3D Environmental
vegetation analysis and mapping specialists

ECOSMART ECOLOGY
Ecological Research, Survey and Assessment

Surat Gas Project

Supplementary Terrestrial Ecology Assessment

Prepared for

Coffey Environments Australia Pty Ltd

by

3D Environmental / Ecosmart Ecology

Final, June 2013



NOTICE TO USERS OF THIS REPORT

Purpose of the report: 3D Environmental has produced this report in its capacity as {consultants} for and on the request of Coffey Environments Australia Pty Ltd (the "Client") on behalf of Arrow Energy Pty Ltd. The information and any recommendations in this report are particular to the Specified Purpose and are based on facts, matters and circumstances particular to the subject matter of the report and the specified purpose (The Surat Gas Project Supplementary Report to the Environmental Impact Statement) at the time of production. This report is not to be used, nor is it suitable, for any purpose other than the Specified Purpose. 3D Environmental disclaims all liability for any loss and/or damage whatsoever arising either directly or indirectly as a result of any application, use or reliance upon the report for any purpose other than the Specified Purpose.

Whilst 3D Environmental believes all the information in it is deemed reliable at the time of publication, it does not warrant its accuracy or completeness. To the full extent allowed by law, 3D Environmental excludes liability in contract, tort or otherwise,for any loss or damage sustained by any person or body corporate arising from or in connection with the supply or use of the whole or any part of the information in this report through any cause whatsoever.

Executive Summary

Arrow Energy Pty Ltd (Arrow) is proposing to develop the Surat Gas Project, an upstream gas field development in the Surat Basin, southeastern Queensland. An environmental impact statement (EIS) has been prepared for the project which was approved by the Queensland Government for public release in March, 2012 with a public review period that closed on 14th June 2012.

3D Environmental has been contracted to undertake a supplementary ecological assessment for the project to inform the Supplementary Report to the EIS (SREIS), which includes an assessment of both floristic and faunal values. The SREIS study was undertaken to verify the impact assessment made in the EIS study, assess the relevance of changes to project description on terrestrial ecology, and provide site specific impact assessment for a number of survey areas that are subject to development. In total, five survey areas were assessed. Two of these, survey area 2 and survey area 9 were assessed in detail, survey area 2 in particular. The other areas, being survey area 7, survey area 8 and survey area F were assessed more broadly with specific focus on identifying potential ecological constraints to project development. In addition, the findings of the EIS were considered in light of updated information that has become available after the EIS was submitted.

Review of the EIS indicated a number of variations to assessments made within that report. Specifically these are:

- Inclusion of the Mature Regrowth dataset (EHP 2012b) has included an additional 27,136 ha of vegetation that must be considered remnant with the SREIS project development area. This includes:
    - 2533 ha of brigalow regrowth bringing the total extent of the Brigalow Ecological Community in the project development area to 6982 ha (as per EHP 2012a and 2012b).
    - 27 ha of vine thicket regrowth bringing the total extent of the Semi-Evergreen Vine Thicket Ecological Community in the project development area to 59 ha (as per EHP 2012a and 2012b).
    - 163 ha of coolabah regrowth bringing the total extent of the Coolibah-Black Box Woodland Ecological Community to 484 ha.

In total, 777 ha of the Natural Grassland Ecological Community and 260 ha of the White Box-Yellow Box- Blakely's Red Gum Ecological Community are mapped as occurring within the project development area (EHP 2012a). Mature regrowth for these communities has not been incorporated into the relevant EPBC Act listed communities due to the requirement for retaining native groundcover that is often heavily impacted by disturbance.

Detailed mapping (3D detailed mapping area) developed from EIS and SREIS surveys combined with certified RE (EHP 2012a) and Mature Regrowth mapping (EHP 2012b) where detailed

mapping is not available indicates the following extent of EPBC Act listed ecological communities within the project development area:

- 7387 ha of the Brigalow Ecological Community Brigalow (*Acacia harpophylla* dominant and co-dominant) is identified in detailed mapping datasets.
- 678 ha of the Natural Grassland Ecological Community.
- 206 ha of the Coolibah- Black Box Ecological Community.
- 35 ha of the Semi-evergreen Vine Thicket Ecological Community.
- 260 ha of the White Box –Yellow Box, Blakely's Red Gum Ecological Community.
- 0.85 ha of the Weeping Myall Ecological Community.

A comparison between the EIS and SREIS studies in relation to threatened flora and fauna species (i.e. those listed as Endangered, Vulnerable or Near Threatened under the EBPC Act or NC Act) indicates a number of variations in species reported in desktop assessments, mostly due to changes in the project development area footprint and some additional variation as a result of updated data being made available for the SREIS study. These variations are detailed below.

Flora:

- Seventy-four flora species listed under the NC Act were identified during EIS desktop searches as being potentially present within the project development area. Of these, 38 were later excluded from the assessment following more detailed analysis. Six NC Act listed species were verified during EIS field surveys.
- Fifty-nine flora species listed under the NC Act were identified during SREIS desktop searches as being potentially present within the project development area, four of which were assessed as unlikely to occur within the EIS. Of these, 19 were later excluded from the assessment following more detailed analysis. No further NC Act listed flora species were verified during SREIS field surveys. An additional five NC Act species identified in the SREIS as possibly occuring have been assessed for impacts.
- Thirty-nine EPBC Act listed flora species were identified during EIS desktop searches as being potentially present within the project development area. Of these, 20 were later excluded from the assessment following more detailed analysis. Two EPBC Act listed flora species were verified during EIS field surveys.
- Twenty nine EPBC Act listed flora species were identified during desktop searches associated with the SREIS. Of these, 7 were excluded from the assessment following more detailed analysis. No further EPBC Act listed flora species were verified during SREIS field surveys.

Fauna:

- Forty-three fauna species listed under the NC Act were identified during EIS desktop searches as being potentially present within the project development area. Of these, 16 were later excluded from the assessment following more detailed analysis with 27 assessed for impacts. Three NC Act listed fauna species were verified during EIS field surveys.
- Forty-seven fauna species listed under the NC Act were identified during SREIS desktop searches as being potentially present within the project development area. Of these, 21 were later excluded from the assessment following more detailed analysis including spotted-tail quoll (*Dasyurus maculatus maculatus)* which was assessed as 'possibly occuring' in the EIS. An additional four NC Act listed fauna species were verified during SREIS field surveys bring the total number of verified species to seven.
- Twenty-six fauna species listed under the EPBC Act were identified during EIS desktop searches as being potentially present within the project development area. Of these, 15 were later excluded from the assessment following more detailed analysis. No EPBC Act listed fauna species were verified during EIS field surveys.
- Thirty-one EPBC Act listed fauna species were identified during SREIS desktop searches as being potentially present within the project development area. Twenty-one of these were later excluded from the assessment following more detailed analysis. Three EPBC Act listed fauna species were verified during SREIS field surveys. Within SREIS desktop review, an additional four species of potential relevance to the project were identified. Of these Tara wattle (*Acacia lauta), Eucalyptus virens* and Queensland white gum (*Eucalyptus argophloia*), all listed as Vulnerable under the EPBC Act and NC Act were assessed for significance of impact. *Cymbonotus maidenii,* listed as Endangered under the NC Act was identified as an additional species not recognised during the EIS assessment. It has subsequently been assessed for potential project related impacts. Assessment of relevant fauna information suggests that the spotted tail quoll (*Dasyurus maculatus maculatus)* is considered unlikely to occur in the project development area, a downgrade from 'possibly occurring' within the assessment from the EIS.

Within the survey areas subject to detailed ecological survey, a number of significant values relevant to terrestrial fauna and ecological communities were recorded. These are discussed in relation to survey areas below.

Survey area 2: The following listed fauna species were confirmed to occur:

- South-eastern long eared bat (*Nyctophilus corbeni* - Vulnerable EPBC Act) with 701.6 ha of known habitat (core habitat known) and 662.8 ha of possible habitat (core habitat possible) mapped on the survey area.
- Brigalow scaly-foot (*Paradelma orientalis* -Vulnerable EPBC Act and NC Act) with 443.4 ha of known habitat and 806.4 Ha of possible habitat mapped on the survey area.

- Glossy black-cockatoo (*Calyptorhynchus lathami* – Vulnerable NC Act) with 109.67 ha of known habitat and 1022.61 ha of general habitat mapped on the survey area.
- Black-chinned honeyeater (*Melithreptus gularis* – Near Threatened NC Act) with 772.1 ha of known habitat and 645.1 ha of potential habitat mapped on the survey area.
- Little pied bat (*Chalinolobus picatus* – Near Threatened NC Act) with 887.8 ha of known habitat and 524.3 ha of potential habitat mapped on the survey area.
- Golden-tailed gecko (*Strophurus taenicauda* - Near Threatened NC Act) with 1356.7 ha of known habitat and 768.1 ha of potential habitat mapped on the survey area.

Dunmall's snake (*Furina dunmalli),* and squatter pigeon (*Geophaps scripta scripta)* (both Vulnerable under the EPBC Act and NC Act), death adder *(Acanthophis antarcticus)* and square-tailed kite *(Lophoictinia isura)* (both considered Near Threatened under the NC Act) are all considered as possible occurences in survey area 2.

No EPBC listed ecological communites nor flora species listed under either the EPBC Act or NC Act were recorded in survey area 2.

Survey area 9: The following listed fauna species were confirmed to occur:

- Rough collared frog (*Cyclorana verrucosa* – Near Threatened NC Act) with 277.9 ha of known habitat mapped on the survey area.

Potentially occurring species include glossy black-cockatoo (*Calytorhynchus lathami*i) grey snake (*Hemiaspis damelii),* black -chinned honeyeater (*Melithreptus gularis),* bulloak jewel butterfly (Hypochrysops piceata), little pied bat (*Chalinolobus picatus*), square-tailed kite *(Lophoictinia isura),* and squatter pigeon (*Geophaps scripta scripta)*. Koala (*Phascolarctos cinereus)* was also identified as occurring although the species is not considered relevant to the assessment (refer to SREIS, Part B Submissions).

Revised vegetation mapping undertaken for survey area 9 identified 5.4 ha of the Brigalow Ecological Community (as RE11.4.3) within the survey area and 14.5 ha of RE11.3.17 (endangered biodiversity status). Neither of these habitats are identified as occurring within certified mapping produced by EHP. The survey area is also considered to host potential habitat for Belson's panic (*Homopholis belsoni* – Vulnerable EBPC and NC Act), finger panic grass (*Digitaria porrecta* –Endangered EPBC Act) and *Solanum stenopterum* and *Cymbonotus maidenii* (both Endangered under the NC Act).

Survey area 8: No listed fauna species were confirmed to occur on the survey area although it is considered to provide potential habitat for the rough collared frog (*Cyclorana verrucosa),* south-eastern long eared bat (*Nyctophylis corbeni),* brigalow scaly-foot (*Paradelma orientalis)*, glossy-

black cockatoo (*Calyptorhynchus lathami)*, black-chinned honeyeater *(Melithreptus gularis)* and little pied bat (*Chalinolobus picatus)*.

No flora species listed under the EPBC or NC Act were identified during surveys. The presence of one small patch of regrowth brigalow (2.1 ha) with significance under the EPBC Act due to its advanced stage of development (>15 years age) was confirmed to occur.

Survey area 7: No listed fauna species were confirmed to occur on the survey area although it is considered to provide potential habitat for golden-tailed gecko (*Strophurus taenicauda)*, brigalow scaly- foot (*Paradelma orientalis),* rough collared frog (*Cyclorana verrucosa),* Dunmall's snake *(Furina dunmalli), grey snake (Hemiaspis damelii),* south-eastern long eared bat (*Nyctophylis corbeni)* and little pied bat (*Chalinolobus picatus)*.

Whilst no flora species listed under the EPBC or NC Act were identified during field survey, the following EPBC listed ecological communities were confirmed to occur:

- Coolibah Black-Box Woodland Ecological Community (Endangered) with 11.5 ha identified as occurring.
- Weeping Myall Woodlands Ecological Community (Endangered) with 0.85 ha identified on the survey area.
- A small patch of the Brigalow Ecological Community (0.9 ha) as a disturbed regrowth habitat.

These ecological communities are not identified in the certified mapping produced by EHP, although Weeping Myall Woodland is not associated with an RE and the brigalow community is of a patch size that is smaller than standard mapping resolution (5 ha for 1:100 000 scale mapping).

Survey area F: No listed fauna species are confirmed as occurring on the survey area although it is considered to provide potential habitat for rough collared frog (*Cyclorana verrucosa*, golden-tailed gecko (*Strophurus taenicauda)*,, brigalow scaly-foot (*Paradelma orientalis)*, square-tailed kite (*Lophoictinia isura)* Dunmall's snake *(Furina dunmalli), grey snake (Hemiaspis damelii)* south-eastern long eared bat (*Nyctophylis corbeni),* five-clawed worm-skink (*Anomalopus mackayi),* glossy black-cockatoo (*Calytorhynchus lathami*i), black -chinned honeyeater (*Melithreptus gularis),* and little pied bat (*Chalinolobus picatus)*.

Whilst no flora species listed under the EPBC or NC Act was identified within the survey area, 1.1 ha of the Brigalow Ecological Community (associated with RE11.4.3) has been delineated in refined mapping undertaken on the survey area.

Validation of EIS Impact Assessment: Comparisons between EIS and SREIS survey findings indicate the following points:

1. Revised vegetation mapping at 1:10 000 scale undertaken in the SREIS has resulted in delineation of EPBC listed ecological communities and sensitive REs ('endangered' and 'of concern' biodiversity status). This is largely due to limitations in the spatial scale of certified RE mapping (1: 100 000 scale) which fails to represent finer scale variations in REs and vegetation communities. There is also considerable variation in the recognised extent of individual habitats between certified and revised vegetation mapping databases, which directly influences the extent of potential habitat represented for individual flora and fauna species.
2. An assessment of habitat value for sensitive fauna species indicates that comprehensive field survey has resulted in an upgrade of habitat value from ' core habitat possible' to 'core habitat known' for a range of sensitive species identified in field survey. No downgrade of habitat value from 'core habitat possible' to 'general habitat' or 'absence suspected' was facilitated through the results of field survey.
3. An assessment of floristic habitat value indicates that comprehensive field survey has failed to identify any sensitive species within any of the SREIS survey areas. A downgrade in habitat value from 'core habitat possible' to 'general habitat' was undertaken for those species in which comprehensive searches were undertaken within suitable habitats, and the species was not found. Other species, where confidence in survey effort and intensity may be lower due to unsuitable seasonal conditions have retained their original habitat ranking value as assigned in the EIS assessment.

Assessment undertaken at a property (survey area) scale indicates the following trends that can be applied in general to all future detailed surveys undertaken with the Arrow Surat Gas Project Area:

1. Failure to account for fine scale variation in vegetation through refinement of certified RE mapping (EHP 2012a and 2012b) may result in impacts to sensitive REs or EPBC Act listed ecological communities that are not identified in existing mapping databases. Fine scale vegetation mapping should be undertaken at development planning stage to ensure sensitive areas are adequately identified and accounted for.
2. Whilst comprehensive survey for sensitive flora species may result in downgrading the recognised value of habitat in some circumstance, it is much more difficult to do so for fauna species where animal mobility and varying seasonal conditions means that species can be much less reliably detected. Hence it will be desirable to avoid potential habitat for fauna species, whether a sensitive fauna species was confirmed in survey or otherwise.
3. Revised vegetation mapping has greatly increased resolution to the mapping of floristic and faunal habitats, enabling site specific planning to be undertaken on an informed and detailed basis.

The results and implications are largely consistent with the desired objectives of the 'framework approach', being "once the site is ground truthed, and where further constraints are discovered, the site will re-enter the planning phase and the site adjusted to avoid the initial constraint". For both survey area 2 and survey area 9, detailed ground survey has resulted in a greatly refined

understanding of the constraints on the site, allowing detailed planning to reduce impacts to sensitive habitats.

With further refinement of the Arrow Surat Gas project description and site investigation of survey areas identified for development, the release of coal seam gas water into Bottletree Creek and the Condamine River (survey areas 2 and 9 respectively) has been identified as an additional potential source of impact. Release of coal seam gas water has potential to impact to terrestrial ecological values, the most likely being:

- Changes to composition or growth rates of riparian and/or aquatic vegetation, favouring some native and/or exotic species. This could lead to some geomorphic changes including trapping of sediment, reduced channel capacity and channel migration. Bank erosion may also facilitate tree fall through bank collapse creating a niche for exotic species invasion.

Measures to manage such impacts to riparian habitats caused by regulated discharge are addressed through discharge limits, flow regimes and water quality guidelines.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Term	Definition
abiotic	Pertaining to physical and inorganic components of the environment.
alluvial	Sediments deposited by flowing water.
alluvium	A general term for unconsolidated deposits of inorganic materials (clay, silt, sand, gravel, boulders) deposited by flowing water.
arboreal	Relating to or moving within a tree (refering to fauna)
Back on Track	The Back on Track species prioritisation framework (Queensland Government) that prioritises Queensland's native species to guide conservation management and recovery.
basal area	A measure of the total cross-section area of stems at breast height (1.3 metres above the ground).
base flow (stream)	Groundwater discharge into a stream providing sustained stream flow.
benchmark	A description of a regional ecosystem that represents the median characteristics of a mature and relatively undisturbed ecosystem of the same type (Eyre *et al.,* 2006).
biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: • Genetic diversity – the variety of genes (or units of heredity) in any population; • Species diversity – the variety of species; • Ecosystem diversity – the variety of communities or ecosystems.
biodiversity significance	The ranked significance of an area according to specified biodiversity values to account for ecological concepts such as rarity, diversity, fragmentation, habitat condition, resilience, threats, and ecosystem processes. Biodiversity Planning Assessments identify three levels of biodiversity significance – state, regional and local –based on a number of data queries that simultaneously integrate an array of information for a bioregion. They may also indicate areas that have not been assigned a biodiversity significance because they have not met the criteria for state, regional or local significance based on current information (EPA, 2002).
biodiversity status	The status for regional ecosystems applied to gas and petroleum act activities, rather than the Vegetation Management act status.
bioregion (biogeographical region)	Queensland is divided into 13 bioregions based on broad landscape patterns that reflect the major underlying geology, climate patterns and broad groupings of plants and animals. Also defined in a national system of regionalisation by Thackway & Creswell (1995). (adapted from Sattler and Williams 1999).
Bitterlich Stick	A gauge used to measure the basal area in a vegetation habitat in m^2.
braun-blanquet (method)	A method of describing an area of vegetation devised by J. Braun-Blanquet in 1927. It is used for rapid survey of large areas. It uses two scales consisting of a plus sign and a series of numbers from 1 to 5 denoting both the numbers of species and the proportion of the area covered by that species.
Brigalow belt	A bioregion that spans inland and eastern Queensland from Townsville in the north to northern New South Wales, covering an area of about six million hectares.

Term	Definition
canopy	Defined in Beadle and Costin (1952) as a cover of foliage formed either by the community as a whole or by one of its component layers. It may be continuous or discontinuous (Neldner *et al.* 2005).
crepuscular	Pertaining to a species that is active in twilight.
critically endangered	Designated as 'critically endangered' under the EPBC Act. Refer to definition of 'EPBC Act conservation status' for meaning of critically endangered under the Act.
crown cover	The percentage of the sample site occupied by the vertical projection of the periphery of the tree crowns. Crowns are treated as opaque (Neldner *et al.,* 2005).
declared pests	An animal or plant may be declared under the *Land Protection (Pest and Stock Route Management) Act 2002.*
Coppicing	The ability of a plant to generate new growth from a stump or roots following disturbance.
disturbance	The physical displacement of existing features that leads to impacts.
ecological community	An assemblage of species occupying a particular area.
ecological condition	The health/condition of an ecological community, as assessed against the following criteria: • Disturbance (whether this be natural or human) including its degree or severity, its extent and distribution within the community; • Weed content — description of species abundance, horizontal and vertical distribution of each species; • Ecological viability — measure of a community's ability to survive in the longer term; • Ecological health — measure of regeneration, size structure and number of dead or dying plants within a community; • Ecological relationships — the sequential relationship of one community to another.
ecotone	A gradational change or transition between two habitats.
edaphic	Factors relating to conditions of soil or earth.
endangered	Under the Queensland *Nature Conservation Act 1992*, a species may be classified as 'endangered' if: (a) There have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife; or (b) the habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction; or (c) the population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction; or (d) the survival of the wildlife in the wild is unlikely if a threatening process continues. Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, a species may be classified as endangered if: (a) it is not 'critically endangered'; and

Term	Definition
	(b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
endemic	Taxon that has at least 75 % of its known range within a bioregion or which has a total range of 100,000 km^2 or less (Commonwealth of Australia 1995) (EPA, 2002).
environmental offset	An action taken to counter-balance any unavoidable negative impacts that might result from an activity or a development.
environmental weed	A plant that invades native plant communities (it may also invade farmland and urban areas) and which may hinder the survival and regeneration of native vegetation, thus affecting native fauna and, in some cases, permanently altering both vegetation structure and composition. Most environmental weeds are exotic plants, however there is a significant, and increasing, number of Australian plant species that are causing problems outside their normal range.
EPBC Act conservation status	Under the EPBC Act 1999, listed threatened species and ecological communities are assigned a conservation status of 'extinct in the wild', 'critically endangered', 'endangered' or 'vulnerable'. Definitions of these terms under the EPBC Act are as follows: **Extinct in the wild** • Known only to survive in cultivation, in captivity or as a naturalized population well outside its past range'; or • Not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form. **Critically endangered** • Facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria. **Endangered** • Not 'critically endangered'; and • Facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria. **Vulnerable** • Not 'critically endangered' or 'endangered'; and • Facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
ephemeral stream	A stream that flows periodically in response to rainfall and has no baseflow components.
erosion	The wearing away of rock or soil caused by physical or chemical processes.
essential habitat	An area identified for a species of wildlife listed as endangered, vulnerable, or near threatened under the *Nature Conservation Act 1992* on a map prepared by the chief executive officer of the EHP and certified by the chief executive officer of the EHP for the purposes of the *Vegetation Management Act 1999*.
EVNT species or taxon/taxa	A species of wildlife listed as ,'endangered', 'vulnerable, or 'near threatened' under the *Nature Conservation Act 1992,* and/or under the EPBC Act 1999, as 'extinct in the wild', 'critically endangered', 'endangered' or 'vulnerable'.
extirpate	Localised extinction of a species.
fossorial	Refers to a fauna species with ground dwelling habit.

