ Disturbance information is to be recorded on: o Land use and evidence of land use o Dieback of trees o Site condition o Fire scars, time since the fire (recent or old) and average height of the fire on trees ▪ Vegetation structure and context information is primarily restricted to the

Process	Actions
	Ecologically Dominant Layer (EDL). The EDL is the vegetation layer that contains the most biomass, not the most numerous individuals within a stratum. The EDL must be identified and the average height and diameter at breast height (DBH) must be recorded. An estimated density of the shrub layer should also be recorded. ▪ A random meander (as per Cropper 1993) must be completed to search for conservation significant (Type A plants), threatened flora species, weed species (declared plants under the *Land Protection (Pest and Stock Route Management) Act 2002)* and regionally significant species. A timed 15 minute search within the ESU is generally adequate, although published survey guidelines should be taken into account for particular threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
Vegetation survey method: – within 50mx10m – Vegetation structure and floristics – Ground cover	▪ The transect (50m x 10m) should be located and oriented so that the entire transect remains in the ESU (ie. same community and same condition state). Normally transects should be oriented so that the long axis of the transect follows the contour. ▪ **Attachment 5** illustrates the standard assessment transect set-up for vegetation survey. Once the transect is located or established, marker posts (if used) are fixed at either end of a firmly tightened 50 metre tape (note: marker posts may be removed if the site is not to be permanently marked). ▪ Coordinates at the start and end of the transect should be collected using a GPS enabled device and recorded on the form. The orientation of the transect should also be noted using a compass and recorded on the form. ▪ Photos should be taken from the centre of the transect facing north, east, south and west and photo numbers corresponding with the direction of the photos recorded on the form. ▪ The data to be collected is divided into a number of sections based on the type of data and the scale of the assessment. There are a range of different methods to be used, including: o The height range for each strata estimated along with an estimate of projective foliage cover as per the following categories: <10%, 10-30%, 30-70% and 70-100% (**Attachment 6**). o All species (woody and non-woody plants) in each layer occurring within the transect recorded. o The stems should be counted for every woody species within the transect. For sites with a dense shrub cover, stems within the S1 and S2 strata may be tallied within a 50m x 2m area. o At 10m intervals along the 50m transect the percentage of each groundcover group (eg. native perennial grasses) present is recorded within a 1m x 1m quadrat and a photograph taken (**Attachment 7**). The lower corner of the quadrat should be placed on the alternating side of the transect at every 10 metres. An average percentage for each groundcover group is calculated across the five quadrats.
Fauna habitat assessment and level of fauna survey required	▪ The *Fauna Survey Guideline*[2] should be read in conjunction with this section and any published survey guidelines for particular species or assemblages. ▪ Fauna habitat and likely occurrence of fauna species are assessed in several ways, being: o Presence of hollow-bearing trees and large woody debris on the ground

Process	Actions
	within the 50m x 10m transect o Abundance of fauna habitat features estimated within the ESU or 100m x 100m using a random meander (Cropper 1993) technique o Fauna signs observed within the ESU or 100m x 100m using a random meander technique o Level of fauna survey performed or required. ▪ An estimate of presence/absence or abundance of certain habitat features is recorded. These features are known to influence the presence of certain species (eg. threatened species) and also the fauna assemblage that could be predicted to occur on the site. The threatened species list generated at the desktop stage should be reviewed to determine likely presence of species on the site, based on habitat presence and condition. ▪ Signs of fauna presence on the site are assessed in terms of the likely species or faunal group that made the sign and particularly whether the species could be a threatened or conservation significant species. Triggs (2004) should be used to match fauna signs with species or samples collected and sent away for analysis. ▪ Survey effort expended for fauna habitat assessment and survey are dependent upon the level of survey requested during the Environmental Desktop Assessment Report and the site validation process (if completed for the site). The results of the fauna habitat and signs assessment will inform which signs should be targeted, if so required. The following provides a description of the levels of fauna survey to be employed on sites: **1) General habitat assessment and daytime search** ▪ A general habitat assessment and daytime search is the minimum level of fauna survey that must be employed on all sites.A random meander is used to collect information on fauna signs (as per above) and active searches according to the Active Searches and Observations methods in the *Fauna Survey Guideline*[2]. There is no minimum time limit enforced for active searches and will vary depending upon the presence of habitat features on the site, although 15 minutes should be used as a rough guide. **2) Comprehensive survey for all faunal groups including trapping** ▪ The most intensive survey effort should be used on large sites and where the proposed activity is likely to result in a significant impact to the habitats on the site. Consultants must be engaged to conduct the fauna survey according to the scope of works provided by the Arrow Senior Ecologists. Arrow currently does not hold the necessary licences or permits to conduct trapping of fauna. ▪ The fauna survey should ideally be conducted over two seasons (preferably late winter / early spring and late wet season) and should utilise methods appropriate to the target fauna groups to account for species detectability constraints. **3) Comprehensive survey for one or more faunal groups or species.** **OR** **4) Targeted survey for one or more threatened species.**