Term	Definition
grey literature	Non peer reviewed scientific articles.
groundwater	Subsurface water, generally saturating the soil or rock in which it occurs.
habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
heterogeneous RE polygon	An area (polygon) delineated on a map of regional ecosystems (REs) comprising a mixture of RE types.
homogeneous RE polygon	An area (polygon) delineated on a map of regional ecosystems (REs) comprising a single RE.
impact	Any event or series of events that disrupt ecosystem, community, or population structure and alter the physical environment, directly or indirectly.
individual	A genetically discrete organism (within the genetic and morphological confines of a species, subspecies or variety) that has arisen from sexual reproduction, *viz.* a seed. It should be noted that for plants, many 'individuals' are genetically indistinguishable due to inbreeding and the accumulation of similar genes or the mode of seed .
Insectivorous	An organism that feeds on insects
intermittent stream	A stream which carries water through most of the annual cycle but stops flow periodically in response to seepage or excessive evapotranspiration.
Lacustrine	Wetland in the form of a Lake (open water).
land degradation	Land degradation includes the following: • Soil erosion; • Rising water tables; • The expression of salinity; • Mass movement by gravity of soil and rock; • Stream bank instability; and • Process that results in declining water quality.
land zones	Land zones represent major differences in geology and in the associated landforms, soils, and physical processes that gave rise to distinctive landforms or continue to shape them (Sattler and Williams 1999). Land zones are generally derived by amalgamating a range of geological, land system and/or soil mapping units at 1:100,000 to 1:250,000 scale. Twelve land zone classes have been defined for Queensland and are numbered from 1-12.
Matters of National Environmental Significance (MNES)	Those areas, places, species, communities or activities listed in Part 3 of EPBC Act as Matters of National Environmental Significance. These are: • World Heritage properties; • National heritage; • Wetlands listed as Ramsar wetlands of international importance; • Threatened species and communities listed under the EPBC Act (note that these species may not be the same as those listed under state legislation); • Migratory species listed under the EPBC Act (these are migratory species protected under international agreements); • Nuclear actions, including uranium mining; • The marine environment (which for the purposes of the Commonwealth is generally Australian waters beyond the 3 nautical mile limit of state waters; and

Term	Definition
	• Any other matter prescribed by regulation.
metapopulation	One to many subpopulations (geographically contiguous or disjunct) that share genetic connectivity. The ultimate aim of conservation biology is to conserve the different subpopulations and genetic variation (total taxon variation and subpopulation variation). The greater the genetic variation within a taxon or subpopulation, then the greater potential exists for 'adaptation' in response to stochastic events (i.e. climate change). A subpopulation may consist of one to many individuals of a species, subspecies or variety (collectively taxon). A taxon may comprise one to many metapopulations.
migratory species	An animal that periodically or occasionally migrates to, or visits, Australia.
native (flora)	The definition of native plants is based on that provided in Bostock and Holland (2010). This is plant taxa that have evolved in Queensland unaided by human intervention, or have migrated to and persist in Queensland unaided by human intervention. This does not include taxa that are naturalised to Queensland or a particular bioregion. Bostock and Holland (2007) lists plant taxa that are accepted as native to Queensland (adapted from Neldner *et al.,* 2005).
naturalised	The definition of naturalised plants or vegetation is based on that provided in Bostock and Holland (2010). This is plant taxa that have originated outside Queensland or a bioregion that have been introduced to Queensland or a bioregion by or with the help of humans intervention, and persist there unaided by human intervention. Bostock and Holland (2010) lists plant taxa that are naturalised in Queensland or particular pastoral districts (adapted from Neldner *et al.,* 2005).
NC Act 1992 conservation status	Under the NC Act, protected species are assigned a conservation status of 'extinct in the wild', 'endangered', 'vulnerable', 'near threatened', or 'least concern'. Definitions of these terms under the NC Act are as follows: **Extinct in the wild** • There have been thorough searches conducted for the wildlife; and • It has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife. **Endangered** • There have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife; or • The habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction; or • The population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of extinction; or • The survival of the wildlife in the wild is unlikely if a threatening process continues. **Vulnerable** • Its population is decreasing because of threatening processes; or • Its population has been seriously depleted and its protection is not secured; or • Its population, while abundant, is at risk because of threatening processes; or

Term	Definition
	• Its population is low or localised or depends on limited habitat that is at risk because of threatening processes. **Near threatened** • The population size or distribution of the wildlife is small and may become smaller; or • The population size of the wildlife has declined, or is likely to decline, at a rate higher than the usual rate for population changes for the wildlife; or • The survival of the wildlife in the wild is affected to an extent that the wildlife is in danger of becoming 'vulnerable'. **Least concern** • The wildlife is common or abundant and is likely to survive in the wild. Native wildlife may be prescribed as 'least concern' wildlife even if; o The wildlife is the subject of a threatening process, or o The population size or distribution of the wildlife has declined, or o There is insufficient information about the wildlife to conclude whether the wildlife is common or abundant or likely to survive in the wild.
near threatened	Designated as 'near threatened' under the NC Act. Refer to definition of 'NC Act conservation status' above for meaning of near threatened.
niche	A term describing the relational position of a species or population in its ecosystem to each other.
non-remnant vegetation	All vegetation that is not mapped as remnant vegetation by EHP and/or that fails to meet EHP criteria for 'remnant vegetation'. May include regrowth, heavily thinned or logged and significantly disturbed vegetation that fails to meet the structural and/ or floristic characteristics of remnant vegetation. It also includes urban and cropping land. Non-remnant vegetation may retain significant biodiversity values (Neldner *et al.* 2005).
not of concern	Designated as 'not of concern' under the VM Act. Refer to definition of 'VM Act status' for meaning of 'not of concern' under the Act.
of concern	Designated as 'of concern' under the VM Act. Refer to definition of 'VM Act status' for meaning of 'of concern' under the Act.
ort	Used to describe a scrap of food although used in this report to indicate a chewed cone of casuarina species indicative of feeding by glossy black-cockatoo.
palustrine	Palustrine wetlands are primarily vegetated non-channel environments of less than eight hectares. They include billabongs, swamps, bogs, springs, soaks etc.
perennial stream	A watercourse or stream that maintains flow throughout the annual seasonal cycle
perennial species	Perennial species are long-lived plants, tending to persist for three or more years. Generally characterised by larger bulk than annual grasses i.e. forming tussocks and large root mass with evidence of previous seasons growth i.e. remains of last year's tiller bases, and presence of stolons or rhizomes (or underground rooting systems) (Eyre *et al.,* 2006).
population	In the absence of genetic data, disjunct locality records (those that are separated by areas of different habitat, i.e. Regional Ecosystems where the taxon is absent). A population may consist of one to many individuals. Greatly disjunct populations are inferred to harbour significant genetic

Term	Definition
	variation due to historical patterns of genetic drift. A species, subspecies or variety that has population groups in e.g., the Wet Tropics and Border Ranges, would be inferred to comprise several metapopulations.
quaternary site	Quaternary site data are used primarily as a record of field traverses and to verify regional ecosystem/vegetation mapping. These sites are generally collected throughout the field survey and entered on spreadsheets or databases. Quaternary sites may be collected at regular intervals along a traverse, and/or made where REs/vegetation communities change.
regional ecosystem (RE)	A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil. REs may be classified under schedules 1–3 of the Vegetation Management Regulation as either 'endangered', 'of concern' or 'not of concern'. Refer to 'VM Act conservation status' for meaning of 'endangered', of 'concern' or 'not of concern' under the VM Act.
regrowth vegetation	Non-remnant vegetation that has a significant woody component but fails to meet the structural and/or floristic characteristics of remnant vegetation. Includes vegetation that has regrown after clearing or been heavily thinned or logged and may retain significant biodiversity values.
regrowth vegetation code	Allows for regulation of the clearing of high value regrowth vegetation (HVR) defined as regrowth vegetation that has not been cleared post December 31, 1989. Exemptions to the code apply to clearing of regrowth vegetation for extractive industry within key resource areas, clearing for a number of prescribed land management practices (e.g. fencing or firebreaks) or for significant community projects.
remnant vegetation (or remnant regional ecosystems)	Remnant vegetation for areas of woody vegetation where there is evidence of past clearing. It follows that used in the *Vegetation Management Act 1999* for areas for which no regional ecosystem or remnant vegetation cover mapping exists. Remnant woody vegetation is defined as vegetation where the dominant canopy has >70 % of the height and >50 % of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy (Neldner *et al.,* 2005).
runoff	All surface flow from within a catchment.
S1	The upper shrub layer of a vegetation community.
secondary site	Vegetation survey sites used for classification and detailed descriptions of regional ecosystems and vegetation communities. Data collected include all location, environmental and overall structural information as well as a list of all species present and basal area (of woody stems using the Bitterlich stick method), percentage cover and stem density measures of abundance within a 50x10 m plot.
Senescing/ senescence	Reaching late maturity.
site (survey)	An area of vegetation with relatively uniform structure, floristics and geology where botanical data are collected such as primary, secondary, tertiary or quaternary sites. For trees, the site includes the area covered by a basal area sweep (Bitterlich stick or prism) (Neldner *et al.,* 2005).
Scale of delineation	The minimum polygon size recorded in a vegetation mapping product. 1:50 000 scale mapping typically has a minimum polygon size of 0.5 ha.
Spatial scale	The spatial accuracy of a vegetation mapping product. 1:10 000 scale = +/- 10 m accuracy of delineated vegetation boundaries; 1:50 000 scale = +/- 50 m accuracy of delineated vegetation boundaries.

Term	Definition
stratum	A layer in a community produced by the occurrence at approximately the same level (height) of an aggregation of plants of the same habit (Beadle and Costin 1952 in Neldner *et al.,* 2005).
stochastic	A process involving a random set of variables interacting over time.
structure	The spatial arrangement of plants within a vegetation community (Beadle and Costin 1952 in Neldner *et al.,* 2005).
survey area	A property or properties within a defined drainage area identified for development and siting of infrastructure associated with a Central Gas Processing Facility or accomodation village.
T1	The tree canopy layer of a vegetation community.
T2	The tree subcanopy layer of a vegetation community.
taxon (plural taxa)	Any group or rank in a biological classification into which related organisms are classified (e.g. phylum, order, family, genus or species).
tertiary site	Vegetation survey sites used for classification and descriptions of regional ecosystems and vegetation communities. Data collected include all location, environmental and overall structural information as well as a comprehensive list of woody species and basal area measure of abundance (of woody stems using the Bitterlich stick method). Generally only the dominant or conspicuous species in the ground layer are recorded.
threatened	Used with reference to ecological communities, REs or species of that are endangered, vulnerable or of concern as listed under the NC Act, the VM Act or the EPBC Act (see NC Act conservation significance, the VM Act conservation significance and EPBC Act conservation significance for more details).
threatened ecological community	Three categories exist for threatened ecological communities under the Commonwealth *Environment and Biodiversity Conservation Act 1999:* • **Critically endangered:** If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future; • **Endangered:** If, at that time, it is not 'critically endangered' and is facing a very high risk of extinction in the wild in the near future; and • **Vulnerable:** If, at that time, it is not 'critically endangered' or 'endangered', and is facing a high risk of extinction in the wild in the medium-term future.
threatening process	A threatening process is any process that is capable of: • Threatening the survival of sensitive areas including any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat; or • Affecting the capacity of any protected area, area of major interest, protected wildlife, community of native wildlife or native wildlife habitat to sustain natural processes.
traverse	The route travelled by vehicle or on foot in the field. For determination of relative reliability it represents a record of where the surveyor has been and is an index to the amount of informal observations (Neldner *et al.,* 2005).
vegetation community	A component of a regional ecosystem that has similar structure and floristics and generally occurs within the same land zone. These components of regional ecosystems are generally mappable at scales larger than 1:100,000. A number of vegetation communities may make up a single

Term	Definition
	regional ecosystem, and is usually distinguished by differences in dominant species composition, frequently in the shrub or ground layers (Neldner *et al.,* 2005).
vegetation map	A map whose primary purpose is to show the geographical distribution of the various vegetation types of a given area (Neldner *et al.,* 2005).
VM Act conservation status	Under the VM Act, REs may be classified as either 'endangered', 'of concern' or 'not of concern'. Definitions of these terms under the VM Act are: **Endangered** • Less than 10 % of pre-clearing extent of remnant vegetation (see following definition) exists in the bioregion, or 10 to 30 % of pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares. In addition, for biodiversity planning purposes EHP also classifies a regional ecosystem as endangered if; o Less than 10 % of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss, or o 10-30 % of its pre-clearing extent remains unaffected by severe degradation, and/or o Biodiversity loss and the remnant vegetation is less than 10,000 hectares; or it is a rare regional ecosystem subject to a threatening process. **Of concern** • 10 to 30 % of pre-clearing extent of remnant vegetation exists in the bioregion, or more than 30 % of pre-clearing extent remains and the remnant vegetation is less than 10,000 ha. In addition, for biodiversity planning purposes DERM also classifies a regional ecosystem as of concern if; o 10-30 % of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss. **Not of concern** • More than 30 % of pre-clearing extent of remnant vegetation exists in the bioregion, and it is greater than 10,000 ha. In addition, for biodiversity planning purposes DERM also classifies a regional ecosystem as not of concern if the degradation criteria listed above for endangered or of concern REs are not met.
vulnerable	Designated as 'vulnerable' under the EPBC Act and/or NC Act. Refer to definitions of 'EPBC Act conservation status' and 'NC Act conservation status' for meaning of 'vulnerable' under these acts.
waterlogging	The saturation of soil by soil water.
watertable	The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric.
WildNet	Queensland EHP WildNet Database which contains recorded wildlife sightings and listings of plants, fungi, protists, mammals, birds, reptiles, amphibians, freshwater fish, marine cartilaginous fish and butterflies in Queensland.

1.0 Introduction

1.1 Background

Arrow Pty Ltd (Arrow) is developing the Surat Gas Project, an upstream gas field development in the Surat Basin, southeastern Queensland. An environmental impact statement (EIS) has been prepared for the project under Chapter 3 of the *Environmental Protection Act 1994* (Queensland) EP Act) and section 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act), to be assessed in accordance with the Bilateral Agreement between the Commonwealth and the state of Queensland relating to environmental assessment. The EIS for the project was approved by the Queensland Government for public release on 16th March, 2012 with a public review period that closed on 14th of June 2012.

3D Environmental has been contracted to undertake a supplementary ecological assessment for the project to inform the Supplementary Report to the EIS (SREIS), which includes an assessment of both floristic and faunal values. The SREIS is required to present information on any changes to the project description, address issues identified in the EIS as requiring further consideration and/or information, and to respond to comments raised in submissions on the EIS.

1.2 Overview of the Framework Approach

The lack of certainty about the preferred location of infrastructure is an issue for environmental impact assessment because the impacts at a specific location cannot be fully understood. However, they can be described based on the typical impacts of project activities. With that knowledge, greater certainty about potential impacts can be achieved by identifying those areas that are not amenable to certain types of development and if they were developed, how development should proceed. This is achieved by identifying constraints to development and establishing environmental management controls that should apply to project activities in constrained areas.

Known as the environmental framework approach, this is a process developed by Arrow for managing impacts in the planning phase (site selection) and in the construction and operation phases. As such, environmental controls are applied that reflect the sensitivity or vulnerability of environmental values at a particular location. Constraints mapping, an integral part of the environmental framework, will guide the selection of sites and routes to avoid and minimise potential impacts, thereby protecting environmental values.

Arrow will undertake the appropriate internal planning phase of the project where constraints mapping will inform the initial site location. Once the site is ground truthed, and where further constraints are discovered, the site will re-enter the planning phase and the site adjusted to avoid the initial constraint. Where a significant environmental constraint cannot be avoided the site will be considered in consultation with the relevant authority.

2.0 Project Description Changes/Review of Data

2.1 Generic Overview

The main changes to the project description, presented in the EIS, which have the potential to affect the terrestrial ecology impact assessment, include changes to the size of the project development area and the identification of sites to locate four central gas processing facilities and two water treatment facilities. In addition, the updated project description proposes to discharge coal seam gas water under normal operations. Details of changes to the project description are provided below.

Through ongoing exploration activities, Arrow has enhanced its understanding of the gas resource and subsequently, relinquished numerous parcels of land, where development activities will cease. Due to the relinquishment of parcels of land within Arrows' exploration tenements, there has been a reduction in the overall size of the project development area from 8,600 km2 to 6,100 km2. The majority of these relinquishments were made in the Goondiwindi development region.

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

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

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

The inclusion of deviated well technology and the use of multi-well pads may increase the separation distance between adjacent well pads.

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

Field development planning has advanced since preparation of the EIS, with the overall project development area being separated into eleven drainage areas **Figure 1**, identified simply by sequential numbering (drainage areas 1, 2, 5, 7, 8, 9, 10 and 11), that correspond with the gas reserves that will be fed into each central gas processing facility. Subsequently, the supplementary

report to the EIS discusses the sequence of the project's development in terms of the drainage areas, as opposed to the five development regions that were described in the EIS.

It is currently expected that eight of these drainage areas will be initially developed for the Surat Gas Project with each drainage basin incorporating wells, a water gathering network, a gas gathering network and a central gas processing facility. This constitutes a reduction in the number of central gas processing facilities from 12 described in the EIS to eight. A further three drainage areas may be developed with favourable reservoir outcomes and future market conditions.

Since the EIS was published, Arrow has identified properties on which to site four CGPFs and one temporary workers accommodation facility (TWAF). It is intended that all properties identified for major facilities (i.e., CGPFs, water treatment facilities, TWAFs) will either be owned by Arrow, or leased under a long-term arrangement.

The specific locations within the properties identified for each of the CGPFs will be guided by site-specific technical, environmental and social features, including ground stability, elevation, remnant vegetation, topography, and proximity of sensitive receptors. The approximate footprint for a central gas processing facility is 350 m x 520 m.

The number of water treatment facilities has been reduced from six described in the EIS to two, co-located with the central gas processing facilities in drainage area 2 and drainage area 9. The total footprint at each water treatment facility will be approximately 2 km2 (200 ha), as originally stated in the EIS.

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

The exact locations of infrastructure within the four identified central gas processing facility sites and one accommodation village site have not been determined, however properties within these areas has been identified for development. Final siting of infrastructure and the specific orientation and layout of each facility will depend on site-specific land and environmental features, such as remnant vegetation, topography, soil and the proximity of sensitive receptors. Properties subject to survey effort for the SREIS will be referred to as survey areas relative to the drainage area in which they are located. Facilities will be designed and constructed to minimise footprint and environmental impact.

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

The updated Coal Seam Gas Water and Salt Management Strategy states that coal seam gas water will be discharged from each water treatment facility to a nearby watercourse as required and

within prescribed limits. Discharge to watercourses is a management option that addresses the variability of other coal seam gas water management options (i.e., distribution to existing and new water users for beneficial use and injection to a suitable aquifer). Surface water aspects such as watercourse type, morphology, and aquatic ecosystems at the two identified water treatment facility sites will dictate the management options that can be utilised.

2.2 Specific Changes Relevant to Terrestrial Ecology

Changes to the project description for the Surat Gas Project along with submissions made on the SREIS include::

1. Arrow have relinquished approximately 2500 km^2 of tenement reducing the EIS project area (8600 km^2) to 6100 km^2 for the purpose of the SREIS. The revised project development area is illustrated in **Figure 1.** The detailed mapping area from the EIS study also shown remains unaffected by the change of project development area boundary.
2. The revised project description describes the locations of five known project facilities and includes the option for discharge of coal seam gas water to watercourses during operations. The location of properties subject to development, being survey area 2, survey area 7, survey area 8, survey area 9 and survey area F are shown in **Figure 1.**
3. Production wells will now be arranged in multi-well pads in some instances. Multi-well pad arrangements will comprise up to twelve well heads on larger pad areas, thereby reducing the cumulative area of land disturbed compared with single well pads.

2.3 Study Aims

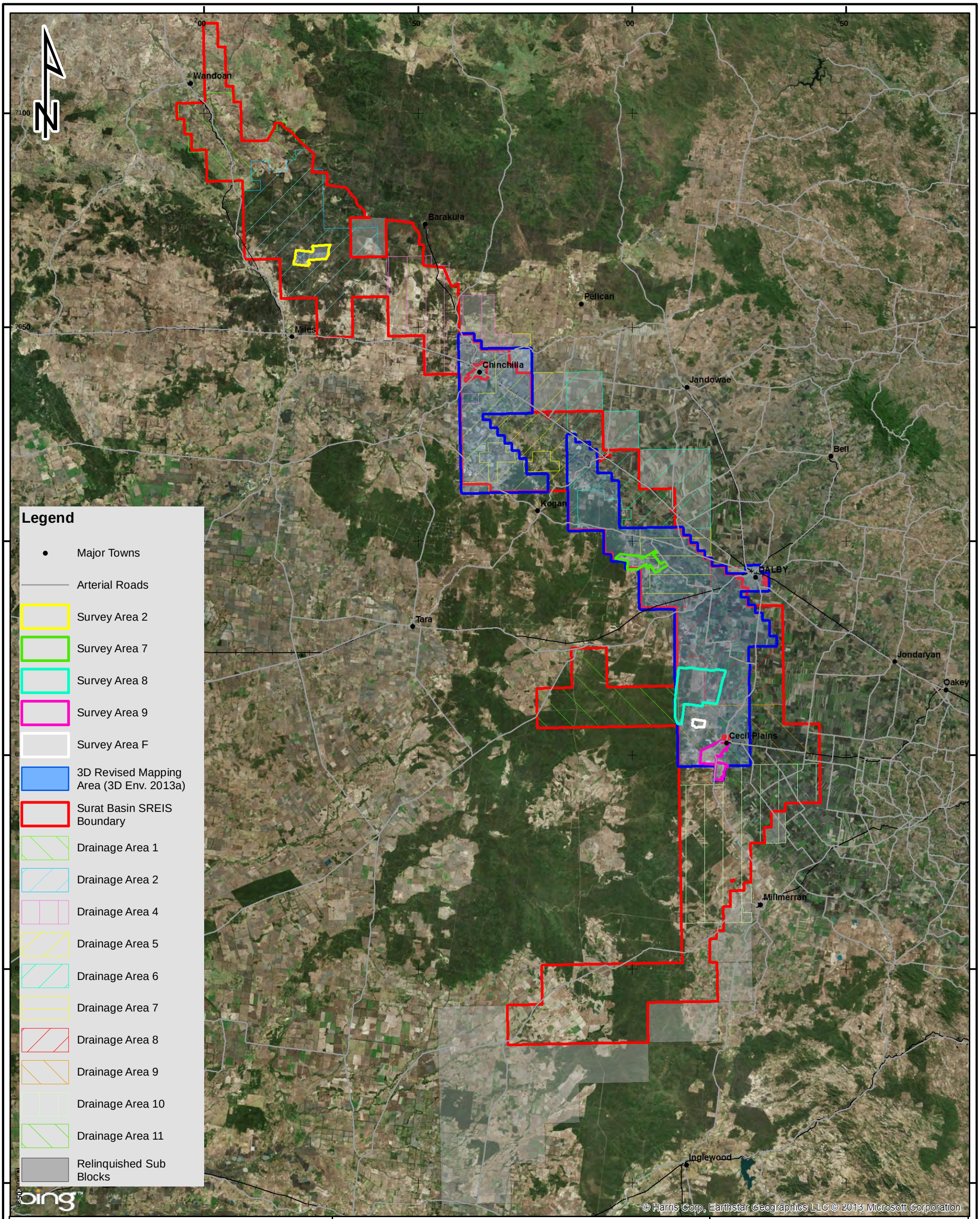
Specific areas requiring attention and further assessment in the SREIS are:

- Updates to the project description: The revised project description describes the option for discharge of coal seam gas water to watercourses during operations.
- Issues requiring further consideration and/or information:
    - The terrestrial ecology assessment in the EIS does not provide a site- specific assessment for facility and infrastructure locations.
    - An estimated area of disturbance (for habitats) must be included in the EIS.
- Issues raised by Department of Sustainability, Environment, Water, Population and Community (SEWPaC) and Department Environment and Heritage Protection (EHP):
    - Vegetation corridors are not adequately described within the EIS with further detail required for the identification of use and potential impacts upon listed species.
    - Additional information is required in the SREIS to identify if potential impacts are likely to be unknown, unpredictable or irreversible for all Matters of National Environmental Significance (MNES) communities and species (i.e. species listed as threatened under the Commonwealth EPBC Act).

The aims of this terrestrial ecology study are to:

- Review and compare changes to the project development area to determine the relevance of assessed impacts made within the EIS to the SREIS. This is to incorporate any additional data that has become available following submission of the EIS.
- Provide results of site- specific field surveys for all known infrastructure locations (four central gas processing facilities and village F) locations. This assessment will:
    - Further refine the desktop assessment of regional ecosystems undertaken for the EIS and map and quantify the extent of core habitat present within the boundaries of known central gas processing facility properties and proposed survey area F (survey areas).
    - Ground-truth vegetation and undertake comprehensive flora and fauna surveys of those areas identified for potential clearance.
- Provide a site specific assessment of riparian vegetation occurring at the location of two conceptual watercourse discharge locations within properties identified for development.
- Map existing wildlife corridors (as identified in the Biodiversity Planning Assessment criteria) and identify how corridors will be assessed as important for listed species.
- Describe whether potential impacts are likely to be unknown, unpredictable or irreversible for all MNES communities and species as required by s 3.01(c) of Schedule 4, Environment Protection and Biodiversity Conservation Regulations. Assessment of impacts to MNES species and ecological communities as per MNES Guidelines (DEWHA 2008) relevant to the project development area within properties subject to development.
- Further verification of EHP Regional Ecosystem Mapping (EHP 2012a) to inform habitat availability pertinent to the calculation of habitat offsets under relevant state and federal legislation.
- Provide methodology objectives and advice to inform survey requirements for ground truthing and the detection of environmental values.

Based on submissions made to the original EIS, some specific aspects of terrestrial ecology within the project development area have been addressed or further elaborated. This includes impacts to bioregional corridors and wetlands. Updates to Environmentally Sensitive Areas (ESA's) are also provided.



N O T E S:

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

Source: Brigalow Belt Biodiversity Planning Assessment (EPA 2008).