Process	Actions
	▪ These levels of survey effort aims to target one or more threatened species and can be used where a full fauna survey is not warranted and only specific faunal groups or species are targeted. This level of survey is dependent upon the condition and extent of the habitat within the site and should be conducted by consultants (if trapping is proposed) according to the scope of works to be prepared by the Arrow Senior Ecologists. ▪ These levels should be used where trapping or a specific detection method is required or where an extended fauna survey is proposed (eg. greater than a diurnal or nocturnal search) **5) Active searches for one or more fauna groups** ▪ Active searches are to be used for targeting certain threatened fauna species that are detectable using active searching methods (excludes trapping). These surveys can be completed by either an Arrow Ecologist or consultant and are generally non-seasonable (although some targeted species will be more detectable in certain seasons). Active searches should be completed at any site where the potential occurrence of a threatened species is likely or possible.
AC recommendations	▪ This section is used to consolidate information gathered during the survey and produce conditions which should be transferred to the Access Condition (AC) document. Standard conditions include: o *Deciding whether a fauna spotter-catcher (FSC) is required.* Generally, a FSC will be required where the risk of disturbance to native fauna is considered significant by the Ecologist. Where a threatened fauna species is known or reasonably suspected, engaging a FSC is mandatory. o *Deciding whether an Ecologist is required to supervise the works.* An Ecologist may supervise the works where specific conditions to manage a significant ecological feature are included in the AC and require specialised knowledge to implement on the site. o *Deciding whether a Species Management Plan is required to manage a threatened flora or fauna species*. o *Deciding whether the site is suitable for minimal disturbance.* To be considered for minimal disturbance, a "YES" must be provided for all four questions. ▪ Other conditions may be proposed either from a Species Management Plan, Species Management Program, the *Fauna Management Guideline*[4] or other authorised document.
Unknown specimens	▪ Where specimens are not known to the Ecologist, they will need to be collected in the field for later identification in the office. Where they still cannot be identified and there is a reasonable suspicion that the specimen could belong to a conservation significant species or declared pest species, specimens should be prepared and sent to an appropriate expert such as the Queensland Herbarium for plant identification (refer to the *Herbarium - Unknown Species - Data Sheet*[5]) or fauna expert.
Vegetation surveys for environmental offsets	▪ In some cases, developing a site will require an environmental offset to compensate for the loss of a significant environmental value. The Ecological Equivalence Methodology (EEM) must then be conducted on the impacted area, and the proposed offset area to determine an appropriate

Process	Actions
	offset ratio. ▪ The *Environmental Offset Assessment Guideline*[6] should be used to determine offset the correct offset assessment process.
Complete Environmental Summary Report	After the ecological field assessment has been completed, the *Form – Environmental Summary Report*[7] (ESR), scan the *Ecological Field Survey Form*[3] and store in the appropriate project folder. Site photographs should be stored in the project folder. ▪ Consultant reports should be saved unamended in the reports folder for consultants. The reports should also be saved in each project file and completed internally, where required.
Ecology data recorded	▪ An electronic database (and temporary registers) that maintain vegetation clearing data for auditing purposes is maintained. These temporary registers are: o Vegetation clearing register - records the estimated quantity cleared for each species for each infrastructure site, to comply with Arrow's exemption under the *Nature Conservation (Protected Plants) Conservation Plan 2006*. o Rehabilitation Monitoring register - records species present from monitoring activities o Threatened species register – records the locations of threatened fauna, flora and vegetation communities o Breeding Places Register – records the location of fauna breeding places tampered with or destroyed during works. ▪ Prior to submitting the internal approval document, an Ecology team member must ensure that the database or temporary registers have been updated with the site results.
Incorrect state mapping	▪ Where the field assessment results indicate that the ESA is incorrectly mapped for a particular location, a letter may need to be prepared by an Ecologist, approved by the Senior or Principal Ecologist and submitted to the relevant authority at least five business day prior to the activity commencing. The letter should contain the precise location of the activity, the correct field identified values and the nature of the proposed activity. Other details supporting the proposed deviation from the state mapping must be kept on file. Such details may include CORVEG secondary site surveys (Neldner, *et al* 2012) to determine remnant status of REs.