Figure 1. SREIS project development area and survey areas

Client

Coffey Environments

0 20 40 60 80

Kilometers

Scale	1:820,000	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_A3P.mxd	Date	2/05/2013	A4

3D Environmental

Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

3.0 Legislative/ Policy Context

No environmental legislative changes of relevance to the project have come into effect since the publication of the EIS However, a number of policy documents have been subsequently released that may influence the SREIS and ongoing project environmental requirements. These documents are listed below:

- The Department of Environment and Resource Management (DERM, now Department of Environment and Heritage Protection (EHP)) has released the revised Policy for Vegetation Management Offsets - Version 3 (DERM, 2011a). This document provides up to date information regarding the required application of vegetation management offsets to achieve the desired outcomes of the Queensland *Vegetation Management Act, 1999.*
- EHP has released the Queensland Biodiversity Offsets Policy (Version 1) (DERM, 2011b). The policy provides a framework to ensure no net loss of biodiversity in Queensland through the application of project specific biodiversity offsets.
- EHP has released the Ecological Equivalence Methodology Guideline (DERM, 2011c). The guideline is intended to inform requirements for ecological offset required under the Policy for Vegetation Management Offsets (DERM 2011a) and Queensland Biodiversity Offsets Policy (DERM, 2011b). Under the Queensland Biodiversity Offsets Policy, offsets must be applied to:
    - Remnant 'endangered' regional ecosystems.
    - Remnant 'of concern' regional ecosystems.
    - High value regrowth vegetation containing 'endangered' regional ecosystems (including mature regrowth).
    - High value regrowth vegetation containing 'of concern' regonal ecosystems (including mature regrowth).
    - Essential Habitat.
    - Landscape connectivity.
    - Protected flora and fauna.
- SEWPaC has released the EPBC Act Environmental Offsets Policy (SEWPaC, 2012). The policy relates to protection of all matters protected under the EPBC Act through application of project specific biodiversity offsets.
- EHP now recognises 'mature regrowth' vegetation which was incorporated under the EP Act as of 24 th June, 2012. Biodiversity status is attributed to mature regrowth as from its parent regional ecosystem (RE).

There have also been a number of species and habitats that have been added to, removed from, or amended within the schedules of the EPBC Act which may influence the project as listed below:

- On January 30 2013 the status of king blue grass (*Dicanthium queenslandicum*) under the EPBC Act was amended to endangered (previously vulnerable). This amendment came into effect after the project was declared a controlled action and as such, the SREIS will consider the species with the status it had at the time the controlled action was decided i.e., as vulnerable. Potential impacts on this species are assessed in accordance with the EPBC significant impact criteria for vulnerable species
- On the 2nd May 2012, the koala in New South Wales and Queensland was added to the EPBC Act as 'vulnerable'. Referral guidelines for the koala have been released and outline criteria for assessing 'critical habitat', 'important populations' and significant impacts. The EPBC Act listing of koala came into effect after the decision was made that the Surat Gas Project was to be a controlled action. Hence the MNES assessment for the project is not affected by this listing.
- On 29 April 2013, the status of Australian painted snipe (*Rostratula australis*) under the EPBC Act was amended to endangered (previously vulnerable). The amendment to the listing for Australian painted snipe (*Rostratula australis*) came into effect after the project was declared a controlled action. The SREIS will consider the species with the status it had at the time the controlled action was decided i.e., as vulnerable. Potential impacts on this species are assessed in accordance with the EPBC significant impact criteria for vulnerable species.
- On 29 April 2013, Brigalow scaly-foot (*Paradelma orientalis*) was delisted (previously vulnerable) and is no longer considered threatened under Commonwealth legislation. Although no assessment is required under the EPBC Act, assessment of the species is retained in this document. Further assessment of the species will be completed at subsequent stages of environmental approval (Environmental Authority Stage). It should be noted that the species retains its status as vulnerable under the NC Act.

As the latter two amendments were made as this report was being finalised, the species are still reflected throughout the report following their status at the time the project was declared a controlled action.

There have also been a number of species removed from schedules of the NC Act that remain referenced in the EIS technical study. These species are identified in subsequent relevant sections.

4.0 Methods

Survey methods follow those detailed in the specialist terrestrial ecology report for the EIS (Appendix K of the EIS) (3D Environmental/ Ecosmart 2011) although additional methods were applied to some components of the SREIS to facilitate comprehensive assessment of all values.

4.1 Literature and Database Review

A review of available literature was undertaken to supplement, refine and update the desktop assessment completed for the EIS. The review considered a full range of information sources to ensure requirements for additional information were adequately addressed. The approach to desktop assessment for flora and fauna is provided below.

4.1.1 Flora

Desktop material reviewed and analysed included raw data derived from database searches, information held by agencies and/or individuals and interpretive reports. Database searches from state and Australian government agencies provided the basis for the majority of background information regarding the presence and distribution of flora species, listed under legislation or otherwise, known from or likely to occur within the project development area. Particular focus was paid to information sources that were not available during the EIS study or were subject to updated information. The major databases and information sources searched are detailed in **Table 1.**

Table 1. Database sources relevant to floristic assessment.

Source	Notes	Abbreviation	Used in EIS	Updated for SREIS
Queensland Herbarium's records system (EHP, 2013).	Specimen-backed, so highly reliable. Geographic co-ordinates available. Search area taken as a 25 km buffer around the revised project development area (defining the study area) with analysis undertaken for all Endangered, Vulnerable and Near Threatened (EVNT) species contained within the study area.	Herbrecs	Yes	Yes
Regional Ecosystem Description Database (EHP, 2012c).	Reliable vegetation descriptions based on site survey data. Latest version (Version 7, was released in August 2012).	REDD	Version 6.0	Yes
EPBC Protected Matters search tool.	Predictive only and includes species restricted to habitats that occur outside the project development area. A buffer of 25 km has been applied to the revised project development area (defining the study area).	EPBC Online	Yes	Yes
EHP's Version 7.0 Regional Ecosystem digital data (EHP, 2012a).	Mapping of regional ecosystems based on aerial photographic/ satellite interpretation and limited site data. Reliability varies dependent of geographic location and accessibility for survey. Dataset has been updated subsequent to submission of the EIS	No Abbreviation	Version 6.0	Yes

Source	Notes	Abbreviation	Used in EIS	Updated for SREIS
	with Version 7.0 data released specifically for use in projects regulated under the EP Act where ´biodiversity status‘ rather than ‚vegetation management status‘ is applicable.			
EHP‘s Mature Regrowth digital data (EHP, 2012b).	Mapping of regrowth vegetation based on temporal analysis of aerial photography or satellite imagery, identifying regrowth vegetation not been cleared subsequent to 31 December 1989. The mature regrowth dataset varies from ´high value regrowth‘ dataset in that it is attributed parent RE.	No Abbreviation	No	Yes
Queensland Wetland Data (EHP, 2012e).	Mapping of wetland habitat based on aerial photograph/ satellite image interpretation, topography and limited site data. Reliability varies dependent upon reliability of RE mapping produced by DERM (2012a). The dataset was not referenced within the EIS.	No Abbreviation	No	Yes
Australia’s Virtual Herbarium (AVH, 2013) (http://avh.ala.org.au)	Compilation of specimen backed data from a range of sources. Generally reliable. Review as a supplementary tool to analyse EPBC Online search results and provide broader context to the Herbrecs search (EHP, 2013).	AVH	No	Yes
Other literature	Primary literature; personal communications with relevant personnel, including EHP staff; books. Other sources include technical and impact assessment reports relevant to the project site including those of other coal seam gas (CSG) proponents and other major infrastructure projects in the region	References are provided throughout document where appropriate.	Yes	Yes
Back on Track (BoT) species prioritisation framework (EHP 2012d)	A framework approach that prioritises species for recovery actions although no information specific to distribution is provided.	BoT	No	Yes
Biodiversity Planning Assessment - Brigalow Belt North (EPA, 2008a)	A geographical information tool based on a range of data sources including expert opinion. Reliability varies dependent on RE mapping and scale of data. Some specimen backed information is presented. The database was reviewed specifically to address additional information requirements in respect to buffers.	BPA	Yes	No
Arrow‘s threatened species survey database	Survey database of threatened species records collected during Arrow preclearance surveys. Mostly relevant to fauna species with all flora records located within the Bowen Basin well north of the project development.	AED	No	Yes
Queensland Herbariums Corveg	Database providing summary floristic information for Queensland Herbarium	Corveg	Yes	No

Source	Notes	Abbreviation	Used in EIS	Updated for SREIS
Database	site survey data. Provides date for sites that have been checked for consistency only and not updated on a regular basis.			
EHP WildNet	Moderately reliable observations. No geographic co-ordinates available. Irregularly updated with material provided from a number of sources. Considered secondary to Herbrecs which provides geographic locality and is regularly updated.	WN	Yes	No

4.1.2 Fauna

During the early stages of the project, the existing database compiled for the EIS was updated to include any records that had been added to the system since 2009. Notably, this included the manual extraction of EVNT and BoT species records from the Queensland Wetlands Database; a database which is based on WildNet records and allows individual taxon search and location-specific records. Previous WildNet searches could not be confined to the Arrow leases, and included surrounding records. The updated database provides spatial information for species of conservation priority.

The Arrow field threatened species survey database was also utilised as an additional point source of EVNT fauna species locations. The Aquatic Conservation Assessments for the southern Brigalow belt was also reviewed, but as the report does not provide location-specific data, it was of limited use. An overview of databases utilised in the EIS is provided below.

Table 2. Database sources relevant to fauna assessment.

Source	Notes	Abbreviation	Used in EIS	Updated for SREIS
Queensland Museum collections database	Specimen-backed, so highly reliable. Geographic co-ordinates available.	QM	Yes	Yes
Birds Australia Atlas	Highly reliable observations. Geographic co-ordinates available. Only data collected from 1980 onwards was used.	BA	Yes	Yes
EHP WildNet	Moderately reliable observations. No geographic co-ordinates available. Only data collected from 1980 onwards was used in EIS.	WN	Yes	No
EPBC Protected Matters search tool	Predictive only. Of limited use for vertebrates. Most of the relevant species returned by this tool are also included in the search results from the other sources.	EPBC Online	Yes	Yes
EcoSmart Ecology database	Observations only. Geographic co-ordinates available. Dataset has been compiled from field surveys in which EcoSmart Ecology personnel have participated. These include surveys conducted in conjunction with DERM and private surveys conducted by Ecosmart Ecology.	ESE	Yes	Yes
Other literature	Primary literature; personal communications with relevant personal,	References are provided	Yes	Yes

Source	Notes	Abbreviation	Used in EIS	Updated for SREIS
	including DERM staff; books; technical reports; Biosecurity Queensland's predictive and annual pest mapping database (DAFF 2012).	throughout document where appropriate.		
Biodiversity Planning Assessment Methodology	A geographical information tool used to generate Biodiversity Planning Assessments (BPAs). The methodology can be used to identify areas of various levels of biodiversity significance.	BPA	Yes	No
Back on Track (BoT) species prioritisation framework	A framework approach that prioritises species for recovery actions although no information specific to distribution in provided.	BoT	Yes	Yes
Queensland Wetlands Database.	Specimen-backed, so highly reliable. Geographic co-ordinates available. Species searches were undertaken within the study area with all records extracted for inclusion within the project fauna records database.	QWD	No	Yes
Arrow threatened species database.	Survey records of threatened fauna species collected during pre-clearance surveys. Geographic co-ordinates available for all records. Considered reliable.	AED	No	Yes
Aquatic Conservation Assessments Database.	Predictive only does not provide location specific data. Of limited use to the SREIS study.	ACA	No	Yes

4.2 Aerial Photograph Review

Arrow has acquired high resolution imagery , as well as LIDAR, for the project development area. The high resolution imagery was utilised specifically to refine RE mapping contained within those areas subject to development (survey areas 2, 7, 8, 9 and F). The date of imagery capture, being November 2012, provides certainty that captured vegetation boundaries represent contemporary distribution of vegetation. Specifically, the high resolution imagery was used to:

- Upgrade vegetation mapping undertaken by 3D Environmental (at 1: 40 000 scale) to a spatial scale of 1: 10 000 areas subject to development (survey areas 2, 7, 8, 9 and F).
- Assist attribution of polygons in vegetation mapping undertaken in 3D Environmental revised mapping area.
- Ensure vegetation boundaries represent contemporary boundaries and that vegetation clearing undertaken post EIS is reflected in mapping undertaken for the SREIS.

Whilst LIDAR data can be useful to remotely assess the height of vegetation, and hence assist the determination of remnant status and vegetation structure, there was no particular application used for LIDAR in the assessment of vegetation in the SREIS study. Historical imagery (stereoscopic pairs) was however acquired to complete coverage for survey areas subject to development, specifically survey area 2 and the southern portion of survey area 9. Historical imagery was used to

determine the age of regrowth vegetation, determine prior landuse activities and hence vegetation condition and assist determination of land zone which is otherwise difficult to ascertain without stereoscopic pairs. Historical imagery acquired for the SREIS is listed as:

- Millmerran (1984) 1: 40 000; Run 3, frames 147 and 147
- Tuluguba (1984) 1: 40 000; Run 14, Frames 35 -39.

4.3 Field Survey

4.3.1 Floristic Survey

Field Conditions: Literature review and review of high resolution imagery in conjuction with historical imagery was used to select locations for site survey, focusing on those areas where it was deemed necessary to acquire additional information to aid assessment. The field investigation was completed over three periods being:

- A nine day period from February 18th to February 26 th, 2013 focusing on collection of data for survey areas 2 and 9.
- A three day period from March 1st to March 3rd 2013 which was subsequently abandoned due to major flooding in Dalby.
- A five day period between March 18th and March 22nd 2013 during which survey was finalised in survey area 9 and additional data was captured for survey areas 7, 8 and F.

Conditions during the field survey were moderate (temperature range of 15 to 32˚C) with heavy rain periods occurring from the 18th to 19th February, 25th February, 28th February and 1st to the 3rd March and warm, sunny intervening periods. The survey period corresponds with the optimum period for sampling of ground covers in savannah and grassland habitats (Neldner *et al* 2004).

Survey Method: The floristic survey method is defined in the Surat Gas Project EIS (**Appendix K** of the EIS) and methods were consistent with this approach using a combination of formalised secondary, tertiary and quaternary level sampling procedures. In addition, the following methods were employed:

- Biocondition sites were completed within representative habitats in survey areas 2 and 9 as per procedures detailed in the Ecological Equivalence Methodology Guideline (DERM 2011c). Survey areas 2 and 9 were given priority for assessment due to guidance provided by Coffey Environments, and of all survey areas, have the least amount of previously gathered survey information gathered during EIS studies. Biocondition sites were undertaken to capture structural data directly relevant to determining baseline requirements for habitat offsets under the Queensland Biodiversity Offsets Policy (DERM 2011b). Meander searches were extended to up to 30 minutes in REs that provide suitable habitat for threatened species. Searches were undertaken within a 100 m buffer surrounding a survey site (biocondition sites in particular) involving two persons.

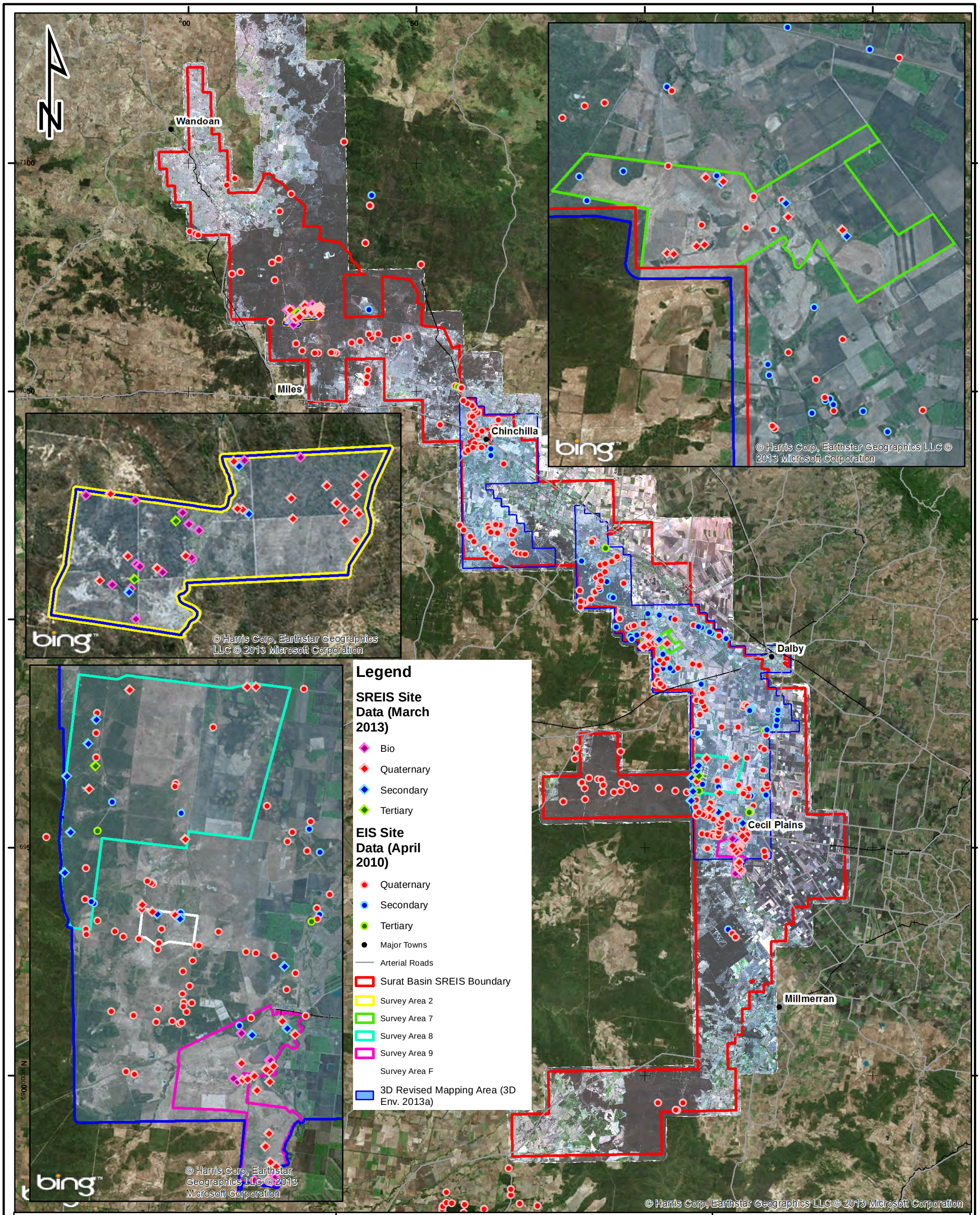
In total, 100 survey sites were completed during SREIS surveys with a combined total of 499 survey sites across both EIS and SREIS survey efforts (**Figure 2**). Within survey areas targeted for field survey, 30 survey sites were previously collected during EIS studies, bringing the total number in these survey areas to 130. The location of floristic survey sites, including those associated with prior studies is shown in relation to the targeted survey areas in **Section 5.6**. A statistical summary of survey sites per development area provided in **Table 3**. A summary of survey sites recorded during this study is provided in **Appendix H** with a floristic survey species list provided in **Appendix J.**

Riparian Assessments: Riparian assessment utilised the techiques described above with biocondition sites applied to riparian vegetation along Bottletree Creek (survey area 2) and the Condamine River (survey area 9). Four bioconditions sites were applied to riparian vegetation along representative sections of Bottletree Creek and a further 5 sites were applied to representative areas of riparian vegetation on the Condamine River. This data provides quantified assessment of the relative contributions made by exotic and native groundcovers shrubs and weeds. Data collected provides baseline condition information for future reference.

Table 3. Summary of floristic survey sites undertaken during SREIS and EIS survey efforts.

Project Location (survey area)	**Biocondition Sites**		**Secondary Sites**		**Tertiary Sites Recorded**		**Quaternary Sites**		**Total Sites**
	EIS	**SREIS**	**EIS**	**SREIS**	**EIS**	**SREIS**	**EIS**	**SREIS**	
2	0	15	0	1	0	2	0	19	37
7	0	0	5	3	0	0	6	8	22
8	0	0	5	5	1	1	9	5	26
9	0	13	1	3	0	0	1	17	35
F	0	0	2	2	0	0	2	4	10
Total Sites	**28**		**27**		**4**		**71**		**130**

Flora Species Assessment: Data from the desktop review and field based survey for flora was analysed and a list of threatened flora species considered relevant or potentially relevant to the project was compiled. The list considers the full range of species assessed in the EIS as well as additional species identified in updated in database searches, or where supplementary review of information suggested that inclusion in the SREIS assessment is warranted. A 'likelihood of occurrence' assessment was completed based on available records, known species and habitat distribution, and habitat suitability. This assessment served primarily to validate assessments made in the EIS or provide detail of assessments for species not assessed within the EIS survey. The information was used specifically to target floristic survey effort within properties identified for development.



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

Figure 2. Floristic survey locations

Client
Coffey Environments

0 20 40 60 80
Kilometers

Scale	Drawn By	Checked	File Path	Date	
1:766,575	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Insets_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

4.3.2 Fauna Field Survey

Field surveys were undertaken under QPWS license WISP06137309 and Animal Ethic License CA 2012/07/624. Data collection was broadly consistent with relevant guidelines for baseline assessment (Eyre et al. 2012) although variation may have occurred due to logistical constraints.

Prior to systematic trapping methods, a pilot study survey was undertaken on the February 9th to February 10th 2013, whilst the baseline survey was undertaken from February 20th to February 28th, inclusive. During the pilot study two ecologists undertook a visual assessment of survey area 2 and survey area 9. The visual assessment allowed access, vegetation complexity (i.e., habitat variability) and areas of suitable habitat for individual EVNT species, to be considered in the survey design (i.e., location of trap sites) for the main body of field survey undertaken in late February 2013.

Original survey plans included the systematic trapping and habit assessment in survey area 2 and survey area 9 over a minimum of four consecutive nights. However due to extensive flooding restricting access, the survey design was modified; survey area 2 was trapped for three consecutive nights while trapping was substituted by increased active searching in survey area 9.

Despite slightly less trapping effort on survey area 2, a large suite of vertebrate species were recorded (214 taxa, see Section 5.3) and, with the exception of Dunmall's snake (*Furina dunmalli*), all EVNT species considered likely based on habitat assessment were recorded. A number of additional EVNT species not considered high possibilities were also recorded. These results suggest that the loss of one night trapping may not have significantly affected survey results.

In total 86 hours of active man-hour searches, which included spotlight searches, was undertaken on survey area 9. While trapping was not undertaken, active searching and spotlighting is suitable for the detection of some EVNT species considered likely to occur based on habitat suitability (e.g., rough collared frog (*Cyclorana verrucosa*) and grey snake (*Hemiaspis damelii*). However the lack of trapping is recognised as a survey limitation as some species are difficult to detect through searching alone (e.g., five-clawed worm-skink, *Anomalopus mackayi*).

Sampling of survey areas 7, 8, and F was undertaken through habitat assessment, and did not include trapping methods, to identify potential habitat for EVNT species. Generally, access was restricted in all properties except survey area 2 by the extremely wet conditions. Survey locations for all survey areas is shown in **Figure 3**.

Survey Locations

Trap Sites: Trap locations (Tr) on survey area 2 were based on habitat assessments undertaken during the pilot study and located in areas that would:

- Target habitats/areas most suitable for threatened taxa (e.g., brigalow scaly-foot (*Paradelma orientalis*)

- Detect high vertebrate diversity (i.e., areas with abundant ground debris providing sheltering opportunities).
- Use natural features which maximise trap captures (e.g., suitable flyways for harp trapping).
- Allow for sampling of all broad vegetation groups across the project site (Eyre et al. 2012).

Ten trap sites were established on survey area 2, all were operational for three consecutive nights. A variety of fauna sampling methods are used at trapping sites, including pitfall and funnel traps, active searching, bird surveys, and spotlighting.

Observation Sites: Observation sites (Ob) are used to supplement data gathered from trapping sites. Repetitive sampling and labour intensive methods (i.e., pitfall trapping) are not used at observation sites. Rather, active searches, spotlighting and habitat assessments are used to determine:

- If priority species are present.
- Habitat suitability for priority species.
- Similarity to habitats at trapping transects (thereby allowing extrapolation or comparison).
- Habitat condition.

The inclusion of observation sites improves spatial representation; allow sampling of habitats too small to trap, and assists in determining locations or habitats for EVNT and non-EVNT species. It also ensures that rare habitats (e.g., waterbodies, rocky gorges) are adequately considered. Observation sites are visited only once and at any time during the day.

Riparian assessment: Riparian assessment was only applicable to survey area 2, along Bottle Tree Creek, and on survey area 9, along the Condamine River. Bottle tree creek was subject to active searching and habitat assessment at four locations scattered along its length ensuring both the upper and lower reaches of the creekline were thoroughly assessed. Spotlighting was undertaken by three observers on one night whilst a camera trap was set along a rocky section of creek for the duration of the survey. Riparian areas along the Condamine River on survey area 9 were not assessed due to recent flooding and restricted access. Limited access restricted surveying to a single nights spotlighting by three observers along a side branch, 1 km from the main river.