References

Referenced Documents	
Reference	**Document Title**
1	99-H-PR-0081 Ecological Impact Assessment Procedure
2	99-H-GDL-0061 Guideline – Fauna Survey
3	99-H-FM-00110 Form – Ecological Field Survey
4	99-H-GDL-0060 Guideline – Fauna Management
5	99-V-FM-0021- Form – Herbarium Unknown Species Data Sheet
6	99-H-GDL-0062 Guideline – Guideline – Environmental Offset Assessment
7	99-V-FM-0033 Form – Environmental Summary Report

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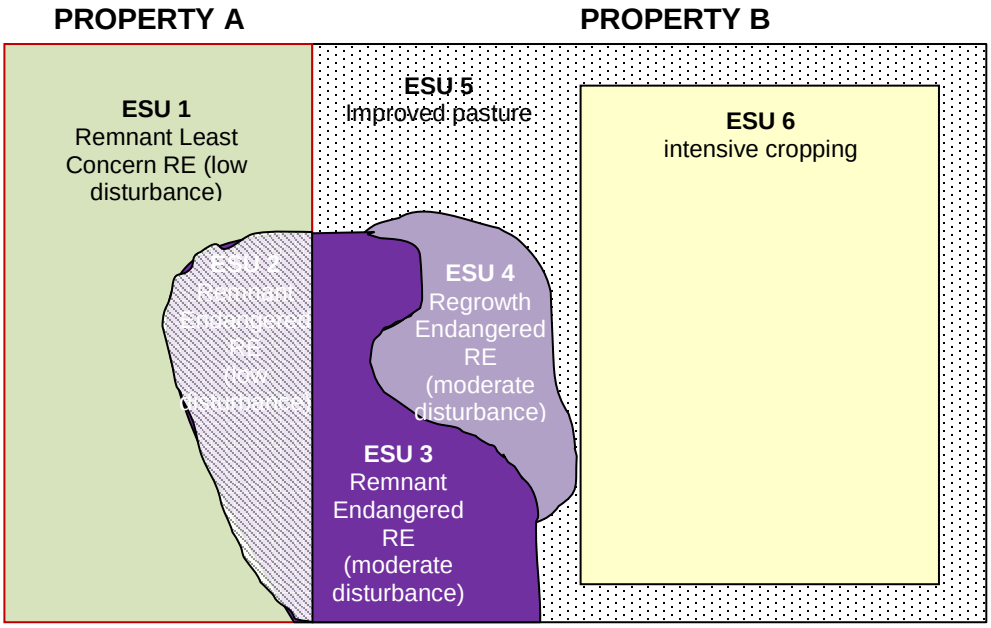
Document Control			
Revision	**Revision Date**	**Reviewer**	**Approver**
0	29/10/2013	H. Wood	H. Wood
1	15/1//2013	P. Finn, H. Wood	J. Flint