Wandoan

Miles

Chinchilla

Dalby

Cecil Plains

Millmerran

© Harris Corp, Earthstar Geographics LLC © 2013 Microsoft Corporation

© Harris Corp, Earthstar Geographics LLC © 2013 Microsoft Corporation

© Harris Corp, Earthstar Geographics LLC © 2013 Microsoft Corporation

© Harris Corp, Earthstar Geographics LLC © 2013 Microsoft Corporation

Legend

Method

- Anabat
- Camera Trap
- Habitat Assessment
- Harp Trap
- Observational Site
- Spotlighting
- Trap Site
- Major Towns
- Arterial Roads
- Surat Basin SREIS Boundary
- Survey Area 2
- Survey Area 7
- Survey Area 8
- Survey Area 9
- Survey Area F
- 3D Revised Mapping Area (3D Env. 2013a)

NOTES:

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

Figure 3. Vertebrate sampling locations

Client

Coffey Environments

0 20 40 60 80

Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Insets_A3P.mxd	Date	18/06/2013	A4

3D Environmental

Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Survey and Species Detection Techniques

Pitfall and funnel trapping: Pitfall trap lines include five 20L pitfall buckets established along a single drift fence with two funnel traps at each end (**Figure 4**), although due to hard substrates and time constraints, three sites were not completely arranged using this method. Sites Tr10 and Tr02 did not contain buckets, with Tr10 containing eight funnel traps and Tr02 using four funnel traps. At Tr07 included only three buckets rather than the standard five.

All sites were visited twice daily, once in the morning and once in the late evening. No trapping was undertaken on survey areas 7, 8, 9 and F.

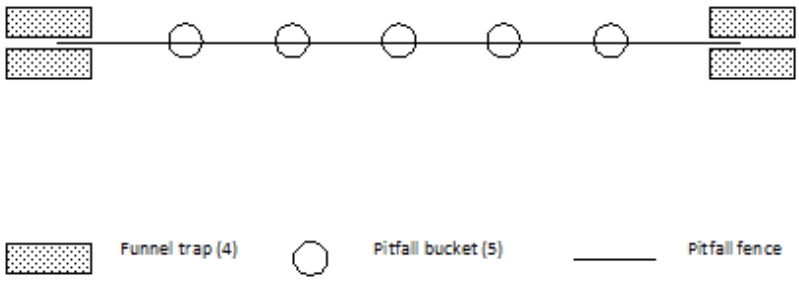


Figure 4. Trap transect layout

Camera Traps: Camera traps were used to detect the presence of medium-sized mammals using non invasive methods. Two cameras were set on survey area 2, one along a road edge and a second along a small rocky gorge that follows an anabranch of Bottle Tree Creek. Cameras were baited with tinned sardines and left for the duration of the survey (4 days).

Bird Survey: Bird surveys were conducted at each trapping site on survey area 2 on at least two mornings. All surveys were conducted prior to 9am, when bird activity is at its peak. Birds within 100 m of a centre point (i.e., the pitfall/funnel trap) were located by sight or sound, and were possible their numbers estimated. Incidental observations of birds heard calling outside of 100 m were also noted, although there was no attempt to estimate abundance. Bird surveys always exceeded 20 minutes in duration, although more time may have been allocated if bird activity was high.

Dedicated bird surveys were not undertaken on survey areas 7, 8, 9 or F, although incidental observations of birds were recorded while on these properties.

Active Searching: Active searching involves the shifting of logs, rocks, exfoliating bark and other debris for sheltering terrestrial vertebrates such as frogs, reptiles, geckoes and small mammals. Larger mammals such as wallabies taking flight from field staff were identified and recorded. Birds were identified and recorded by either direct observation or by call. Traces, such as droppings and claw marks on trees, were identified.

Active searching included inspecting known koala (*Phascolarctos cinereus*) food trees (e.g., *Eucalyptus tereticornis*) for scratches and scats, as well as searching for feeding remains (orts) left by glossy black-cockatoo (*Calyptorhynchus lathami*) below preferred feed trees (e.g., *Casuarina cristata* and *Allocasuarina inophloia*).

Spotlighting: Two teams of three observers spotlighted both on foot and by car for three nights on survey area 2, whilst one team of between three and five observers spotlighted on foot and by car for three nights on survey area 9. Due to other survey methods not being used on survey area 9, spotlighting effort was increased to 4-5 hours each night (vs. 2-3 at survey area 2).

Spotlighting on foot was conducted at each of the trap sites on survey area 2, as well several locations on survey area 9 (see **Figure 3**). This method is particularly useful in detecting small EVNT taxa such as golden-tailed gecko (*Strophurus taenicauda*), and rough collared frog (*Cyclorana verrucosa*). Both terrestrial and arboreal vertebrates can be detected using this method as it allows for individuals to be located via eye shine.

Vehicular based spotlighting allows spotlighting over a greater distance, but is bias toward larger animals such as medium- to large-sized mammals and nocturnal birds. Some smaller vertebrates such as frogs and reptiles can be located while spotlighting from a vehicle, although most are detected when crossing roads or tracks.

Habitat Assessment: Habitat assessments methods used during this work are consistent with those described in the EIS and focus on habitat characteristics known to influence vertebrate community diversity and composition. In particular, habitats were evaluated to determine their suitability for EVNT species.

Incidental observations: Opportunistic observations of fauna were recorded throughout the survey. Records may have included direct observation or indirect signs (e.g., scats, tracks, scratch mark, nests, or feeding signs). Opportunistic observations of taxa in proximity to the project site were also recorded as these species likely to occur within the project area, provided suitable habitats are present. It should be noted that incidental records collected by AMEC during aquatic surveys have been incorporated into site data.

Survey Conditions and Limitations

Conditions: Rain coincided with the commencement of the survey, and delayed the survey start by two days. Approximately 24 mm of rain fell during near survey area 2, resulting in some pooling of water which rapidly drained on the sandy substrate. Conditions during the survey were generally warm; temperatures ranged between 15.9 and 31.7°C and included periods of cloud and sun. Wet weather followed by warm conditions is likely to have encouraged activity in all fauna groups.

Rain returned prior to the completion of surveys at survey area 2, and as such, the survey was active for only three nights.

Rainfall hampered the surveys of survey areas 7, 8, 9, F, and as a consequence, no trapping was undertaken on survey area 9 (trapping at survey areas 7, 8 and F was never planned). However localised flooding which included swollen rivers and creeks inhibited movement around the properties. While most areas of remnant vegetation were inspected, some areas were not accessed.

The rainfall (approximately 50.4 mm) caused pooling and localised flooding which provided excellent conditions for amphibian activity. Temperatures during the survey of survey areas 7, 8, 9 and F ranged from 19-28°C and it is likely that these conditions would have been suitable for most fauna groups.

Limitations: Detailed surveys approximating standards described in Terrestrial Vertebrate Fauna Survey Guidelines for Queensland' (Eyre et al. 2012) were planned for survey areas 2 and 9. Rain affected the duration of trapping on survey area 2 (reducing trap nights from four to three), and the area has not been subjected to seasonal sampling. It is undoubtable that some resident taxa remain undetected. However, the strong survey results from survey area 2 (i.e., a very high diversity and detection of most expected EVNT taxa) suggest that a large portion the vertebrate community has been sampled. In particular, it seems unlikely based on habitat assessment that further work will unveil numbers of additional priority vertebrates.

Access on survey area 2 was generally good west of Bottle Tree Creek. Several roads and tracks allowed the teams to move across the site and position traps in a variety of habitat types. However access to the east of Bottle Tree Creek was more restricted. Here tracks and roads were less frequent, and often overgrown; vehicular access was only possible along Pelham Road and the northern boundary fence. Inspections undertaken by foot toward the centre of these lots (31AU60 and 32AU60) failed to find any habitats not sampled elsewhere on survey area 2. Access constraints are not likely to have affected survey results on survey area 2.

By contrast, trapping on survey area 9 has not possible due to extensive rainfall. Increasing search effort (which included spotlighting) may have compensated for the lack of trapping for selected taxa than can be actively located (e.g., rough collared frog (*Cyclorana verrucosa*) and grey snake (*Hemiaspis damelii*)), but not sufficient for others (e.g., *Anomalopus mackayi*). Further, access prevented the systematic searching of some locations which had habitat elements suitable for selected priority taxa (e.g., glossy black-cockatoo (*Calyptorhynchus lathami*) and koala (*Phascolarctos cinereus*)). Generally, the vertebrate list from survey area 9 is strong, but a large number of more cryptic species are likely to have been overlooked. EVNT species on survey area 9 will be presumed present if suitable habitats are located.

Access on survey area 9 was problematic due to a combination of rainfall and black clay soils. This prevented any vehicle access and all efforts were restricted to foot-based searches. Despite these constraints, many areas of valuable habitat were inspected and spotlighted, with the exception of riparian vegetation along the Condamine River or its immediate flood plain. Derived grasslands, which might contain habitat for a few grassland specialty EVNT taxa, is located within

the Condamine flood plain and was not inspected or surveyed however its presence was confirmed during the field survey.

Systematic trapping of survey areas 7, 8 and F was never planned due to project-related constraints. While heavy rainfall made access in these areas problematic, most areas of vegetation were accessed by foot. Access was not possible within derived grasslands associated long-swamp on survey area 8. Where suitable habitat on these properties has been located, EVNT species will be assumed present unless verified otherwise using field surveys consistent with recognised guidelines (Eyre et al. 2012; DEWHA (2010; 2011); see Section 4.3.2). As such, the resulting lack of site-specific knowledge does not pose a significant threat to conservation outcomes.

4.3.3 EVNT Species Habitat Mapping

The habitat requirements of EVNT species was assessed during desktop assessment, supplemented with the results of field survey, to determine a series of mapping rules relevant to individual species listed under either the NC Act or the EPBC Act. Attribution of the following datasets was undertaken to provide comprehensive mapping of habitat for individual flora and fauna species across the entire project development area. Datasets attributed for habitat are:

- Version 7.0 RE data clipped to the project development area (EHP 2012a).
- The EP Act mature regrowth dataset clipped to the project development area (EHP 2012b).
- Refined vegetation mapping completed for the EIS and SREIS surveys completed at 1:40 000 and 1:10 000 scales for specific areas of the project development area.

In total, over 500 000 individual data fields were attributed with an indicator of EVNT species habitat value. Further information in regard to the habitat mapping process is provided within **Appendix A.**

5.0 Survey Results

5.1 Summary of EIS Findings Relevant to SREIS Assessments

Threatened ecological communities, flora and fauna species as well as sensitive REs ('endangered' or 'of concern' biodiversity status considered known or likely to occur within the project development area (as defined in the EIS) are presented and summarised in **Appendix K**, terrestrial ecology impact assessment summary data. These values include 6 listed ecological communites (EPBC Act), 20 REs, 38 flora species (18 EPBC Act, 35 NC Act), 27 fauna (12 EPBC Act, 24 NC Act) and 22 migratory species (EPBC Act). Four species not assessed in the EIS have been identified and are subject to further assessment in **Appendix C**. As the project is regulated by Queensland's EP Act, biodiversity status is applied as the primary designation of RE status.

Environmentally sensitive areas (ESAs) and other areas of ecological value, have been assessed in the EIS and do not require further discussion within SREIS reporting.

5.2 Floristic Assessment

5.2.1 Threatened Ecological Communities and Regional Ecosystems

The EIS survey identified six threatened ecological communites listed under the EPBC Act, as known or likely to occur within the project development area. An updated search of the EPBC Act Protected Matters Search Tool (PMST) confirmed those findings with the following ecological communities predicted to occur within the SREIS project development area:

1. Brigalow (*Acacia harpophylla* dominant and co-dominant) (Endangered)
2. Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland (Critically Endangered).
3. Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Endangered).
4. Weeping Myall Woodlands (Endangered).
5. White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Critically Endangered).
6. Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (Endangered).

The extent of these ecological communities in the project development area based on RE associations is provided in **Table 4** with summary data indicating the extent of ecological communities within project development area. As the Weeping Myall Ecological Community has no RE association, and is of insufficient patch size to be mapped as remnant vegetation in the RE mapping framework, it has not been assigned an RE or biodiversity status**.** Further information on all ecological communities, including maps of distribution, their relevance and extent within the project development area, sensitivities and potential for impact is provided within site specific

assessments (**Section 5.3**) and **Appendix B.** Individual assessments also provide rules for mapping of threatened ecological communities, giving and indication of how their mapped extent, listed in **Table 4,** has been derived.

Table 4. Summary of the extent of EPBC Act listed ecological communities in project development area.

Ecological Community	**EIS Project Development Area as per DERM 2009a**	**SREIS project development area within RE# (EHP 2012a) and Mature Regrowth## (EHP 2012b) datasets.**	**Detailed Mapping Area (Ha) as per 3D Env.**	**Detailed Mapping Area (Ha) as per RE# (EHP 2012a) and Mature Regrowth## (EHP 2012b) datasets.**	**Combined Total (Ha) in Project Development Area*****
Total Extent of the Brigalow Ecological Community	10254	6982 (4449#, 2533##)	1307*	902 (664#, 238##)	7387
Total Extent of Natural Grassland Ecological Community**	570	777 (777#, 60##)	200	337 (299#, 38##)	678
Total Extent of Semi-Evergreen Vine Thicket Ecological Community	27	49 (22#, 27##)	0	14 (8#, 6##)	35
Total Extent of Coolibah Ecological Community****	259	484 (259#, 225##)	12	290 (127#, 163##)	206
Total Extent of White-box, Yellow –Box, Blakely's Red Gum Ecological Community**	1138	260 (260#, 123##)	0	0	260
Total Extent of Weeping Myall Ecological Community***	0	0	<1	0	<1

Bio Status: E = Endangered; OC = Of Concern, NCAP=No Concern at Present
EPBC Status: E = Endangered; CE = Critically Endangered; NA = Not Applicable.
* Includes 572 ha of brigalow regrowth > 15 yrs age.
** Indicates mature regrowth vegetation (EHP 2012b) not included within the relevant threatened ecological community.
***Not assessed as a mappable community in datasets produce by EHP (2012a and 2012b).
**** Does not include patch sizes < 5 ha
*****Incorporates 3D Env. dataset with EHP datasets (EHP 2012a and 2012b) outside detailed mapping area.

5.2.2 Regional Ecosystems

Changes to the project development area boundary, regulation of 'mature regrowth' under the EP Act (EHP 2012b) , and revision of vegetation mapping as a result of field survey all contributed to variations in the extent of vegetation (both REs and EPBC listed ecological communities) recognised within the project development area. A summary of REs within the project development area and indicated occurences within properties subject to development is provided in **Table 5**. Further indication of the extent of REs within individual survey areas is provided in **Section 5.6**. **Table 6** provides a summary of the extent of REs within project development area with associated EPBC act listed communities indicated where relevant. It should be noted that those habitats heavily dependent on ground-cover condition have not been assigned EPBC status in the mature regrowth dataset (EHP 2012b) due to tendency for groundcovers to be heavily modified by disturbance. Technical descriptions for REs identified during field survey in survey area 2 and survey area 9, which were the focus of intensive floristic survey and data calculation, are contained in **Appendix I**. Technical descriptions are also included for those REs (and EBPC act listed communities) that were not recorded on the properties during EIS surveys, these being the only REs and ecological communities subject to detailed site survey.

Inclusion of the mature regrowth dataset (EHP 2012b) has added an additional 27 136 ha of vegetation that must be considered remnant to the SREIS project development area including 2533 ha of the Brigalow Ecological Community, 27 ha of the Semi-Evergreen Vine Thicket Ecological Community and 225 ha of the Coolibah-Black Box Woodland Ecological Community.

Comparisons between the 3D Environmental Dataset (3D Environmental 2013a) and mapping provided by EHP which includes remnant RE (EPH 2012a) and mature regrowth datasets (EHP 2012b) indicate 27644 ha compared to 37517 ha of remnant vegetation is contained within the detailed mapping area respectively. Furthermore, the 3D Environmental dataset indicates 1307 ha of the Brigalow Ecological Community compared to 902 ha (EHP 2012a and 2012b), 200 ha of the Natural Grassland Ecological Community compared to 290 ha (EHP 2012a and 2012b), 0 ha of the Semi-Evergreen Vine Thicket Ecological Community Compared to 14 ha (EHP 2012a and 2012b) and 12 ha of the Coolibah Black Box Woodland Ecological Community compared to 290 ha (EHP 2012a and 2012b).

Environmentally Sensitive Areas Applied to Mature Regrowth Vegetation: REs contained within the mature regrowth datasets (EHP 2012b), are attributed with biodiversity status as per remnant vegetation (EHP 2012a). The regulation of mature regrowth under the EP Act has resulted in the inclusion of 3280 ha of mature regrowth vegetation classed as Category B ESAs (endangered biodiversity status) and 5450 ha of mature regrowth vegetation classed as Category C ESAs (of concern biodiversity status) into the project development area. REs associated with environmentally sensitive areas are indicated in **Table 6**.

Table 5. Regional ecosystems occurring within the project development area and associated areas of development.

RE	Description	Identified in Mature Regrowth Database	Survey areas*				
			2	7	8	9	F
Land Zone 3 - Quaternary Alluvial Plains							
11.3.1**	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	*Yes*	-	-	-	*Yes*	-
11.3.14**	*Eucalyptus* spp., *Angophora* spp., *Callitris* spp. woodland on alluvial plains.	*Yes*	-	*Yes*	-	-	-
11.3.17**	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.	*Yes*	-	-	-	-	-
11.3.18**	*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium.	*Yes*	-	-	-	*Yes*	*Yes*
11.3.19*	*Callitris glaucophylla, Corymbia* spp. and/or *Eucalyptus melanophloia* open-forest to woodland on Cainozoic alluvial plains.	*Yes*	-	-	-	-	-
11.3.2**	*Eucalyptus populnea* woodland on alluvial plains.	*Yes*	-	*Yes*	*Yes*	*Yes*	-
11.3.21**	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils.	*Yes*	-	-	*Yes*	-	-
11.3.24*	*Themeda avenacea* grassland on alluvial plains. Basalt derived soils.	*Yes*	-	-	-	-	-
11.3.25**	*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines.	*Yes*	*Yes*	*Yes*	-	*Yes*	-
11.3.26*	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains.	*Yes*	-	-	*Yes*	-	-
11.3.27	11.3.27a**: Lacustrine wetland (e.g. lake)	*Yes*	-	-	-	-	-
	11.3.27b: Palustrine wetland (e.g. vegetated swamp)	*Yes*	-	-	-	-	-
	11.3.27c: Palustrine wetland (e.g. vegetated swamp). Mixed grassland or sedgeland with areas of open water +/- aquatic species.	*Yes*	-	-	-	-	-
	11.3.27d**: Palustrine wetland *Eucalyptus camaldulensis* and/or	*Yes*	-	*Yes*	-	*Yes*	-

RE	Description	Identified in Mature Regrowth Database	Survey areas*				
			2	7	8	9	F
	Eucalyptus tereticornis woodland						
11.3.3	11.3.3c: Palustrine wetland (e.g. vegetated swamp). Eucalyptus coolabah woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels.	*Yes*	-	-	-	-	-
11.3.4**	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	*Yes*	*Yes*	*Yes*	-	*Yes*	-
Land Zone 4 – Pleistocene Alluvial Terraces							
11.4.10***	*Eucalyptus populnea* or *E. pilligaensis, Acacia harpophylla, Casuarina cristata* open forest to woodland on margins of Cainozoic clay plains.	*Yes*	-	-	-	-	-
11.4.12**	*Eucalyptus populnea* woodland on Cainozoic clay plains.	*Yes*	-	-	-	-	-
11.4.3**	*Acacia harpophylla* and/or Casuarina cristata shrubby open forest on Cainozoic clay plains.	*Yes*	-	-	-	-	-
11.4.3a***	Palustrine wetland (e.g. vegetated swamp). *Melaleuca bracteata* woodland associated with *Acacia harpophylla* communities.	*No*	-	-	-	-	-
Land Zone 5 – Tertiary Plains							
11.5.1	11.5.1: *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces	*Yes*	*Yes*	-	*Yes*	*Yes*	-
	11.5.1a:**: *Eucalyptus populnea* woodland with *Allocasuarina luehmannii* low tree layer.	*Yes*	*Yes*	-	*Yes*	*Yes*	-
11.5.20**	*Eucalyptus moluccana* and/or *E. microcarpa/E. pilligaensis*[1] ± *E. crebra* woodland on Cainozoic sand plains.	*Yes*	-	-	*Yes*	-	-
11.5.21**	*Corymbia bloxsomei* ± *Callitris glaucophylla* ± *Eucalyptus crebra* ± *Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces.	*Yes*	*Yes*	-	-	-	-

[1] *E. pilligaensis* has been recently consumed within the broader reclassification of *E. woollsiana.*

RE	Description	Identified in Mature Regrowth Database	Survey areas*				
			2	7	8	9	F
11.5.4**	11.5.4: *Eucalyptus crebra, Callitris glaucophylla, C. endlicheri, E. chloroclada, Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces. Deep sands.	*Yes*	*Yes*	-	-	-	-
	11.5.4a: *Callitris glaucophylla* ± *Eucalyptus* spp. and *Corymbia* spp. woodland.	*Yes*	-	-	-	-	-
Land Zone 7 - Tertiary Rises							
11.7.2**	*Acacia* spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	*Yes*	-	-	-	-	-
11.7.4**	*Eucalyptus decorticans* and/or *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust.	*Yes*	*Yes*	-	*Yes*	-	*Yes*
11.7.4c*	*Eucalyptus decorticans* ± *Eucalyptus* spp. ± *Acacia* spp. Occurs on low hills and ranges with shallow soils.	*Yes*	-	-	-	-	-
11.7.5**	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.	*Yes*	*Yes*	-	-	-	-
11.7.6**	*Corymbia citriodora* or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust.	*Yes*	-	-	-	-	-
11.7.7**	*Eucalyptus fibrosa* subsp. *nubila* ± *Corymbia* spp. ± *Eucalyptus* spp. on Cainozoic lateritic duricrust.	*Yes*	*Yes*	-	-	-	-
Land Zone 8 - Cainozoic Igneous Rocks							
11.8.2a	11.8.2a*: *Eucalyptus tereticornis* and *E. melliodora* occurring on low hills.	*Yes*	-	-	-	-	-
11.8.3*	Semi-evergreen vine thicket on Cainozoic igneous rocks.	*Yes*	-	-	-	-	-
Land Zone 9 – Fine Grained Sedimentary Rocks							
11.9.4a*	11.9.4a*: Semi-evergreen vine thicket or *Acacia harpophylla* with a semi-evergreen vine thicket understorey on fine grained sedimentary rocks.	*Yes*	-	-	-	-	-
11.9.5**	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained	*Yes*	-	-	-	-	*Yes*

RE	Description	Identified in Mature Regrowth Database	Survey areas*				
			2	7	8	9	F
	sedimentary rocks.						
11.9.6*	*Acacia melvillei* ± *A. harpophylla* open forest on fine-grained sedimentary rocks.	*Yes*	-	-	-	-	-
11.9.7**	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks.	*Yes*	-	*Yes*	-	-	-
11.9.9**	*Eucalyptus crebra* woodland on fine-grained sedimentary rocks.	*Yes*	-	*Yes*	-	*Yes*	*Yes*
11.9.10	*Acacia harpophylla, Eucalyptus populnea* open forest on fine-grained sedimentary rocks.	*Yes*	-	-	-	-	-
Land Zone 10 – Coarse Grained Sedimentary Rocks							
11.10.1*	*Corymbia citriodora* open forest on coarse-grained sedimentary rocks.	*Yes*	-	-	-	-	-
11.10.1d***	*Eucalyptus crebra* woodland	*No*	-	*Yes*	-	-	*Yes*

* Identified in certified ecosystem mapping only.
** Identified in certified ecosystem mapping and observed in detailed mapping survey.
*** Not identified in certified ecosystem mapping although observed in the mapping survey.
'–' Not identified in field surveys

Table 6. Extent and status of regional ecosystems within SREIS project development area compared to EIS.