Attachment 1 – Typical field survey kit

- A typical field kit should contain the following equipment:
  - GPS, plus spare batteries
  - Digital camera, plus spare batteries)
  - 1.5m fibreglass posts and post driver, flagging tape or wire pegs (check permit to work requirements)
  - Compass and clinometer (combined compass/clinometer is preferable)
  - 50m and 10m fibreglass tapes (metres printed on both sides preferable)
  - Tree diameter tape (also known as DBH tapes (diameter at breast height))
  - Flags and flagging tape
  - Photo-board and chalk (chalk board recommended)
  - Data sheets and clipboards
  - Hand lens, sample bags, plant press, plant identification books
  - Jewellery tags
  - Sterilised secateurs
  - Small crowbar
  - Binoculars
  - Vertical tube for measuring FPC (after Specht 1983)
  - Spotlight or head torch
  - 2x hand held radios (refer to the relevant SOP for use)
  - Two methods of communication for the field location (SPOT, satellite phone if no mobile phone coverage is expected)
  - Mobile phone, fully charged
  - PPE – steel capped, lace-up, ankle support boots, anti-static long sleeved shirt and pants, hard hat (for production areas) with sun protection, safety glasses, high visibility vest/shirt (production sites and as where required) and gloves
  - 10 litres water for vehicle, water supply for walking (eg. camelbak or water bottle)
  - First aid kit, including compression bandages for snake bite
  - Esky (optional)

Attachment 2 – Environmental Stratification Units (ESU) Example



Attachment 3 – Macrohabitat definitions

Key	Macrohabitat	Definitions
CEST	Coastal & estuarine	Includes mangroves, tidal flats, salt marsh and beaches.
Rf	Rainforest	Characterised by high density of trees (Closed Forest) with a projective foliage cover of 70-100%.
H	Heath	Characterised by low growing, multi-stemmed shrubs, with herbs, grasses and sedges. Vegetation is low growing (less than 2m high).
FOR	Forest	Characterised by medium to high density of trees either over 30m tall (Tall Open Forest), less than 30m tall (Open Forest), or less than 10m tall (Low Open Forest). Canopy cover is dense/closed to mid-dense with projective foliage cover between >30-70% to >70%. Includes wet and dry sclerophyll forests.
WDL	Woodland	Characterised by widely spaced trees. Canopy cover is sparse to very sparse, with projective foliage cover between <10% - 10-30%.
GRL	Grassland	Characterised by prevalence of grass species. Includes both native and exotic species.
IMP	Improved pasture	Characterised by exotic species sown for grazing.
LKE	Lake/dam	Associated with a lake or dam
RIP	Riparian	Associated with watercourses, drainage lines.
SHR	Shrubland	Characterised by low growing, multi-stemmed shrubs, with herbs, grasses and sedges. The average height of vegetation in shrublands is more than 2m high
SW	Swamp/Wetland	Associated with a swamp or wetland. Area either permanently or periodically inundated with water.
DIS	Disturbed areas	Includes cropping land, roadsides, urban areas, etc.