RE	Bio Status	EPBC Status	EPBC listed Ecological Community	Area (Ha) Identified in EIS (as per DERM 2009a)	Area identified in SREIS with RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Detailed Mapping Area (Ha) as per 3D Env*.	Detailed Mapping Area (Ha) as per RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Combined Total (Ha) in Project Development Area**	Contribution (%) of RE to Remnant Vegetation in in Project Development Area
11.3.1	E	E	Brigalow[1]	585	549 (444[#], 105[##])	189	449 (352[#], 97[##])	289	0.1
11.3.17	E	NA.	NA	4245	862 (617[#], 245[#])	182	811 587[#], 224[##])	233	0.1
11.3.21	E	CE	Natural Grassland[2]	517	734 (676[#], 58[##])	200	326 (290[#], 36[##])	608	0.3
11.3.24	E	CE	Natural Grassland[2]	53	103 (101[#], 2[#])	0	2[##]	101	0.0
11.4.3	E	E	Brigalow[1]	4077	1150 (669[#], 481[##])	509	405 (290[#], 115[##])	1254	0.6
11.4.3a	E	NA	Brigalow[1]	2	0	37	0	37	0.0
11.4.10	E	E	Brigalow[1]	1784	105 (67[#], 38[##])	0	0	105	0.1
11.4.12	E	NA	NA	712	821 (453[#], 368[##])	234	540 (288[#], 252[##])	515	0.2
11.9.4a	E	E	Semi-evergreen vine thicket[3]	12	49 (22[#], 27[##])	0	14 (8[#], 6[##])	35	0.0
11.9.5	E	E	Brigalow[1]	3791	5017 (3152[#], 1865[##])	0	44 (19[#], 25[##])	4998	2.4
11.9.6	E	E	Brigalow[1]	151	161 (117[#], 44[##])	0	4 (3[#], 1[##])	157	0.1

RE	Bio Status	EPBC Status	EPBC listed Ecological Community	Area (Ha) Identified in EIS (as per DERM 2009a)	Area identified in SREIS with RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Detailed Mapping Area (Ha) as per 3D Env*.	Detailed Mapping Area (Ha) as per RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Combined Total (Ha) in Project Development Area**	Contribution (%) of RE to Remnant Vegetation in in Project Development Area
11.9.10	E	NA	NA	175	133 (86[#], 47[##])	0	0	133	0.1
11.9.7	OC	NA	NA	654	814 (670[#], 44[##])	53	86 (55[#], 31[##])	781	0.4
11.3.2	OC	NA	NA	4150	9185 (6193[#], 2992[##])	1144	3909 (2710[#], 1199[##])	6420	3.1
11.3.25 /25g	OC	NA	NA	7532	8215 (7176[#], 1039[##])	2218	3419 (3929[#], 510[##])	7014	3.4
11.3.27b a/c/d	OC	NA	NA	255	546 (295[#], 251[##])	668	532 (388[#], 44[##])	682	0.3
11.3.3	OC	NA	Coolibah Black Box[6]	259	484 (259[#], 225[##])	16	290 (127[#], 163[##])	210	0.1
11.3.4	OC	NA	NA	2544	3588 (2695#, 893##)	2860	2194 (1340[#], 854[##])	4254	2.1
11.8.3	OC	E	Semi-evergreen vine thicket[4]	19	0	0	0	0	0.0
11.8.2a	NCAP	CE	White Box – Yellow Box- Blakely's Red Gum Woodlad[5]	1138	383 (260[#], 123[##])	0	0	383	0.2
11.3.14	NCAP	NA	NA	Not Assessed	6379 (5458[#], 921[##])	194	37 (33[#], 4[##])	6554	3.2
11.3.18	NCAP	NA	NA	Not Assessed	2537 (2158[#], 379[##])	218	657 (389[#],268[##])	2098	1.0

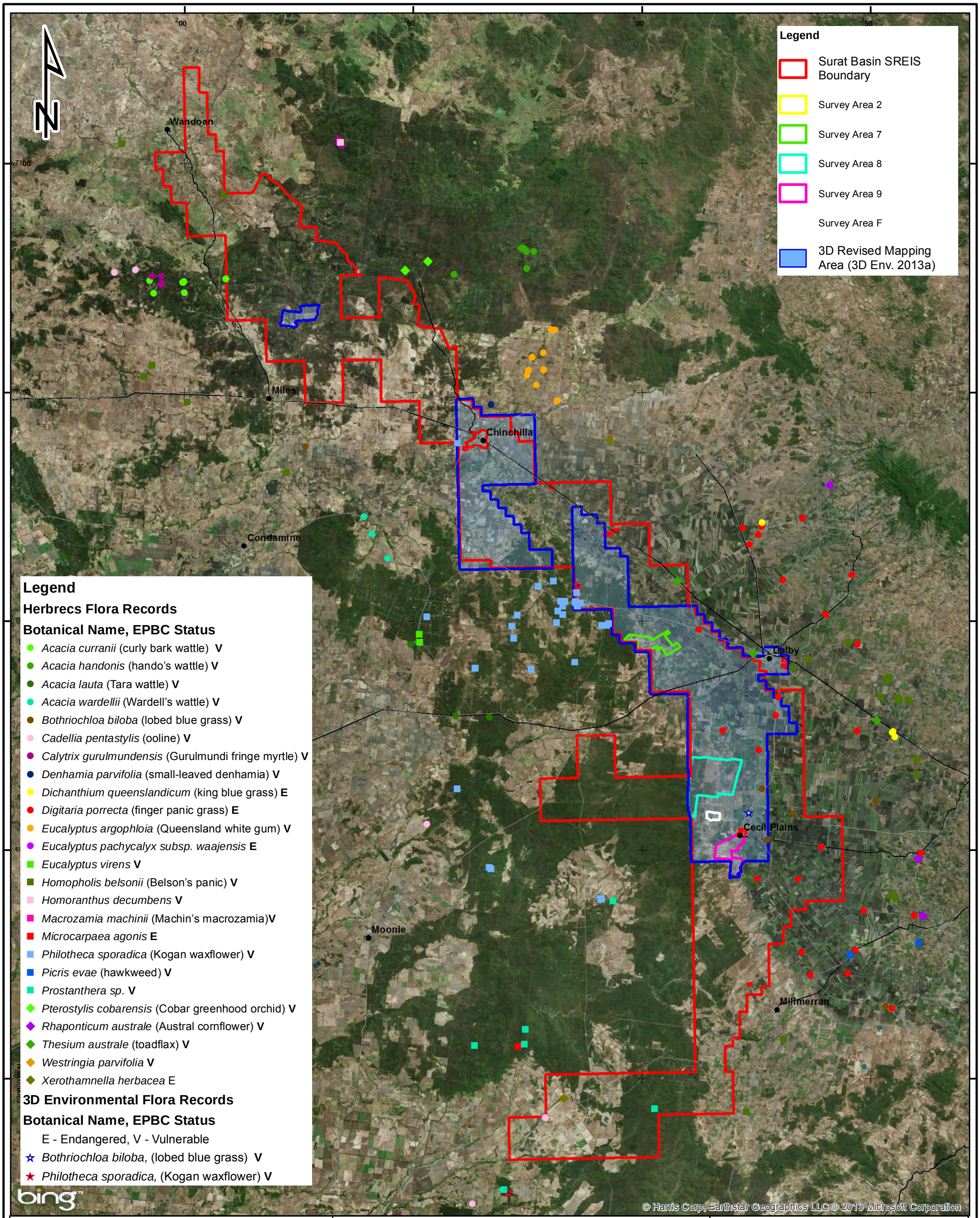
RE	Bio Status	EPBC Status	EPBC listed Ecological Community	Area (Ha) Identified in EIS (as per DERM 2009a)	Area identified in SREIS with RE# (EHP 2012a) and Mature Regrowth## (EHP 2012b) datasets.	Detailed Mapping Area (Ha) as per 3D Env*.	Detailed Mapping Area (Ha) as per RE# (EHP 2012a) and Mature Regrowth## (EHP 2012b) datasets.	Combined Total (Ha) in Project Development Area**	Contribution (%) of RE to Remnant Vegetation in in Project Development Area
11.3.19	NCAP	NA	NA	Not Assessed	9#	0	0	0	0.0
11.3.26	NCAP	NA	NA	Not Assessed	94 (58#, 36##)	7	0	101	0.0
11.5.1/ 11.5.1a	NCAP	NA	NA	Not Assessed	57080 (49834#, 7246##)	5842	10793 (7708#, 3085##)	52129	25.3
11.5.20	NCAP	NA	NA	Not Assessed	11121 (10277#, 844##)	1831	1704 (897#, 807##)	11248	5.5
11.5.21	NCAP	NA	NA	Not Assessed	8811 (7856#, 955##)	8	98 (51#, 47##)	8721	4.2
11.5.4/ 11.5.4a	NCAP	NA	NA	Not Assessed	19645 (18764#, 971##)	0	1491 (1149#, 342##)	18154	8.8
11.7.2	NCAP	NA	NA	Not Assessed	2335 (2202#, 133##)	0	61 (52#, 9##)	2274	1.1
11.7.4/ 11.7.4c	NCAP	NA	NA	Not Assessed	42055 (38068#, 3987##)	3665	5909 (4376#, 1173##)	39811	19.3
11.7.5	NCAP	NA	NA	Not Assessed	10578 (9742#, 836##)	418	591 (543#, 147##)	10405	5.0
11.7.6	NCAP	NA	NA	Not Assessed	2389 (2345#, 44##)	0	0	2389	1.2
11.7.7	NCAP	NA	NA	Not Assessed	18989 (17180#, 1809##)	1767	3039 (2451#, 588##)	17717	8.6

RE	Bio Status	EPBC Status	EPBC listed Ecological Community	Area (Ha) Identified in EIS (as per DERM 2009a)	Area identified in SREIS with RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Detailed Mapping Area (Ha) as per 3D Env*.	Detailed Mapping Area (Ha) as per RE[#] (EHP 2012a) and Mature Regrowth[##] (EHP 2012b) datasets.	Combined Total (Ha) in Project Development Area**	Contribution (%) of RE to Remnant Vegetation in in Project Development Area
11.9.9/ 11.9.9a	NCAP	NA	NA	Not Assessed	603 (577[#], 26[##])	5177	0	5780	2.8
11.10.1/ 11.10.1d	NCAP	NA	NA	Not Assessed	347 (345[#], 2[##])	206	0	553	0.3
Totals				**Not Assessed**	**215871 (188735[#],27136[##])**	**27644**	**37518 (27525[#],9993[##])**	**206143**	**100**

* Contains vegetation that would be considered mature regrowth in EHP databases. Based on mapping produced by 3D Environmental (2013);
** Incorporates 3D Env. dataset with EHP datasets (EHP 2012a and 2012b) outside detailed mapping area; ═=Category B ESA; ═= Category C ESA
[#] Extent of remnant vegetation as per EHP 2012a; [##] Extent of mature regrowth as per EHP 2012b.
Bio Status: E = Endangered; OC = Of Concern, NCAP=No Concern at Present
EPBC Status: E = Endangered; CE = Critically Endangered; NA = Not Applicable.
1. Brigalow dominant and co-dominant ecological community.
2. Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland
3. Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
4. Weeping Myall Woodlands
5. White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland
6. Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions

5.2.3 Threatened Flora Species

Analysis of updated data sources coupled with a detailed review of relevant literature identified an additional four species considered to potentially occur within the SREIS project development area. **Table 7** presents an overview of species of relevance to the revised project development area where the assessment made in the EIS has been updated or revised. Those species that have been excluded from the assessment due to a lack of suitable habitat or unsuitable geographic location are indicated within **Table 8** with justification for exclusion provided. Species are excluded from the assessment where evidence suggests that they are 'unlikely' to occur in the project development area. The location of previous EPBC Act and NC Act species records in relation to the project development area are shown in **Figure 5** and **Figure 6** respectively.



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

Herbrecs (EHP 2013); 3D Environmental

Figure 5. Records of EPBC Act listed flora species in relation to project development area.

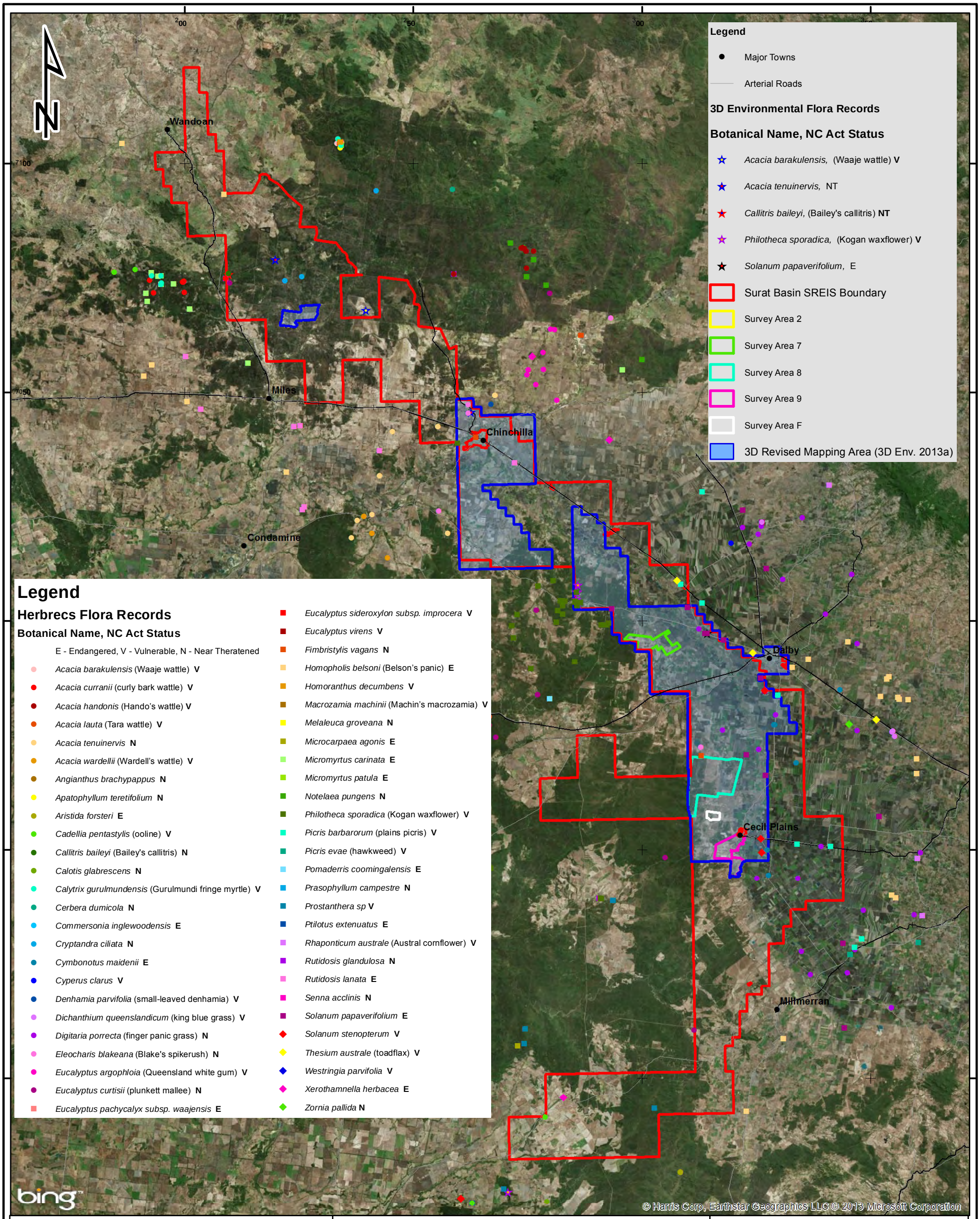
Client
Coffey Environments

0 20 40 60 80
Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Fauna_A3P.mxd	Date	21/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



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

Herbrecs (EHP 2013); 3D Environmental

Figure 6. Location of NC Act listed flora species records in relation to project development area

Client
Coffey Environments

0 20 40 60 80
Kilometers

Scale	Drawn By	Checked	File Path	Date	
1:766,575	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Fauna_NCA_A3P_new.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Table 7. Summary of threatened flora species identified in desktop review where assessment has changed from EIS to SREIS studies.

Species Name	Conservation Status			Source					Comments
	EPBC Act Status	NC Act Status	BoT	Herbrecs *	Corveg**	Wildnet**	CFNC**	PMST Online*	
Species Assessed in EIS									
Dichanthium queenslandicum (king blue grass)	V	V	-	X	-	-	-	X	Assessed as possibly occuring in project development area in EIS and SREIS. Listed as Vulnerable in EIS although EPBC status upgraded to Endangered in January 2013.
Gonocarpus urceolatus	Not listed	V	-	X	-	X	-	-	Assessed as known to occur in project development area in EIS. Species has been removed from schedules of the NC Act and of no further relevance to the project.
Additional Species of Relevance Identified in SREIS									
Eucalyptus argophloia (Queensland white gum)	V	V	C	X	-	-	X	X	Assessed as possibly occurring in project development area in SREIS: Occurs on clay soils in association with regrowth brigalow. No known populations occur in remnant vegetation. Small population known from north east of Chinchilla in Heavy clay soils. 13 records within 25 km buffer with nearest record 10 km north east of study area boundary and 16 km north east of Chinchilla
Eucalyptus virens	V	V	-	X	-	-	-	X	Assessed as possibly occurring in project development area in SREIS: Two Herbrecs records within 25 km buffer located 18 km south east of study area boundary and 10 km north

Species Name	Conservation Status			Source					Comments
	EPBC Act Status	NC Act Status	BoT	Herbrecs *	Corveg**	Wildnet**	CFNC**	PMST Online*	
									east of Tara where it grows in sandy soils on sandstone. Other records near Inglewood outside study area
Acacia lauta (Tara wattle)	V	V	-	X	-	-	-	-	Assessed as possibly occurring in project development area in SREIS: Nearest Herbrecs record 17 km west of the study area boundary – 61 km west of Dalby. 9 records within 25 km buffer. Three populations known from sandy soils in ironbark forest between Inglewood and Tara (TSSC 2008o). Inglewood record 26 km south of project area.
Cymbonotus maidenii	Not Listed	E	M	X	-	-	-	-	Identified in SREIS and known to occur in project development area: Five Herbrecs specimens recorded in the study area, mostly in the Cecil Plains / Millmerran Area including collections on road reserved on the Cecil Plains / Millmerran Road.

E = Endangered; V = Vulnerable; NT = Near Threatened (NC Act only)
* Indicates a database search updated for SREIS.
** Database search completed for EIS study (N.B. Herbrecs is update more regularly that either Wildnet or Corveg hence presents the most current information available).
PMST Online: EPBC Act Protected Matters Search Tool.
Herbrecs: Herbrecs database extract (EHP 2013).
Corveg: Queensland Herbarium Corveg Database
Wildnet: Wildnet Database
CFNC: Chinchilla Field Naturalist Club Database.
BoT (Back on Track): C = Critical Priority; H = High Priority; M = Medium Priority
"X" Recorded in species search.
"-" not recorded in species search.

Table 8. Species excluded from the SREIS assessment.

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
Cerbera dumicola	Not listed	NT	X	-	-	-	-	Nearest Herbrecs record is 8 km north east of Barakula, 19 km north east of study area boundary on east facing slope of Dawson Range (Herbrecs 2013) (although Herbrecs lists the location as Baralaba which is 100 km north of the project area. The collection date of this specimen, being 1943, renders the collection location unreliable. The species is typically associated with dry vine thickets (RE11.7.1) and lancewood forest (RE11.7.2). The former is not known to occur and the latter highly restricted in the project development area. The species is considered unlikely in the project development area occur based on the unsuitable geographic range and limited nature of suitable habitat.
Commersonia argentea	V	Not listed	-	-	-	-	X	No records within the 25 km buffer (study area) with the nearest record in the vicinity of Kragra, 45 km north east of the study area boundary. Major population known from Kadarga 55 km north east of project area. Considered unlikely to occur based unsuitable geographic range and lack of previous species collections.
Commersonia inglewoodensis	Not Listed	E	X	-	-	-	-	Nearest record 16 km south of study area boundary and 11 km north of Inglewood. Occurs in heathland and woodland formed on duricrust. There are no previously confirmed records within the study area and habitat within the project development area is marginally

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
								suitable. On this basis, the species is considered unlikely to occur.
Angianthus brachypapus	Not Listed	N	X	-	-	-	-	Small herbaceous weed growing along roadsides and in areas of poor soil. Nearest records near Yelarbon, in an area of stunted vegetation known as the Yelarbon Desert, 25 km south of the study area and 50 km south of project development area. The species is considered unlikely to occur based on lack of suitable habitat and unsuitable geographic range.
Eucalyptus pachycalyx subsp. waajensis	Not listed	E	X	-	-	-	-	Cluster of 9 records 16 km north east of the Study area boundary and 30 km east of Guluguba. All records contained within the Waaje Scientific Area (Barakula state forest) where it occurs on sandy soils that overtop ironstone jump-ups. A further two populations are known from the area between Taroom and Eidsvold (AVH 2013i) 80 to 100 km north east of study area. The species is considered unlikely to occur based on unsuitable geographic range and marginal nature of habitat for the species in the project development area.
Eucalyptus sideroxylon	Not Listed	V	X	-	-	-	-	Cluster of 6 records within 25 km buffer (EHP 2013) all restricted to the Waaje Scientific area where they occur on sandy soils overtopping ironstone. The species is considered unlikely to occur in the project development area based on marginally

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
								suitable habitat and the highly endemic nature of the plant.
Haloragis exalata subsp. *velutina*	V	V	-	-	-	-	X	All collection records from Bunya Mountains 60 km north east of Dalby (EHP 2013) where it occurs in moist open forests, often on vine forest margins. The habitat in the project development area is considered unsuitable for the species and it is considered unlikely to occur.
Homoranthus decumbens	E	V	X	-	-	-	-	Five Herbrecs (EHP 2013) records all from the Waaje Scientific area, 16 km north east of study area boundary where the species occurs on sandy soils within shrubland RE11.7.5. Habitat within the project development area is is marginally suitable for the species. The localised, highly endemic nature of the known population, suggests that the species is unlikely to occur.
Lepidium peregrinum	E	Not listed	-	-	-	-	X	Major population in the Bunya Mountains 60 km north east of Dalby (Herbrecs 2013) where it is associated with moist, disturbed location. The species is considered unlikely to occur based on an unsuitable geographic location in the project development area. A single specimen is shown to occur 60 km south west of Dalby, approximately 12 km north west of the study area (35 km north west of project development area) on roadside margins. The description of the collection reads as Mt Glorious (AVH 2013j) and it is possibly erroneous. This specimen is not included in Herbrecs (EHP 2013)

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
								collections.
Macrozamia conferta	V	V	X	-	-	-	-	Precise locality not provided. Locality description as 25 km west of Warwick (TSSC 2011) indicates the species occurs well outside the study area. Nearest record shown on AVH (2013k) is 25 km south south east of Millmerran, 27 km outside study area boundary. The species is considered unlikely to occur in the project development area based on an unsuitable geographic location.
Melaleuca groveana	Not listed	NT	X	-	-	-	-	Five Herbrecs records restricted to Waaje Scientific area, Barakula State forest 16 km north east of study area boundary (EHP 2013). Highly endemic and considered unlikely to occur based on restricted species range.
Micromyrtus patula	Not listed	E	X	-	X	-	-	Three Herbrecs records all restricted to Waaje Scientific area, Barakula State forest 16 km north east of area boundary. Highly endemic and considered unlikely to occur based on restricted species range.
Notelaea pungens	Not listed	NT	X	-	-	-	-	Eleven Herbrecs records in study area all to the NE of Chinchilla in the Barakula State forest area. Nearest record 20 km north east of study area boundary. Considered unlikely to occur based on highly restricted species range.
Prasophyllum campestre	Not listed	NT	X	-	-	-	-	Single Herbrecs record (EHP 2013) in the buffer area 25 km south of the study area boundary. Specimen recorded from woodlands near Inglewood. An old, low precision record with collector and

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
								collection date unknown. Species considered unlikely to occur in the project development area due to a sparsity of previous collections.
Rutidosis glandulosa	Not listed	NT	X	-	-	-	-	Two Herbrecs records within 25 km buffer with a single record located in Barakula SF and another 35 km west of Cecil Plains. Generally roadside collections from sandy soils in disturbed areas. Species is considered unlikely to occur due to the paucity of previous collections in the study area. Considered a low chance of occurrence.
Senna acclinis	Not listed	NT	X	-	-	-	-	Low precision Herbrecs record (+16 km) on the eastern boundary of the project development area. Habitat notes describe collection site as Ooline scrub in Gurrulmundi. Expected that record is well outside project development area and considered unlikely to occur due to lack of suitable habitat in the project development area.
Tylophora linearis	E	E	-	-	-	-	X	No records in study area. Nearest reported collection from Glenmorgan 100 km west of study area (TSSC, 2009ab). Considered unlikely to occur due to a lack of suitable habitat in the project development area.
Westringia parvifolia	V	V	X	-	-	-	X	Three low precision records (+16 km) located near Inglewood 25 km south of project development area. Collections from 1948, 1910, 1908 are all historical and poorly confined spatially. Suitability of

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
								habitat in the project development area is considered marginal. The species is considered unlikely to occur based on unsuitable geographic location and lack of previous records.
Zornia pallida	Not listed	NT	X	-	-	-	-	A single Herbrecs record located 11 km west of project development area and 25 km south-east of Dalby in E. crebra woodland. The species is considered unlikely to occur due to a lack of previous records in the vicinity of the project development area. Scattered populations occur well east of the project development area in the Warwick region.
Eriocaulon carsonii	E	E	-	-	-	-	-	The Surat Underground Water Impact Report (QWC, 2012) prepared by the Queensland Water Commision identified listed fauna and flora species associated with spring complexes within the Surat Basin. Eriocaulon carsonii was identified to be associated with a spring complex (situated outside of the project development area) (Figure 8-2 of the QWC report) with a relationship to groundwater systems potentially impacted by the Surat Gas

Species Name	Conservation Status		Source					Comments
	EPBC Act	NC Act	Herbrecs*	Corveg**	Wildnet**	CFNC**	PMST Online*	
Arthraxon hispidus	V	V	-	-	-	-	-	Project. The spring is located outside of the project development area 35 km from the boundary and is therefore not anticipated to be subject to any direct impacts from project related activities. The relationship of that spring complex with potentially affected groundwater systems is provided in the groundwater assessment of the SREIS. Should modelling show a significant change in spring function that could potentially impact vegetation communities and associated species, Arrow will need to determine the required action through the Spring Impact Mitigation Strategy. Field investigations found these species to be absent from the spring complex (unpublished report). The nearest confirmed record of Eriocaulon carsonii is located 50 km NE of the project development area in the Taroom district (AVH, 2013j).
Phaius australis	E	E	-	-	-	-	-	

E = Endangered; V = Vulnerable; NT = Near Threatened (NC Act only)
* Indicates a database search updated for SREIS.
** Database search completed for EIS study (N.B. Herbrecs is update more regularly that either Wildnet or Corveg hence presents the most current information available).
PMST Online: EPBC Act Protected Matters Search Tool.
Herbrecs: Herbrecs database extract (EHP 2013).
Corveg: Queensland Herbarium Corveg Database
Wildnet: Wildnet Database
CFNC: Chinchilla Field Naturalist Club Database.
“X” Recorded in species search. “-“ not recorded in species search.