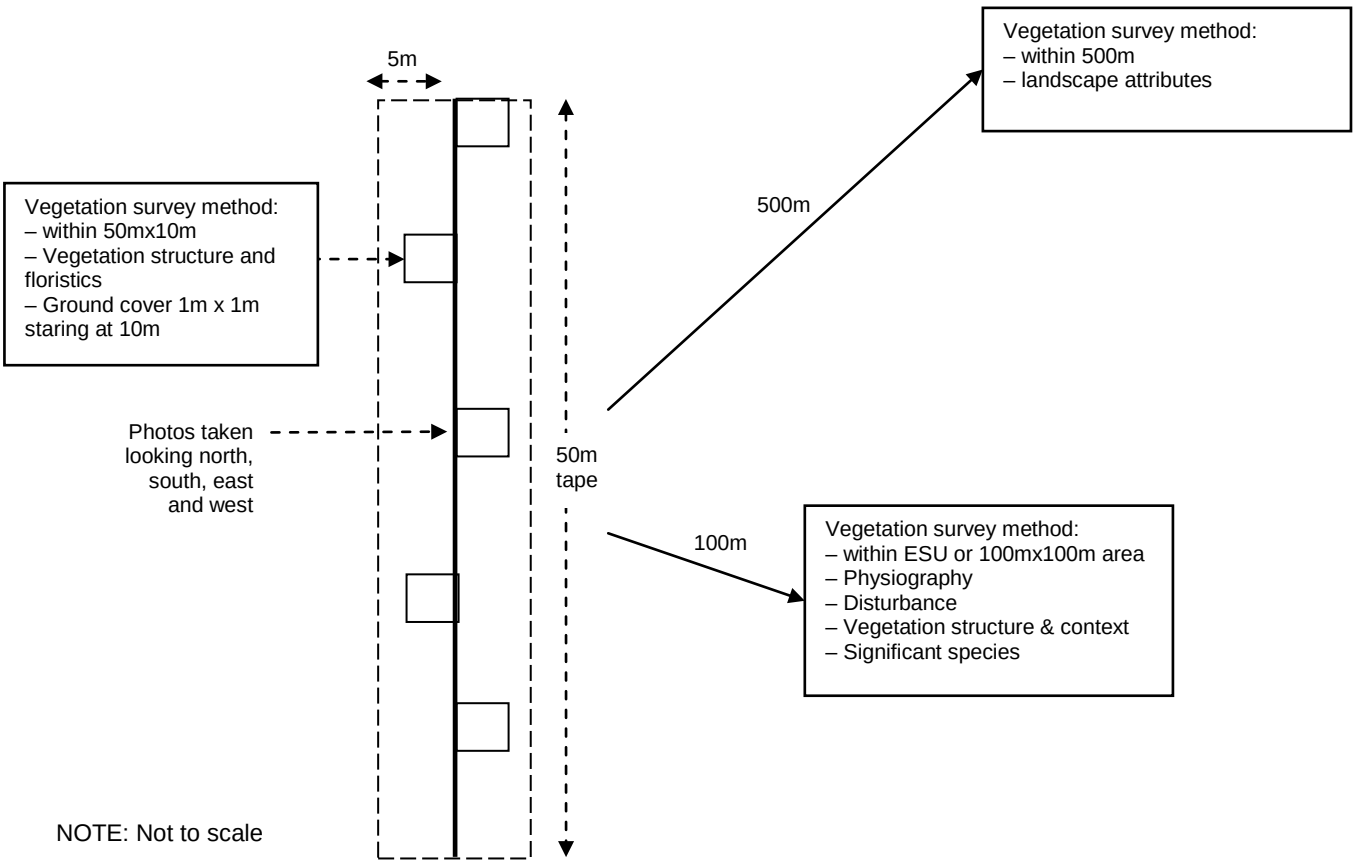
Attachment 4 – Soil texture grade

- Soil texture grade is assessed according to the Australian Soil and Land Survey Field Handbook (McDonald 2009). The method to classify a soil bolus (small rounded mass of soil) is described below.
- Field texture is a measure of the behaviour of a small handful of soil when moistened and kneaded into a ball and then pressed out between thumb and forefinger.
- Take a sample of soil sufficient to fit comfortably into the palm of your hand. Moisten the soil with water, a little at a time, and knead until the ball of soil, so formed, just fails to stick to the fingers. Add more soil or water to attain this condition, known as the sticky point, which approximates field capacity for that soil.
- Continue kneading and moistening until there is no apparent change in the soil balls, usually a working time of 1 – 2 minutes. The soil bolus is now ready for shearing manipulation, but the behaviour of the soil during bolus formation is also indicative of its field texture. The behaviour of the bolus and of the ribbon produced by shearing (pressing out) between thumb and forefinger characterises the field texture. Do not assess field texture grade solely on the length of ribbon.

Code	Texture grade	Behaviour of moist bolus (Bolus = small rounded mass of a soil)	Approximate clay content (5)
S	sand	nil to very slight coherence, cannot be moulded; sand grains of medium size; single sand grains adhere to fingers	commonly < 5%
LS	loamy sand	slight coherence; sand grains of medium size; can be sheared between thumb and forefinger to give minimal ribbon of about 5 mm	about 5%
CS	clayey sand	slight coherence; sand grains of medium size; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain; will form minimal ribbon of 5-15 mm	5-10%
SL	sandy loam	bolus coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible; will form ribbon of 15-25 mm	10-20%
L	loam	bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter present; will form ribbon of about 25 mm	about 25%
ZL	silty loam	coherent bolus; very smooth to often silky when manipulated; will form ribbon of about 25 mm	about 25% and with silt 25% or more
SCL	sandy clay loam	strongly coherent bolus, sandy to touch; medium-size sand grains visible in finer matrix; will form ribbon of 25-40 mm	20-30%
CL	clay loam	coherent plastic bolus, smooth to manipulate; will form ribbon of 40-50 mm	30-35%
CLS	clay loam, sandy	coherent plastic bolus; medium-size sand grains visible in finer matrix; will form ribbon of 40-50 mm	30-35%
ZCL	silty clay loam	coherent smooth bolus, plastic and often silky to the touch; will form ribbon of 40-50 mm	30-35% and with silt 25% or more

Code	Texture grade	Behaviour of moist bolus (Bolus = small rounded mass of a soil)	Approximate clay content (5)
LC	light clay	plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50-75 mm	35-40%
LMC	light medium clay	plastic bolus; smooth to touch; slight to moderate resistance to ribboning shear; will form ribbon of about 75 mm	40-45%
MC	medium clay	smooth plastic bolus; handles like plasticine and can be moulded into rods without fracture; has moderate resistance to ribboning shear; will ribbon of 75 mm or more	45-55%
MHC	medium heavy clay	smooth plastic bolus; handles like plasticine and can be moulded into rods without fracture; has moderate to firm resistance to ribboning shear; will ribbon of 75 mm or more	50% or more
HC	heavy clay	smooth plastic bolus; handles like stiff plasticine and can be moulded into rods without fracture; has firm resistance to ribboning shear; will ribbon of 75 mm or more	50% or more

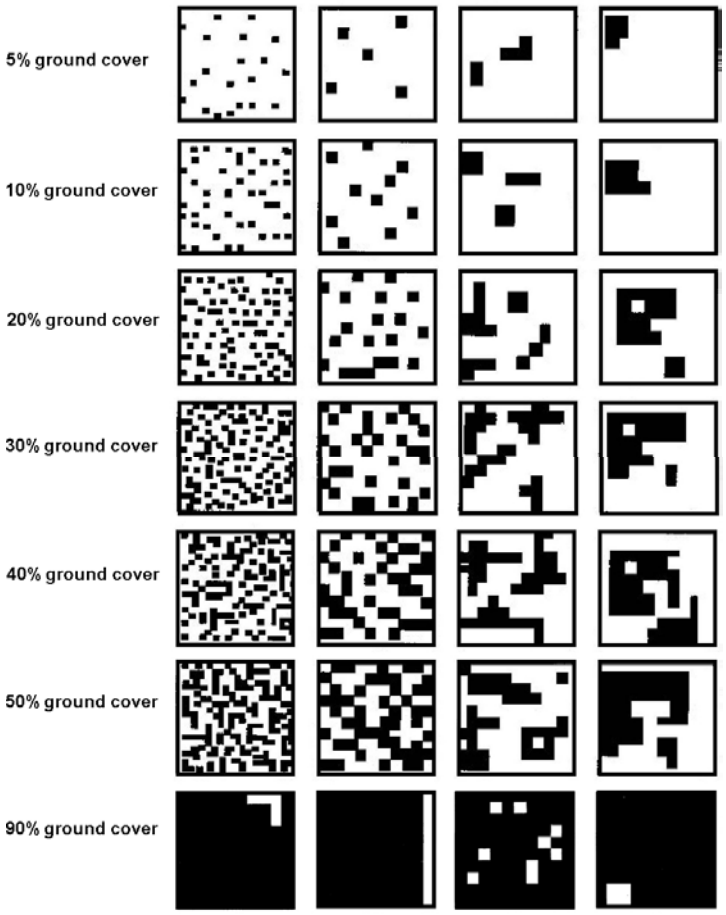
Attachment 5 – Schematic layout of transects and vegetation assessment areas (plots)



Attachment 6 Structural forms of vegetation (Specht 1970)

Projective foliage cover	70-100%	30-70%	10-30%	< 10%
Form and height of tallest layer	**Structural formation classes**			
"General rule"	"Crowns overlapping"	"Crowns just touching or slightly separated"	"Crowns obviously separated"	"Crowns widely separated"
Trees >30m	Tall closed-forest	Tall open-forest	Tall woodland	Tall open-woodland
Trees 10-30m	Closed-forest	Open-forest	Woodland	Open-woodland
Trees <10m	Low closed-forest	Low open-forest	Low woodland	Low open-woodland
Shrubs >2m	Closed-shrub	Open-shrub	Tall shrubland	Tall open-shrubland
Shrubs/seedlings (S2) strata	Closed-heath	Open-heath	Low shrubland	Low open-shrubland

Attachment 7 Stylised examples of ground cover percentages (Eyre *et al* 2011)



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