5.3 Fauna Assessment

Table 9 presents an overview of all EVNT fauna species identified in the EIS survey database searches as known or potentially occurring within the project development. Those species that have been excluded from the assessment due to a lack of suitable habitat or unsuitable geographic location are also indicated in **Table 10**. The location of previous NC Act and EPBC Act fauna species records in relation to the project development area are shown in **Figure 7** and **Figure 8** respectively.

Table 9. Threatened fauna species assessment from EIS and SREIS assessment

Species Name	Conservation Status			Source						Comments
	EPBC Status	NCA Status	BoT Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Species Assessed in EIS										
Hypochrysops piceatus (bulloak jewel)	Not listed	E	H	-	-	X	X	X	-	Assessed as known to occur in project development area in EIS. **Downgraded to possibly occurring in SREIS** due to the relinquishment of lots around Bendidee NP/SF.
Jalmenus eubulus (pale imperial hairstreak)	Not listed	V	-	-	-	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Cyclorana verrucosa (rough collared frog)	Not listed	NT	-	X	-	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Strophurus taenicauda (golden-tailed gecko)	Not listed	NT	M	X	-	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Paradelma orientalis (brigalow scaly-foot)	V	V	M	X	-	X	X	X	X	**Assessed as known to occur** in project development area in EIS and SREIS
Delma torquata (collared delma)	V	V	H	X	-	X	-	X	X	**Assessed as known to occur** in project development area in EIS and SREIS
Anomalopus mackayi (five-clawed worm-skink)	V	E	H	X	-	X	-	X	X	**Assessed as known to occur** in project development area in EIS and SREIS
Egernia rugosa (yakka skink)	V	V	M	-	-	X	-	X	X	**Assessed as possibly occurring** in project development area in EIS and SREIS
Tympanocryptis cf tetraporophora (Darling Downs earless dragon)	E	E	H	-	-	-	X	-	X	**Assessed as possibly occurring** in project development area in EIS and SREIS
Acanthophis antarcticus (common death adder)	Not listed	NT	M	-	-	X	-	X	-	**Assessed as known to occur** in project development area in EIS and SREIS

Species Name	Conservation Status			Source						Comments
	EPBC Status	NCA Status	BoT Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Furina dunmalli Dunmall's snake	V	V	M	X	-	X	-	X	X	**Assessed as known to occur** in project development area in EIS and SREIS
Hemiaspis damelii (grey snake)	Not listed	E	M	X	-	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Accipiter novaehollandiae (grey goshawk)	Not listed	NT	-	-	X	X	X	X	-	**Assessed as possibly occuring** (transient) in project development area in EIS and SREIS.
Lophoictinia isura (square-tailed kite	Not listed	NT	-	-	X	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Nettapus coromandelianus (cotton pygmy-goose)	Not listed	NT	-	-	X	X	-	X	-	**Assessed as possibly occuring** in project development area in EIS and SREIS
Stictonetta naevosa (freckled duck)	Not listed	NT	-	-	X	X	-	X	-	**Assessed as possibly occuring** in project development area in EIS and SREIS
Calyptorhynchus lathami (glossy black-cockatoo)	Not listed	V	H	-	X	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Ephippiorhynchus asiaticus (black-necked stork)	Not listed	NT	-	-	X	X	-	X	-	**Assessed as possibly occuring** in project development area in EIS and SREIS
Geophaps scripta scripta (squatter pigeon - southern)	V	V	M	-	X	X	-	X	X	**Assessed as possibly occuring** in project development area in EIS and **known to occur** in SREIS
Anthochaera phrygia (regent honeyeater)	E	E	M	X	X	X	-	X	X	**Assessed as possibly occuring** in project development area in EIS and SREIS
Grantiella picta (painted honeyeater)	Not listed	NT	H	-	X	X	-	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Melithreptus gularis (black-chinned honeyeater)	Not listed	NT	-	-	X	X	-	X	-	**Assessed as known to occur** in project development area in EIS and SREIS

Species Name	Conservation Status			Source						Comments
	EPBC Status	NCA Status	BoT Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Neophema pulchella (turquoise parrot)	Not listed	NT	-	-	-	X	-	X	-	**Assessed as possibly occuring** in project development area in EIS and SREIS
Rostratula australis (Australian painted snipe)	V	V	M	-	X	X	-	X	X	**Assessed as possibly occuring** in project development area in EIS and SREIS
Dasyurus m. maculatus (spotted-tailed quoll)	E	V	-	-	-	X	-	-	X	**Assessed as possibly occuring** in project development area in EIS. Downgraded to unlikely to occur in the SREIS and not assessed.
Chalinolobus picatus (little pied bat)	Not listed	NT	M	-	-	X	X	X	-	**Assessed as known to occur** in project development area in EIS and SREIS
Nyctophilus corbeni (south-eastern long-eared bat)	V	V	M	-	-	X	X	X	X	**Assessed as known to occur** in project development area in EIS and SREIS

Key: E = Endangered; V = Vulnerable; NT = Near Threatened; LC = Least Concern (Common); WN = WildNet (EHP's Wildlife Online database); QM = Queensland Museum; EPBC PMR = EPBC Protected Matters Report generated from the EPBC Act Protected Matters Search Tool.
* Indicates a database search updated for SREIS.
** Database search completed for EIS study only
*** Database search completed for SREIS
"X" Recorded in species search.
"**-**" not recorded in species search.

BoT (Back on Track) Priority Status; H = High, M = Medium

Table 10. Fauna species excluded from the assessment of impacts in SREIS assessment.

Species Name	Conservation Status		Source						Comments
	EPBC Status	NCA Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Mixophyes iteratus (giant barred frog)	E	E	-	-	-	-	-	X	Within the bioregion, this species was known only from the Bunya Mountains. The species is thought to be extinct in this location (Hines 2012b). The project development area does not encompass this location, or other areas of suitable habitat.
Elseya belli (Bell's turtle) Also known as western saw-shelled turtle (*Myuchelys belli*)	V	Not listed	-	-	-	-	-	X	In Queensland, this species is known only from a 10 km stretch of Bald Rock Creek (Fielder 2012) more than 150 km from the project development area. Due to the distance separating the known range of this species from the project development area, project related impacts on this species are therefore not expected
Rheodytes leukops (Fitzroy River turtle)	V	V	-	-	-	-	-	X	This species is limited to the Fitzroy River catchment in central Queensland (Gordos 2012). This species is not known to occur as far south as the project development area. Further justification for the exclusion of this species from assessment is provided in the aquatic ecology SREIS assessment.
Uvidicollis (Underwoodisaurus) sphyrurus (border thick-tailed gecko)	V	V	-	-	-	-	-	X	This species is known to occur north to Durikai State Forest (Hines 2012a), which is south of the project development area (80 km). There is no known specimen or sighting to suggest this species might occur within the project development area. Project related impacts on this species are therefore not expected.

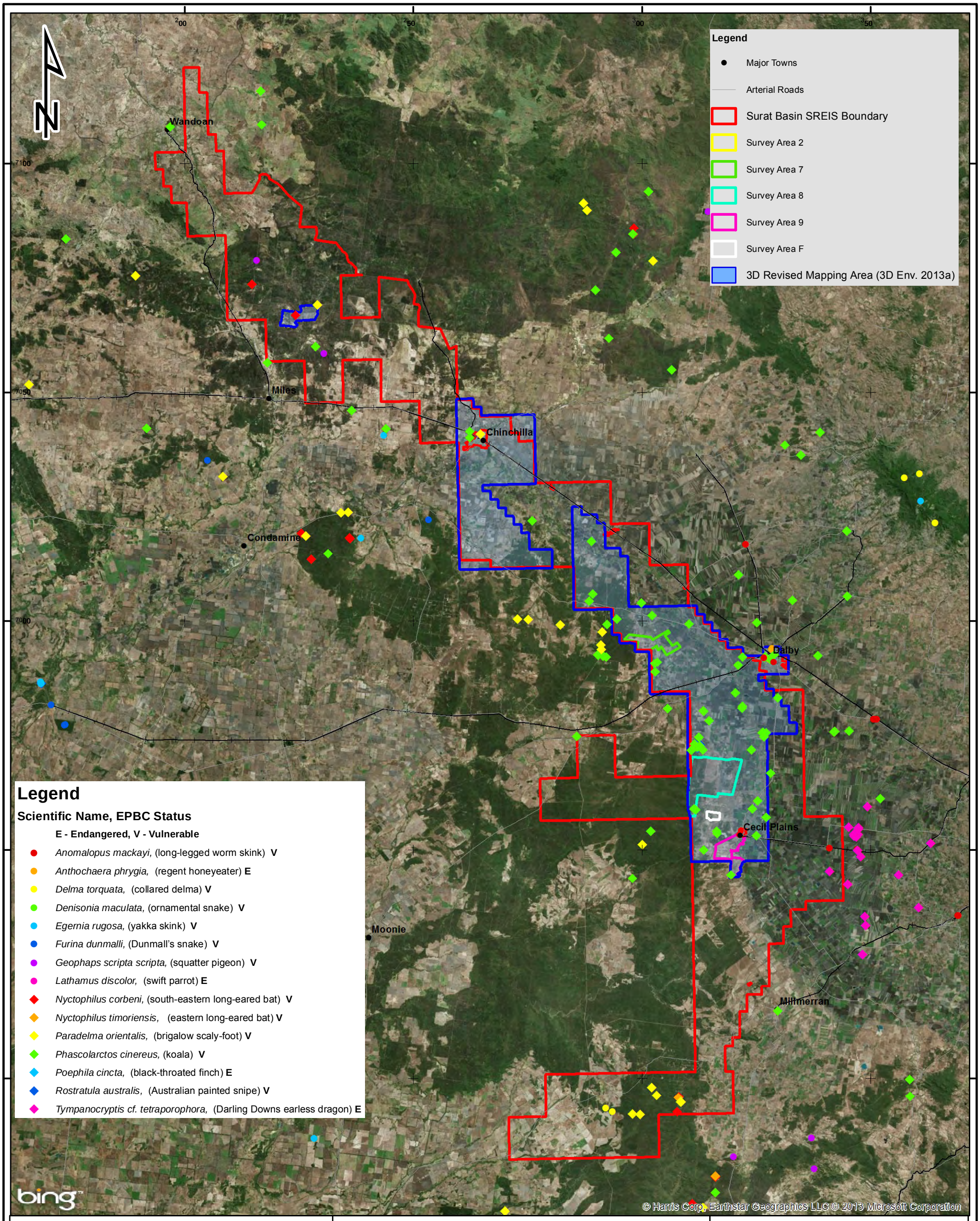
Species Name	Conservation Status		Source						Comments
	EPBC Status	NCA Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Denisonia maculata (ornamental snake)	V	V	-	-	-	X	-	X	The nearest known record of ornamental snake is 160 km to the north of the project development area, with known populations of this species occurring south to the Dawson River valley (Melzer 2012. There is no known specimen or sighting to suggest this species might occur. Project related impacts on this species are therefore not expected.
Botaurus poiciloptilus (Australasian bittern)	E	LC	-	-	-	-	X	X	Historical records of the Australasian bittern occur near the project development area. One is from near the Condamine River north of the town Condamine. The other is from Chinchilla, which is within the area, though excised. *Today, it is rarely recorded in Queensland, and possibly survives only in protected areas such as the Cooloola and Fraser regions* (taken from the SPRAT database DSEWPaC 2013a). Any occurrence in the project development area highly unlikely and would be of vagrant individuals.
Erythrotriorchis radiatus (red goshawk)	V	E	-	-	X	X	-	X	Only two pre-1979 records of low spatial precision from the general area are known. The sparsity of records indicates this would only be a vagrant species in the area. The project area is on the edge of the species range and with an estimated 100-140 pairs remaining in Queensland (Czechura 2011) it is unlikely to be an area frequented by red goshawks.
Lophochroa leadbeateri (Major Mitchell's cockatoo)	Not listed	V	-	-	X	-	X	-	The project area is not far outside the range of the species however there is only one un-dated (so probably pre-1980) record from project area. With the project area there is little or no suitable habitat available. It is likely that there was either a vagrant individual or possibly an erroneous record.

Species Name	Conservation Status		Source						Comments
	EPBC Status	NCA Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Turnix melanogaster (black-breasted button-quail)	V	V	-	-	-	-	X	X	Known from state forests north of, but connected to, Barakula State Forest. There is little suitable habitat within the project development area and no known confirmed record from the area.
Ninox strenua (powerful owl)	Not Listed	V	X	-	X	X	-	-	Two pre-1980 records, including one 1885 record of low spatial precision from the Chinchilla region. One post-1980 record from the project development area in close proximity to the Bunya Mountains. Habitat within the Bunya mountains is very different to that within the project area with little suitable habitat within the project area. Powerful owl is not expected to occur.
Pedionomus torquatus (plains wanderer)	V	V	-	-	X	-	X	-	One un-dated (likely pre-1980) record from project area. The project area is well outside of the core range of the species and only just borders the range of the species. Little or no suitable habitat is available on the project site. It is considered that the record is either a vagrant individual or possibly an erroneous record.
Neochmia ruficauda ruficauda (star finch)	E	E	-	-	-	-	-	X	There has been no definite record of the nominate race since 1995 and although the population is estimated at less than 50 individuals it may be extinct (Payne 2010; Garnet et al. 2011). Presumed locally extinct and therefore unlikely to occur on the project site.
Poephila cincta (black-throated finch)	E	E	X	-	-	-	-	X	One 1885 record from Project development area. The subspecies *cincta* is extinct in most places south of the Burdekin River (Higgins et al. 2006) and is now considered to extend southwards only as far as the upper Burdekin River basin over 500km north (Payne 2010). Presumed locally extinct.

Species Name	Conservation Status		Source						Comments
	EPBC Status	NCA Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Lathamus discolor (swift parrot)	E	E	-	--	X	-	X	-	Three pre-1965 records of low spatial precision from the general area. A migratory species that spends very little time in Queensland. Any possible current or future occurrence would be of vagrant individuals; these would be considered very rare.
Polytelis swainsonii (superb parrot)	V	LC	-	-	-	-	-	X	In Queensland the species is known from near Cunnamulla and between Goondiwindi and Warwick (Parker and Webster 2012). There is no known record from the project development area.
Dasyurus hallucatus (northern quoll)	E	LC	-	-	-	-		X	EPBC predictive result only. No known specimen or observation records. The species range is not in proximity to the project site
*Dasyurus maculatus maculatus (*Spotted-tailed quoll)	E	LC	-	-	-	-	-	X	The current status of this species in the Brigalow Belt is uncertain, with the last record of this species in 1990 (Keto et al. 2004). The Granite Belt and the Border Ranges are the only regions in Queensland where this subspecies is still recorded regularly (Burnett and Meyer-Gleaves 2012). Probably locally extinct. The species was assessed as possibly occurring in the EIS although has been downgraded to 'unlikely to occur' in SREIS.
Petrogale penicillata (brush-tailed rock-wallaby)	V	V	-	-	X	-	X	X	Three post-1980 records from project area. In the project area, this species is known only from Wondul Range. As of 2008, this population was thought to be extinct (EPA 2008b).

Species Name	Conservation Status		Source						Comments
	EPBC Status	NCA Status	QM**	BA*	Wildnet*	Other*	WM online***	EPBC PMR*	
Chalinolobus dwyeri (large-eared pied bat)	V	V	-	-	-	-	X	X	There is one record of the large-eared pied bat within 25 km of the project development area (within western Creek State Forest, northwest of Wondul National Park). In Queensland, the species occurs in areas with extensive cliffs and caves in the central Queensland sandstone belt (Dennis 2012). There is no suitable habitat in the Project development area.
Potorous tridactylus tridactylus (long-nosed potoroo)	V	V	-	-	-	-	-	X	EPBC predictive result only. No known specimen or observation records. In Queensland this species is generally found within 50 km of the coast and in areas with rainfall exceeding 750 mm per annum (Norton 2012).
Pteropus poliocephalus (grey-headed flying-fox)	V	LC	-	-	-	-	-	X	EPBC predictive results only. Vagrant west of the Great Dividing Range. No known specimen or observation records.
Phascolarctos cinereus (koala)	V	LC	-	-	X	X	X	X	Known to occur within the project development area, but listed after the development was referred. This species has therefore not been the subject of detailed assessment. The species is however considered 'special least concern' species under the Queensland Nature Conservation (Koala) Conservation Plan (2006) and guidelines for management of this species detailed in the plan should be followed.

Key: E = Endangered; V = Vulnerable; NT = Near Threatened; LC = Least Concern (Common); WN = WildNet (EHP's Wildlife Online database); QM = Queensland Museum; EPBC PMR = EPBC Protected Matters Report generated from the EPBC Act Protected Matters Search Tool.
* Indicates a database search updated for SREIS.
** Database search completed for EIS study only
*** Database search completed for SREIS
"X" Recorded in species search.
"**-**" not recorded in species search.



NOTES:

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

Data sources; Ecosmart Ecology- ESE, Birds Australia -BA, Queensland Wetlands Database, Queensland Museum - QM, Arrow Energy

Figure 7. Distribution of EPBC Act fauna species records relative to the project development area.

Client

Coffey Environments

0 20 40 60 80

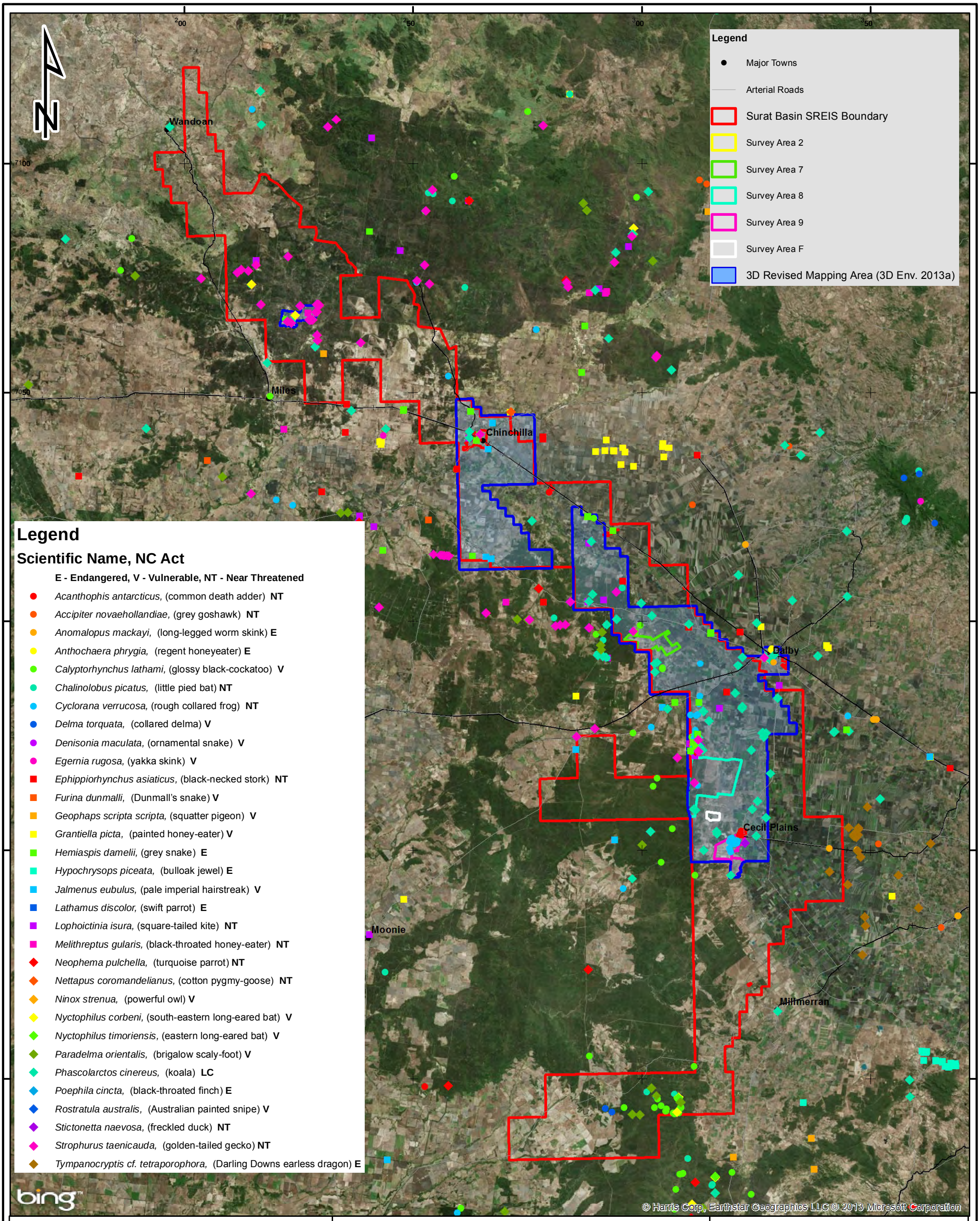
Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	Date	
						C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Fauna_NCA_A3P_new.mxd	2/05/2013	A4

3D Environmental

Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



NOTES:

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

Data sources; Ecosmart Ecology- ESE, Birds Australia -BA, Queensland Wetlands Database, Queensland Museum - QM, Arrow Energy

Figure 8. Location of NC Act listed fauna species records in relation to project development area

Client

Coffey Environments

0 20 40 60 80

Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_Fauna_NCA_A3P_new.mxd	Date	22/05/2013	A4

3D Environmental

Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

5.4 Bioregional Corridors

5.4.1 Distribution in Project Development Area

The Biodiversity Planning Assessment (BPA) (EPA 2008a) for the Brigalow belt shows state significant corridor vegetation is scattered throughout the project development area. A detailed description of all corridor vegetation is not possible due to the scale of the project development area, although some obvious aggregations of corridor vegetation, as shown in **Figure 9**, are noted as follows:

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

5.4.2 Ecological Function of Bioregional Corridors

Corridors provide a vital ecological role in fragmented landscapes (Lindenmayer and Fischer 2006). They are believed to:

- Facilitate the movement of animals, thereby maintaining migration and dispersal. This may be particularly important if a species breeds in areas separated from its normal feeding area, requires access to refugia or is a species that undertakes migrations.
- Improve recruitment by reducing mortality during dispersal.
- Prevent and reverse local extinctions by allowing the recolonisation of patches

- Promote the exchange of genes between sub-populations, increasing effective population size, reducing genetic drift and inbreeding depression.
- Maintain inherent species richness at a patch and landscape scale.

Increased fragmentation in the southern Brigalow belt posses a significant risk to existing terrestrial ecology values. The impact of corridor loss will depend on the existing value and function of the corridor, the types of species affected (i.e., community composition), and the habitat structure of modified areas. Accordingly, impacts can only be quantified on a property-by-property and species-by-species basis. As a guide, the possible sensitivity of individual EVNT fauna assessed as potentially present within the project development area, to fragmentation of vegetation contained in corridors is provided in **Table 11**. The evaluation provided in **Table 11** relates to a fauna species ability to move across open ground (i.e., between populations or habitat patches), it does not reflect the species sensitivity to loss of habitat. Further information on the relevance of bioregional corridors to individual corridors is contained in species profiles (see **Appendix C** and **D**).

Table 11. Susceptibility to fragmentation of EVNT fauna.

Group	Scientific Name Common Name	EPBC Act Status*	NC Act Status*	Possible susceptibility to fragmentation of bioregional corridors	Notes
Invertebrates	*Hypochrysops piceatus* Bulloak jewel	-	E	Moderate	Ability to move over open areas unknown, although being highly mobile it is assumed this species can move substantial distance. Extremely sensitive to habitat loss.
	Jalmenus eubulus Imperial hairstreak	-	V	Moderate	Ability to move over open areas unknown, although being highly mobile it is assumed this species can move substantial distance.
Amphibians	*Cyclorana verrucosa* Rough frog	-	NT	Low	Inhabits open country and highly mobile. Unlikely to be affected by fragmentation
Reptiles	*Strophurus taenicauda* Golden-tailed Gecko	-	NT	Moderate	Observed crossing roads (~30 m). Probably able to cross open areas up to 50 m. Ability to cross 100+ m unknown.

Group	Scientific Name Common Name	EPBC Act Status*	NC Act Status*	Possible susceptibility to fragmentation of bioregional corridors	Notes
	Tympanocryptis cf. tetraporophora Grassland earless dragon	E	E	High	Never observed away from cover or seen crossing roads, Not expected to leave grasslands with any frequency and unlikely to cross any substantially cleared areas.. Species not associated with corridors in the project development area.
Reptiles (*cont'd*)	*Delma torquata* Collared delma	V	V	Very High	Never observed to cross roads, rarely ever found active. Fragmentation is highly likely to restrict individuals to fragmented areas.
	Paradelma orientalis Brigalow scaly-foot	V	V	Moderate	Observed crossing roads (~30 m) and probably able to cross up to 50 m. Ability to cross 100 m unknown.
	Anomalopus mackayi Five-clawed worm-skink	V	E	Very High	Never observed away from cover, unlikely to cross any substantially cleared areas. Not expected to leave grasslands and cover with any frequency
	Egernia rugosa Yakka skink	V	V	High	Strongly associated with burrows, rarely seen to move far from burrows. Ability to move across open areas is unknown.
	Hemiaspis damelii Grey snake	-	E	Moderate	Observed crossing roads (~30 m) and probably able to cross up to 50 m. Ability to cross 100 m unknown.
	Acanthophis antarcticus Common death adder	-	NT	High	Observed crossing roads (~30 m). Most records in the southern Brigalow Belt are from large intact remnant vegetation patches. Responses, and ability to cross, larger open areas is unknown.
	Furina dunmalli Dunmall's snake	Vul	Vul	Moderate	Observed crossing roads (~30 m), but general movements are virtually unknown.
Birds	*Anthochaera phrygia* Regent honeyeater	E	E	Very Low	Highly mobile, nomadic, following flowering events. Unlikely to be affected by fragmentation

Group	Scientific Name Common Name	EPBC Act Status*	NC Act Status*	Possible susceptibility to fragmentation of bioregional corridors	Notes
	Geophaps s. scripta Squatter pigeon	V	V	Very Low	Frequents road edges and cleared grassy areas, mobile, unlikely to be impacted by fragmentation
	Calyptorhynchus lathami Glossy black-cockatoo	-	V	Very Low	Highly mobile, moves between food trees. Habitat fragmentation is only likely to impact on glossy black-cockatoos through loss of feed trees.
Birds (*cont'd*)	*Accipiter novaehollandiae* Grey goshawk	-	NT	Very Low	A large ranging species that will nest within small areas of vegetation adjacent to cleared areas. Habitat fragmentation is unlikely to impact on this species.
	Lophoictina isura Square-tailed kite	-	NT	Very Low	A large ranging species that will nest adjacent to roads. Often found in highly disturbed areas. Habitat fragmentation is unlikely to impact on this species.
	Nettapus coromandelianus Cotton pygmy-goose	-	NT	Very Low	Strongly associated with waterbodies, rarely seen out of aquatic habitats. Unlikely to be affected by habitat fragmentation.
	Stictonetta naevosa Freckled duck	-	NT	Very Low	Strongly associated with waterbodies, rarely seen out of aquatic habitats. Unlikely to be affected by habitat fragmentation.
	Ephippiorhynchus asiaticus Black-necked stork	-	NT	Very Low	Associated with water bodies and inundated paddocks, highly mobile and nomadic. Unlikely to be impacted up by habitat fragmentation.
	Grantiella picta Painted honeyeater	-	V	Very Low	Highly mobile, nomadic, following flowering events. Unlikely to be affected by habitat fragmentation.
	Melithreptus gularis Black-chinned honeyeater	-	NT	Very Low	Highly mobile, nomadic, more abundant during flowering events. Unlikely to be affected by CSG fragmentation.

Group	Scientific Name Common Name	EPBC Act Status*	NC Act Status*	Possible susceptibility to fragmentation of bioregional corridors	Notes
	Neophema pulchella Turquoise parrot	-	NT	Low	Highly mobile, often occurring in association with cleared lands. CSG fragmentation is unlikely to impact upon the species.
	Rostratula australis Australian painted snipe	V	V	Very Low	Strongly associated with waterbodies and aquatic vegetation, rarely seen out of aquatic habitats. Unlikely to be affected by CSG fragmentation.
Mammals	*Chalinolobus picatus* Little pied bat	-	NT	Low	The mobility of little pied bats poorly documented. Individuals have been recorded from relatively fragmented pockets, and the species is expected to cross open areas.
	Nyctophilus corbeni South-eastern long-eared bat	V	V	High	Known only from large patches of vegetation. Assumed to cross small clearings based on the presence of management tracks (i.e., <30 m) within known habitat, but ability to cross larger clearings (>50m) unknown.

*E = 'Endangered', V=Vulnerable', NT='Near threatened', V='Vulnerable',- not listed.

In addition, a number of flora species may be impacted by impacts to bioregional corridors, most obviously those where ecology and reproduction is governed to a significant degree by fire. Fragmentation of wildlife corridors has potential to interrupt the natural movement of fire across the landscape leaving fire dependent species susceptible to habitat change associated with either fire exclusion or too little fire. Species which are typically associated with bioregional corridors that may rely on habitat factors promoted by habitat continuity on a regional scale are indicated in **Table 12** with further discussion for individual EPBC Act species provided within **Appendix C**.

Table 12. Suspectibility of species to impacts associated with fragmentation of bioregional corridors.

Species	EPBC Act	NC Act	Susceptibility to impact associated with disturbance to bioregional corridors	Notes
Acacia curranii Curly-bark wattle	V	V	High	Many acacia species require habitat contiguity to promote natural movement of fire through the landscape. Fire at regular

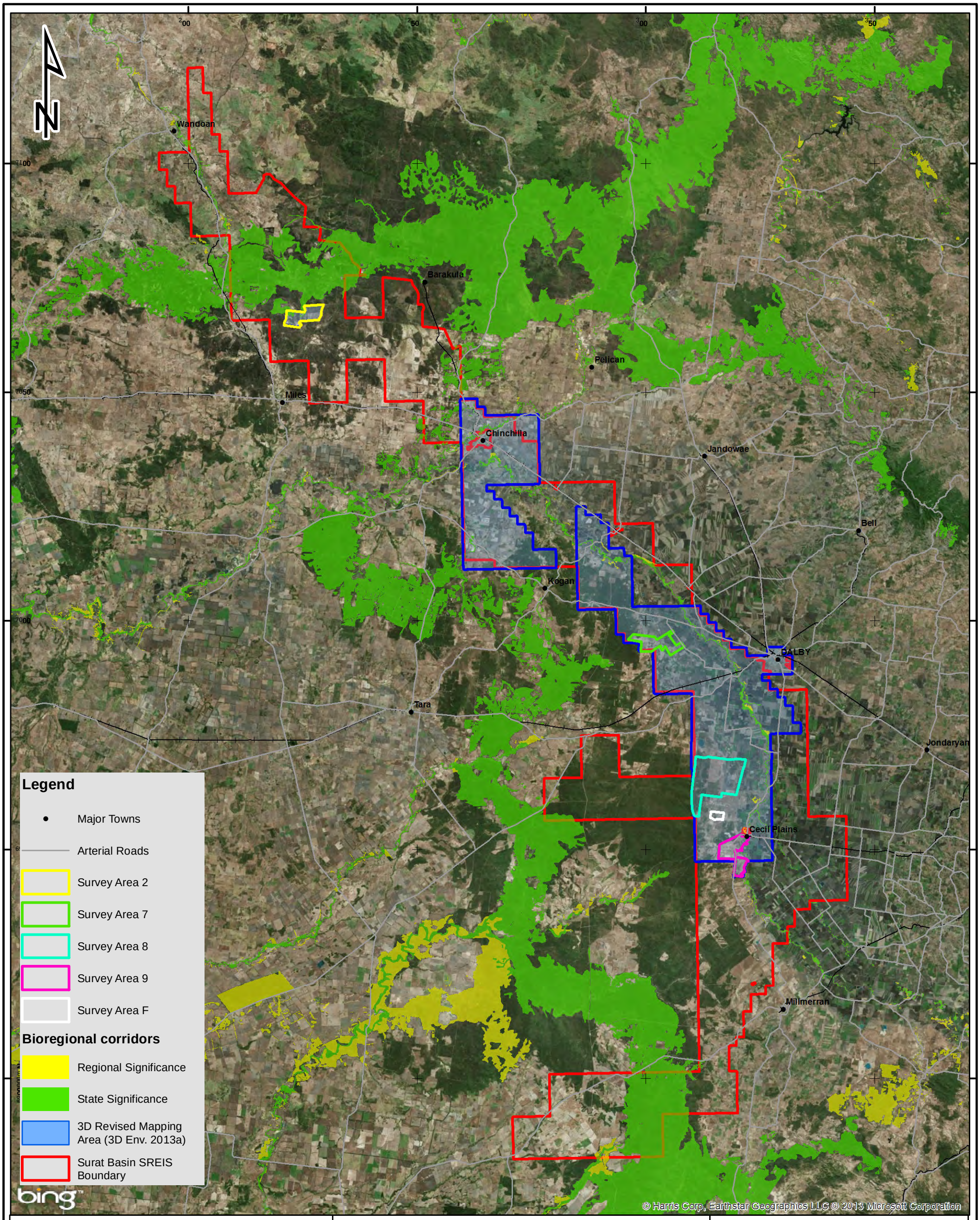
Species	EPBC Act	NC Act	Susceptibility to impact associated with disturbance to bioregional corridors	Notes
Acacia handonis Hando's wattle	V	V		intervals is required to promote recruitment and seed germination. Too frequent fire may also result in failure of plants to reach maturity and complete the reproductive cycle.
Acacia lauta Tara Wattle	V	V		
Acacia barakulensis Waaje wattle	-	V		
Aristida forsteri Forster's wiregrass	-	E	High	Little is known about the ecology of this grass although it is known to occur within contiguous intact habitatsin the south of the project development area. Contiguous habitats provide a buffer against weed invasion with the species likely to be particularly threatened by invasive exotic grasses such as love grass (*Eragrostis curvula)f*
Macrozamia machinii Machin's macrozamia	V	V	High	Like many of the acacia species, Macrozamia *machinii* is likely to be heavily reliant on fire to complete their reproductive cycle. Fire exclusion as may occur within highly fragmented habitats may alter habitat ecology, resulting in senescence of a population. Too frequent hot fires may result in plants being destroyed prior to reproductive maturity.
Prostanthera sp. Dunmore (D.M. Gordon 8a)	V	V	Moderate	Little known about the ecology of these species and likely response to fragementation although they are typically associated with intact contiguous remnants. Some species may also be associated with disturbed vegetation although their long term response to disturbance is unknown.
Callitris baileyi Bailey's callitris	-	NT	Moderate	
Apatophyllum teretifolium Sandstone pricklebush	-	NT	Moderate	
Eucalyptus virens	V	V	Moderate	
Calytrix gurulmundensis Gurulmundi fringe myrtle	V	V	Moderate	
Cryptandra ciliata	-	NT	Moderate	
Pomaderris coomingalensis	-	E	Moderate	
Philotheca sporadica Kogan waxflower	V	V	Moderate	
Pterostylis cobarensis	V	V	Moderate	

Species	EPBC Act	NC Act	Susceptibility to impact associated with disturbance to bioregional corridors	Notes
Micromyrtus carinata	-	NT	Moderate	
Eucalyptus curtisii Plunkett mallee	-	NT	Moderate	
Dicanthium queenslandicum King blue grass	E	V	Low	These species occur in the project development area in habitats that have been heavily fragmented. Impacts to bioregional corridors and other areas of broadscale contiguous vegetation will have limited impact of these species
Digitaria porrecta Finger panic grass	E	NT	Low	
Homopholis belsonii Belson's panic	V	V	Low	
Bothriochloa biloba Lobed blue grass	V	-	Low	
Xerothamnella herbacea Xerothamnella	E	E	Low	
Rhaponticum australe Austral cornflower	V	V	Low	
Picris evae Hawkweed	V	V	Low	
Thesium australe	V	V	Low	
Eucalyptus argophloia	V	V	Low	
Acacia wardellii Wardell's wattle	V	V	Low	
Acacia tenuinervis	-	NT	Low	
Cymbonotus maidenii	-	E	Low	
Eleocharis blakeana Blake's spikerush	-	NT	Low	
Fimbristylis vagans	-	NT	Low	
Rutidosis lanata	-	NT	Low	

*E = 'Endangered', V=Vulnerable', NT='Near threatened', V='Vulnerable','-' not listed.

5.4.3 Management of Bioregional Corridors

The location of bioregional corridors, as identified in EPA (2008), should be considered in the desktop review process to minimise the project footprint and habitat fragmentation within these areas. As connectivity is considered a State Significant Biodiversity Value (SSBV), impact to bioregional corridors may require an offset under the Queensland Biodiversity Offsets Policy (Version 1) (DERM, 2011b) where other SSBVs are in proximity and the impact will compromise the function of the SSBV. Habitat fragmentation will also be mitigated through site rehabilitation.



N O T E S:
(i) This plan has been produced for exclusive use of Arrow Energy Pty Ltd, Coffey Environments and **3D Environmental**
Source: Brigalow Belt Biodiversity Planning Assessment (EPA 2008).

Figure 9. Bioregional corridors in the project development area and surrounds.

Client
Coffey Environments

0 20 40 60 80
Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_EIS_A3P.mxd	Date	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

5.5 Wetland Management Areas

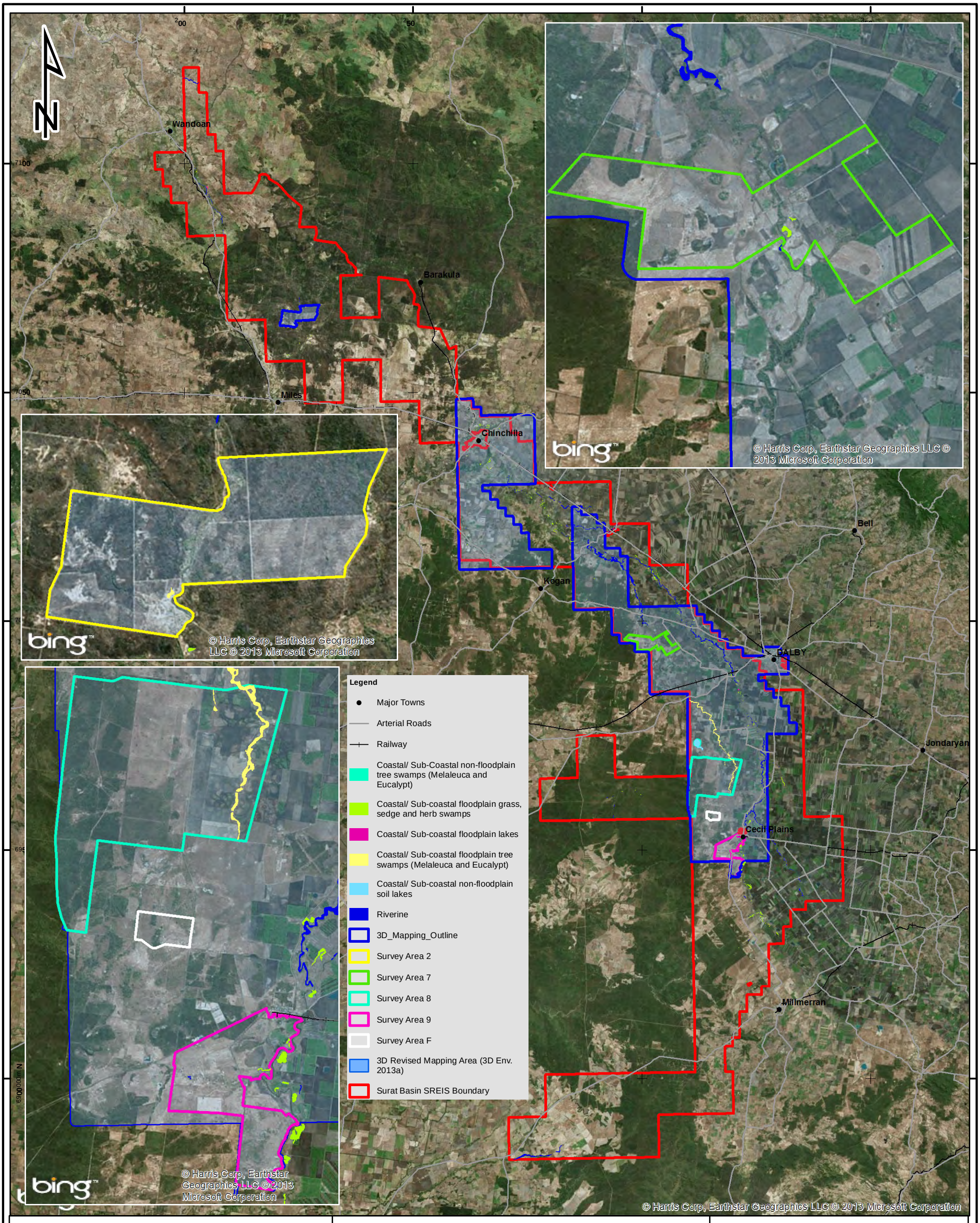
In addition to Lake Broadwater, a major lacustrine Wetland of National Significance, the project development area contains an extensive mosaic of palustrine wetland habitats, many of which are associated with the Condamine River floodplain. Across Queensland, comprehensive mapping has been undertaken for wetlands of high ecological significance and general ecological significance (EHP 2012d). These units include habitats associated with remnant vegetation (REs) which may include RE11.3.27, 11.3.25 and RE11.4.3a, and non-vegetated (non-remnant) areas. Wetland datasets produced by EHP (2012e) incorporate two layers:

- Wetland Protection Areas are wetlands of high ecological significance within catchments of the Great Barrier Reef . The project development area does not contain WPAs.
- Wetland Management Areas are wetlands of general or high ecological significance in parts of Queensland not associated with a Great Barrier Reef catchment area. WMAs include lacustrine, palustrine, riverine and estuarine wetlands.

Wetland Management Areas are of specific relevance to the project, requiring adherence to appropriate management buffers and specific mitigation measures. The location of Wetland Management Areas in the project development area is shown in **Figure 10**. The extent of Wetland Management Areas within survey areas is provided in **Table 13**, being located within all properties subject to development with the exception of Survey area F.

Table 13. Extent of Wetland Management Areas within the project development area and survey areas.

Location	**Wetland Management Area (Ha)**
Project development area	4489.8
Survey area 2	2.3
Survey area 7	6.9
Survey area 8	10.2
Survey area 9	172.3
Survey area F	0



NOTES:

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

Source: Brigalow Belt Biodiversity Planning Assessment (EPA 2008).

Figure 10. Wetland Management Areas in the project development area.

Client

Coffey Environments

0 20 40 60 80

Kilometers

Scale	1:766,575	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\RobFriend\Hay_Point\3D_Surat_EIS_Fauna_NCA_Insets_A3P.mxd	Date	6/06/2013	A4

3D Environmental

Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

5.6 Site Specific Assessments

The following assessment considers potential impacts at all proposed project sites individually. As the development footprint within these properties has not been defined, the assessment assumes that all vegetation and habitat within these sites is subject to clearing and included within impact calculations. In reality however, there maybe opportunity for infrastructure to be located away from sensitive habitats with the total size of a CGPF being 350 m x 520 m (18.2 ha) and non-remnant sites cleared of vegetation being available. During SREIS field surveys, survey areas 2 and 9 were subject to detailed assessment with survey areas 7, 8 and F subject to broader habitat assessments (refer to methods **Section 4.3.1**and **4.3.2**).

5.6.1 Survey area 2

General Description

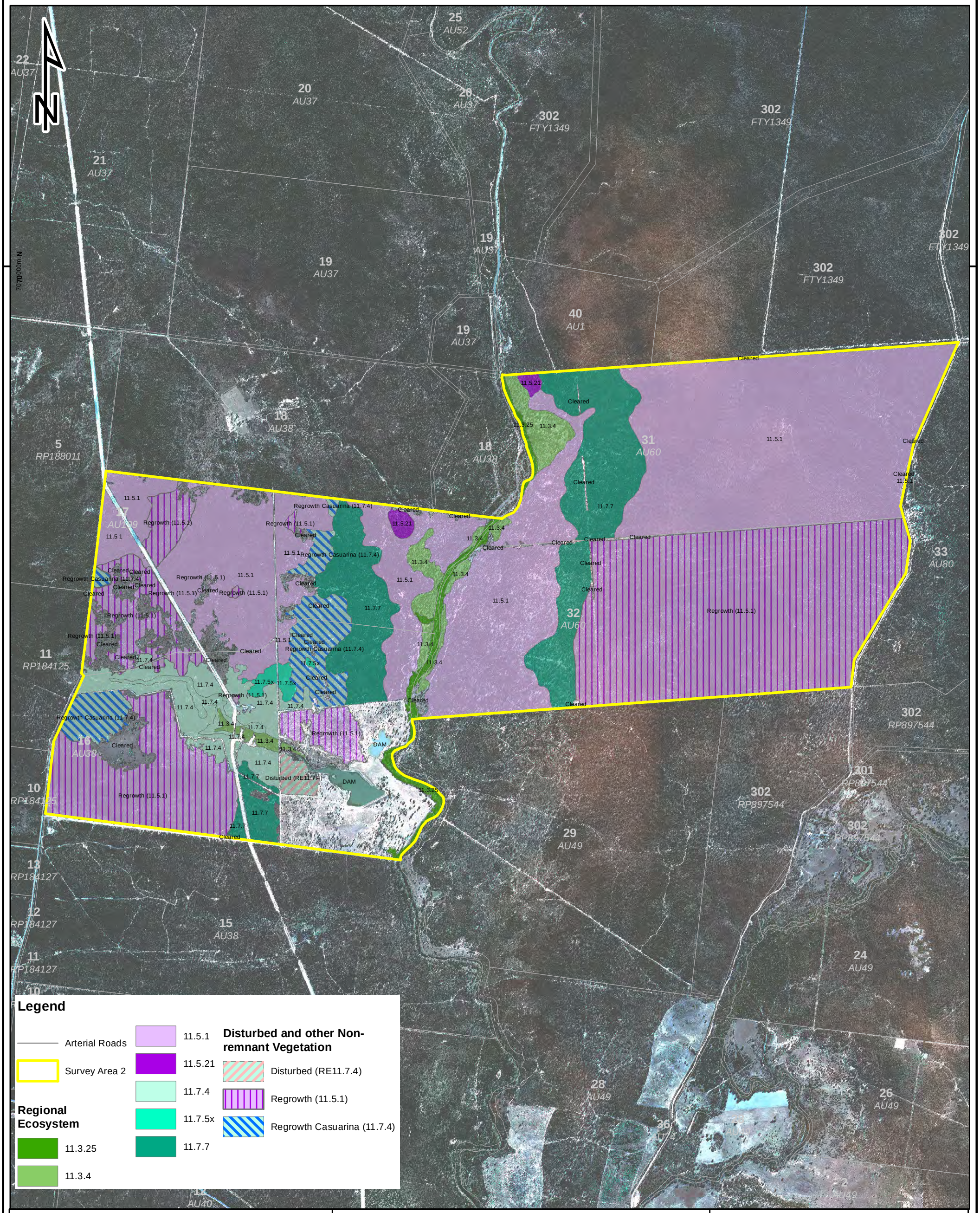
Survey area 2 is located approximately 15 km to the north east of Miles with the northeastern portion of the property contiguous with Barakula State Forest. A wildlife corridor of state significance intrudes into the central portion of the property from the north. Based on detailed (1:10 000) mapping, the property occupies 2416 ha, comprises 1376 ha of remnant vegetation (56%), 798 ha or recent regrowth (33 %) with a balance of cleared land. Whilst habitats are largely contiguous, they have been subject to extensive extraction of timber (mostly ironbark) which has resulted in a loss of structural complexity (large trees removed) and some habitat fragmentation with numerous small clearings and access tracks noted with remnant woodland habitats.

Associated Ecological Communities and Regional Ecosystems

Reference to **Table 3** indicates a total of 37 floristic survey sites recorded during field surveys including 15 sites undertaken for biocondition using the Ecological Equivalence Methodology (EEM), a single secondary survey site, two tertiary survey sites and 19 descriptive quaternary sites.

EPBC Act Listed Ecological Communities: No ecological communities of national significance were recorded on this property.

Regional Ecosystems: A total of seven REs were identified on survey area 2 during field survey. The surveyed extent of REs with comparisons to certified RE mapping is provided within **Table 14.** Summary site data and detailed floristic descriptions for REs identified on the site are provided below. It should be noted that remnant vegetation defined within the 3D mapping database includes areas that would be considered 'mature regrowth' within datasets provided by EHP (2012b). Mapping of REs is represented wthin **Figure 11.** Whilst REs are broadly consistent with the mapping provided by EHP (2012a and 2012b), there is considerable variation in the extent of some RE's. In particular EHP mapping has not recognised extensive areas of RE11.5.1 (*Eucalyptus crebra* woodland on loamy plains) on the property which occupies 934 ha. Riparian and floodplain habitats (REs 11.3.25 and RE11.3.4) are also poorly defined in the EHP mapping, with greater definition and an increase in associated areas of vegetation within revised mapping datasets.



NOTES:

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

Figure 11. Distribution of regional ecosystems within survey area 2

Client

Coffey Environments

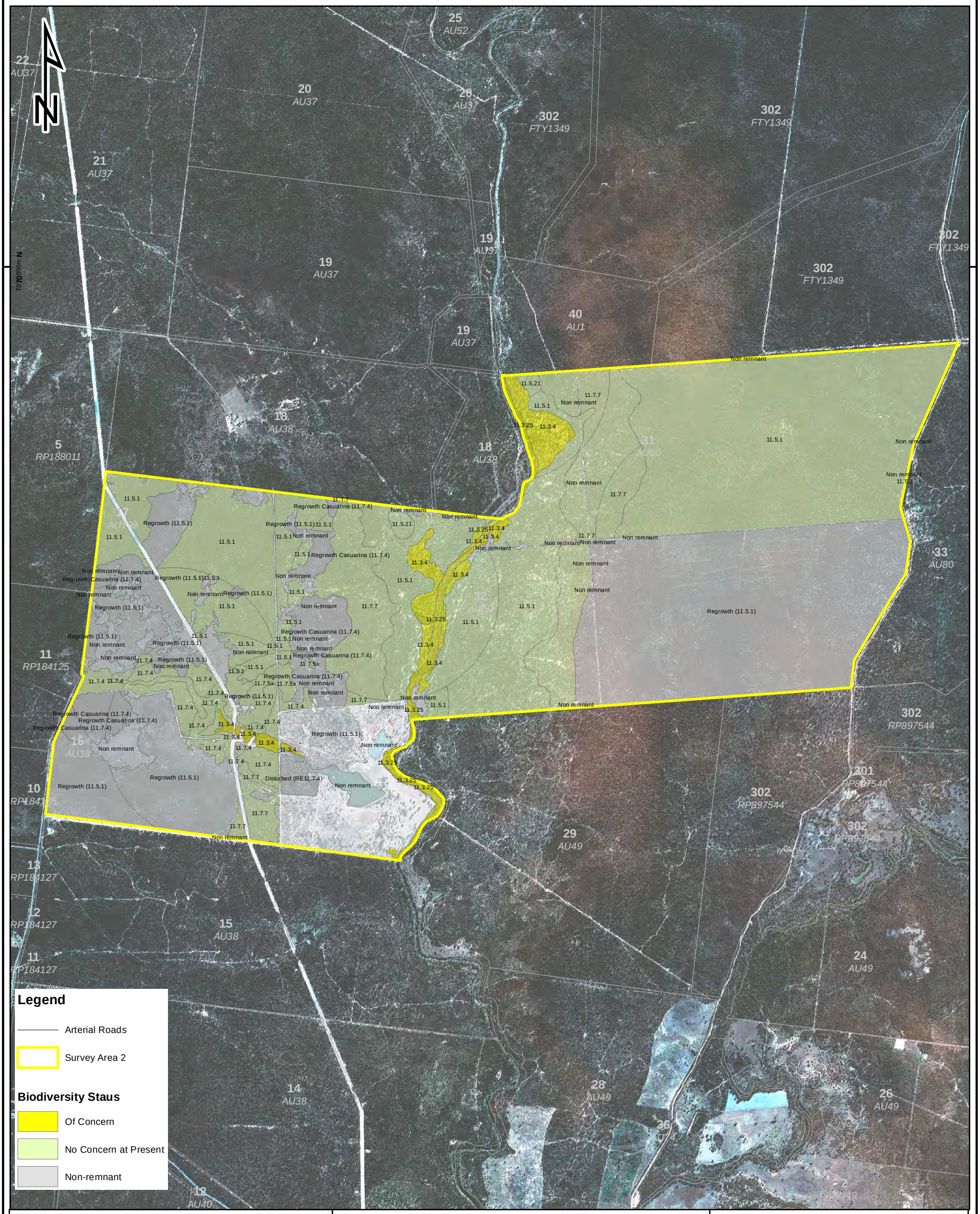
0 700 1,400 2,100 2,800

Meters

Scale	Drawn By	Checked	File Path	Date	
1:33,297	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



NOTES:

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

Figure 12. Biodiversity status of vegetation in survey area 2

Client

Coffey Environments

0 700 1,400 2,100 2,800

Meters

Scale	Drawn By	Checked	File Path	Date	
1:33,297	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Table 14. Regional ecosystems identified during field survey on survey area 2.

Regional Ecosystem	Bio-Status	Extent within Property (Revised project scale mapping) (Ha	Extent Within Property (EHP 2012a)	Extent Within Property (EHP 2012b) Mature Regrowth	Total (EHP 2012a and 2012b)
11.3.4	Of concern	56.1	15.1	17.4	32.5
11.3.14	No concern at present	0	32.9	4.7	37.6
11.3.25	Of concern	31.3	4.5	7.5	12.0
11.5.1	No concern at present	934	0	0	0
11.5.4	No concern at present	0	25.3	23.5	48.8
11.5.21	No concern at present	8.4	50.6	46.9	97.5
11.7.2	No concern at present	0	52.0	23.2	75.2
11.7.4	No concern at present	88.6	890.8	456.0	1346.8
11.7.5	No concern at present	9.8	52.0	23.2	75.2
11.7.7	No concern at present	248.4	103.9	46.4	150.3
Recent Regrowth and Disturbed Vegetation	Non-remnant	798.4	0	NA	NA
Cleared Land	Non-remnant	249.3	1195.4	NA	NA

Floristic Habitat Descriptions

Table 15 provides floristic descriptions for the seven REs recorded on survey area 2 during the course of the survey. Habitat values for threatened flora species are indicated with further expansion provided in following sections. A total of 238 flora species were recorded during survey of survey area 2 which comprises 201 native species, 37 exotic species which includes two species declared under the LP Act.

Threatened Flora Species

No flora species listed as threatened under the NC Act or EPBC Act nor BoT species was identified during the survey although the site contains potential habitat for a range of threatened flora species. 'Core habitat possible' has however been downgraded to 'general habitat' for some species due confidence that surveys were of sufficient adequacy to locate and major populations of the species. A number of species have however retained their habitat ranking where survey conditions were sub-optimal or the species was cryptic and difficult to locate. Threatened species, with potential habitat wihin the property are provided in **Table 16**. Further information on MNES species occurring in survey area 2 is provided within **Appendix C** and **D.**

Exotic (Pest) Flora Species

Habitats on survey area 2 retain native vegetation cover and are largely free of exotic species. Prickly pear (*Opuntia stricta)* and velvet tree pear *(Opuntia tomentosa)* are the only species declared under the Land Protection (Pest and Stock Route Management) Act, 2002 identified as occurring on the property, being listed as Class 2 pests. Populations of these species can be identified during preclearance surveys and mitigations applied to prevent further spread (Section 17.6.3 of Arrow, 2012).

Table 15. Significant floristic habitats contained within survey area 2.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.4	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba*)	This community occurs on seasonally flooded alluvial plains associated with major drainage lines with typical sandy loam soils. The canopy height ranges between 14-24 m and a mean crown cover of 28%. It is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and rough-barked apple *(Angophora floribunda)* with the associated yellow bloodwood (*Corymbia bloxsomei*), narrow leaved ironbark (*Eucalyptus crebra*), and smooth barked apple (*Angophora leiocarpa*).  The second tree layer is sparse and comprises the above canopy species together with white cypress (*Callitris glaucophylla*) and kurrajong (*Brachychiton populnea*). The shrub layer ranges between 1-4 m in height with a mean cover of 22%. Dominant species are moon wattle (*Acacia semilunata*), and white cypress, with frequent yellow tea tree (*Leptospermum polygalifolium*), black wattle (*Acacia crassa* subsp*. crassa),* bull oak *(Allocasuarina Luehmannii*), glory wattle *(Acacia spectabilis),* wilga *(Geijera parviflora),* and paper bark *(Melaleuca decora).* The ground layer is ungrazed, diverse and in good condition with a mean PFC of 81%, which is dominated (97%) by native species. Dominant graminoids species are *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea, Gahnia aspera, Heteropogon contortus, Juncus* sp.*,* and *Paspalidium* sp., with common native herbs including *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Dianella longifolia* var*. longifolia, Rostellularia adscendens,* and *Wahlenbergia communis*. Exotic species are limited to scattered occurrences Mayne's pest (*Verbena aristigera**), buffel grass (*Pennisetum ciliare**) and liverseed grass (*Urochloa mosambicensis*).* Habitat features include, a mean leaf litter cover of 16%, mean coarse woody debris of 40 logs and 170 m of log/ha, and occasional hollows. Overall the alluvial habitats surveyed are in good condition. There is some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers. There is a low incidence of exotic species throughout. A dominance of increaser grasses such as wire grass (aristida) species in the groundcover suggests impacts of previous grazing pressure on species composition, however a lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of dense native cover and high species richness.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.25	No EVNT flora taxa are considered likely to be associated with this RE	***Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland*. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.**  This RE is associated with the riparian margins of the major drainage lines of Bottletree Creek. It is a fringing open forest ranging from 16-24 m and a mean crown cover of 56%. Dominant canopy trees are rough barked apple (*Angophora floribunda*) and Queensland blue gum *(Eucalyptus tereticornis),* with occasional associated yellow bloodwood (*Corymbia bloxsomei).* A distinct sub-canopy is dominated by the above canopy species. The shrub layer which is sparse to very sparse (6-10% cover) ranges between 1-4 m in height and features *Leptospermum polygalifolium,* with associated species such as *Callitris glaucophylla, Acacia crassa* subsp*. crassa,* and saplings of the canopy dominants*.* Ground cover is dense, ranging between 83-86% percent foliage cover (PFC) with a dominance of native perennial grasses such as *Heteropogon triticeus, Dichanthium sericeum* subsp*. sericeum, Imperata cylindrica*, *Chloris divaricata*, *Cymbopogon refractus*, *Chrysopogon fallax, Aristida* spp. and *Lomandra longifolia*. Exotic species are limited to scattered Mayne's pest (*Verbena aristigera**), and prickly pear (*Opuntia stricta**). Mean plot species richness is 42. Habitat features include a mean leaf litter cover of 12%, and a dense cover of native dominant grasses. The limited extent of coarse woody debris is possibly due to periodic flooding, with occasional hollows present in large rough barked apple trees lining the river bank. The riparian habitat is considered in excellent condition on the basis of the health of the canopy and subcanopy (no dieback evident), a low incidence of exotic species in all stratum and particularly in the groundcover, and a lack of recent grazing.
11.5.1	Provides potential habitat for a range of species including Waaje wattle (*Acacia barakulensis*), curly bark wattle (*Acacia curranii*), Wardell's wattle (*Acacia wardellii*) and Cobar greenhood orchid and (*Pterostylis cobarensis).*	***Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.** This woodland ecosystem occurs on sandy and loamy soil associated with undulating loamy plains. Landform is characterised by a general lack of surface outcrop and soil depths of >50 cm, evidenced from pitfall traps and drainage incision. The canopy height ranges between 10-22 m and a mean crown cover of 37%. It is dominated by narrow leaf ironbark *(Eucalyptus crebra)* with associated smooth barked apple *(Angophora leiocarpa),* white cypress *(Callitris glaucophylla),* poplar box *(Eucalyptus populnea),* and scattered yellow bloodwood *(Corymbia bloxsomei).* The sparse second tree layer has an average height of 8.5 m and is dominated by white cypress (*Callitris glaucophylla*) and bulloak (*Alloacasuarina Luehmannii)* with less frequent narrow leaf ironbark and smooth barked apple. A diverse upper shrub layer ranges between 5-30% in cover with a mean height of 4%. Bull oak and white cypress predominate across all sites surveyed. Other typical species are moon wattle (*Acacia semilunata*), *Acacia ixiophylla, Melaleuca decora, Acacia apprepta, Acacia crassa* subsp. *crassa*, *Acacia* l*eiocalyx*, *Acacia spectabilis*, *Petalostigma pubescens, Alphitonia excelsa, Grevillea*

HABITAT		
RE	**Possible EVNT taxa**	**Description**
		striata, and *Ozanthamnus diosmifolius.* The lower shrub layer averaging at 2 m in height and 18.5 % in cover, is similarly diverse with 18 species recorded. Dominant species are *Leucopogon* sp*., Callitris glaucophylla*, *Acacia crassa* subsp*. crassa* and *Allocasuarina Luehmannii.*  A diverse ground layer comprising 76 species displays good condition with cover totally dominated by natives. Dominant species are *Aristida caput-medusae, Fimbristylis dichotoma, Chrysopogon fallax, Cyanthillium cinereum, Dodonaea macrossanii, Panicum decompositum, and Themeda triandra.* Frequent species include *Aristida calycina, Commelina lanceolata, Eragrostis sororia, Goodenia* sp. (GBS4/3), *Lomandra leucocephala* subsp*. leucocephala,* and *Pleurocarpaea* sp. (GBS3/5). Naturalised species are limited to scattered occurrences of *Melinus repens*, Opuntia stricta**), *Opuntia tomentosa**, *Paspalum dilatatum** and *Pennisetum ciliare*.* The ecosystem supports a mean leaf litter cover of 58%. There is evidence of selective removal of narrow leaf ironbark and smooth barked apple, although the presence of mature trees, recruitment of canopy species in the shrub layers, and lack of exotic species, are indicative of the overall good condition of the habitat*.* As for the alluvial habitats there is a dominance of wire grass (Aristida) species in the groundcover suggestive of previous grazing pressure. A lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of a healthy native dominated groundcover and high species richness.
RE11.5.21	Provides potential habitat for a range of species including Waaje wattle (*Acacia barakulensis*), curly bark wattle (*Acacia curranii*), Wardell's wattle (*Acacia wardellii*) and Cobar greenhood orchid and (*Pterostylis cobarensis).*	***Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces.**  This woodland ecosystem occurs on low, well drained sandy soils typically formed on the interface between Land Zone 5 and Land Zone 3. The canopy height ranges between 14-23 m and a mean crown cover of 32%. It is dominated by yellow bloodwood *(Corymbia bloxsomei)* in association with smooth barked apple *(Angophora leiocarpa),* narrow leaf ironbark *(Eucalyptus crebra),* Queensland blue gum *(Eucalyptus tereticornis),* and white cypress *(Callitris glaucophylla).* The second tree layer is poorly formed and often absent with white cypress, bull oak (*Allocasuarina luehmanii*) and occasional narrow leaf ironbark. The shrub layer ranges between 1-5 m in height with a very sparse cover average of 11%. Characteristic species are *Acacia spectabilis*, *Callitris glaucophylla*, *Allocasuarina Luehmannii*. Others include *Acacia amblygona, Acacia ixiophylla, Acacia sp. , Eucalyptus crebra, Hakea purpuea, Leptospermum polygalifolium, Leucopogon sp., Micromyrtus sessilis, Opuntia tomentosa *,*

HABITAT		
RE	**Possible EVNT taxa**	**Description**
		and *Xylomelum cunninghamianum.* The ground layer is in good condition with a mean PFC of 62%, and comprises the following native species: *Triodia scariosa, Aristida caput-medusae, Brachyscome sp., Cheilanthes sieberi, Chrysocephalum apiculatum, Cymbopogon refractus, Dianella brevipedunculata, Eragrostis sp., Eulaia aurea, Fimbristylis dichotoma, Goodenia sp, Homoranthus sp. , Lomandra leucocephala subsp. leucocephala, Murdannia graminea, Pimelea novae-hollandaei, Pleurocarpaea sp., Tricoryne elatior* and *Xanthorrhoea johnsonii*.
RE11.7.4	Provides potential Provides potential habitat for a range of species including Waaje wattle (*Acacia barakulensis*), curly bark wattle (*Acacia curranii*), Wardell's wattle (*Acacia wardellii*), Baileys callitris (*Callitris baileyi)*, sandstone prickle bush (*Apatophyllum teretifolium)* and *Calotis glabrescens.*	***Eucalyptus decorticans* and/or *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* on lateritic duricrust.**  This woodland ecosystem is restricted to low hills and rises where soils are shallow and gravelly with abundant surface outcrop of indurated sandstone. Characteristic species in the canopy are Queensland peppermint (*Eucalyptus exserta)* and smooth barked apple *(Angophora leiocarpa)* with less frequent white cypress *(Callitris glaucophylla)* and narrow leaf ironbark *(Eucalyptus crebra).* The average height of the canopy is 11 m and mean crown cover is 41% although larger emergents, often smooth barked apple are scattered throughout. Well-developed second tree layer has a mean cover of 55% and features Queensland peppermint, Miles mulga (*Acacia apprepta),* white cypress, false mahogany *(Eucalyptus rubiginosa),* and budgeroo *(Lysicarpus angustifolius).* Tall shrubs of *Acacia crassa* subsp*. crassa, Acacia julifera*, and *Acacia semilunata* dominate a sparse upper shrub layer. A distinct yet very sparse lower shrub layer features a range of low shrubs in particular *Leucopogon* sp*., Westringea chellii, Acacia conferta,* and *Micromyrtus sessilis.* The ground layer is mid dense and diverse with 42 species recorded. The native graminoids, which include *Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Panicum decompositum, Scleria sphacelata,* and *Triodia scariosa,* account for 87% of total groundcover. The remainder of cover comprises perennial native herbs such as *Brunoniella acaulis, Cheilanthes sieberi, Goodenia sp.,* and *Pleurocarpaea sp..* The woodland ecosystem is in good condition throughout its distribution on survey area 2.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
RE11.7.5	Provides potential habitat for a range of species including Waaje wattle (*Acacia barakulensis*), curly bark wattle (*Acacia curranii*), Wardell's wattle (*Acacia wardellii*), Baileys callitris (*Callitris baileyi)*, sandstone prickle bush (*Apatophyllum teretifolium)* and *Calotis glabrescens.*	**Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.** This shrubland ecosystem is restricted to poorly drained sandy soils that overlye impervious clays and duricrust. The landform is consistent with Land Zone 5 although there is no suitable RE classification to accommodate this habitat within Land Zone 5. The habitat is relatively restricted on the property to three intact remnant patches. A mid dense upper shrub layer of broombush (*Melaleuca uncinata*) forms the ecological dominant layer with minor occurrences of wattle (*Acacia spp.)* and micromyrtus *(Micromyrtus sessilis).* There are scattered emergents of white cypress *(Callitris glaucophylla)* and blue leaved ironbark *(Eucalyptus fibrosa* subsp*. nubila).* A distinct lower shrub layer is also dominated by broombush and micromyrtus in association with dodder laurel *(Cassytha pubsecens), Leucopogon sp., Hakea purpurea, Pimelea nova-anglica, Dillwynia* sp. and *Callitris glaucophylla.*  In comparison to woodland habitats, this shrubland ecosystem is depauperate in species. Low species diversity is reflected in the ground layer that supports 12 species, of which the spinifex grass (*Triodia scariosa*) tends to dominate overall cover. Other species recorded are the grasses: *Panicum decompositum, Panicum queenslandicum, Paspalidium distans;* the herbs*, Cheilanthes sieberi, Drosera indica, Pleurocarpaea sp., Cassytha filiformis,* and *Boronia bipinnata.*
11.7.7	Provides potential habitat for a range of species including Waaje wattle (*Acacia barakulensis)*, curly bark wattle (*Acacia curranii)* and Baileys callitris (*Callitris baileyi)*.	***Eucalyptus fibrosa subsp. nubila +/- Corymbia spp. +/- Eucalyptus spp.* on lateritic duricrust.** This woodland and open forest ecosystem occurs on scarps formed from deeply weathered sediments. Soils are shallow with sandy and gravelly surface horizons with abundant outcrop and rock float on surface. Blue leaved ironbark (Eucalyptus fibrosa subsp*. nubila)* forms a distinct canopy which ranges between 11 and 25 m in height. The canopy may also include narrow leaf ironbark (*E. crebra*), Queensland peppermint (*E. exserta*) and white cypress (*Callitris glaucophylla*). These species also characterise a distinct yet discontinuous second tree layer. Some areas are dominated by *Eucalyptus elegans* which have been included within the RE due to the consistent presence of blue leaved ironbark (*Eucalyptus fibrosa)* in the canopy.  Scattered tall shrubs such as *Acacia semilunata, Acacia conferta, Allocasuarina inophloia,* and *Callitris glaucophylla* form a sparse to very sparse upper shrub layer. The lower shrub layer is similarly sparse and poorly formed and also comprises *Leucopogon* sp., *Acacia ixiophylla, Acacia muelleriana, Hakea purpurea* and *Westringea cheelii*.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
		The native species dominated ground layer is mid dense with grasses such as *Eulalea aurea, Paspalidium* sp., *Chloris truncata* and *Gahnia aspera* forming the majority of the cover. Characteristic native herbs and low herbaceous shrubs are *Dodonaea macrossanii, Dianella longifolia var. longifolia, Cheilanthes sieberi, Boronia bipinnata*, and *Brunoniella acaulis*. Leaf litter occupies 44% of total groundcover and fallen woody debris in the form of large branches and logs are abundant throughout the forest floor.

* Exotic or Naturalised species.

[1.] As per EEM guideline defined in DERM 2011c.

Table 16. Potential habitat for threatened species within survey area 2.

Species	NC Act	EPBC Act	BoT	Habitat	Core Habitat Possible (Ha)	General Habitat (Ha)
Acacia curranii (curly bark wattle).	V	V	-	General habitat contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7	0	1249.3
Acacia handonis (Hando's wattle).	V	V	-	General habitat contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7	0	1288.0
Acacia wardellii (Wardell's wattle)	V	V	-	General habitat contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7	0	2076.3
Eucalyptus curtisii (plunket mallee)	NT	Not Listed	-	General habitat contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7	0	1371.7
Crytandra ciliata	NT	Not Listed	-	General habitat contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.5, 11.7.6	0	1289.6
Apatophyllum teretifolium (sandstone prickle bush).	NT	Not Listed	-	General habitat contained within REs 11.7.4, 11.7.5, 11.7.6	0	117.4
Calotis glabrescens	NT	Not Listed	-	General habitat contained within REs 11.5.1, 11.7.4,	0	1022.6
Bothriochloa biloba (lobed blue grass)	Not Listed	V	-	Core habitat possible contained in RE11.3.4	56.1	0
Callitris baileyi (Bailey's callitris)	NT	Not Listed	H	Core habitat possible contained within REs 11.5.1, 11.5.21, 11.7.4, 11.7.6 and 11.7.7 and general habitat contained within RE11.7.5.	1502.7	9.8
Peterostylis cobarensis (Cobar greenhood orchid)	Not Listed	V	-	Core habitat possible contained within RE11.5.1. Survey completed outside optimal period for detection.	942.9	0
Micromyrtus carinata	NT	Not Listed	-	General habitat contained within RE11.7.4 and 11.7.5.	0	85.8

V = Vulnerable
NT = Near Threatened
BoT; H= High

Fauna Habitats

Survey area 2 Methodology: Survey area 2 was surveyed using 10 traps sites consisting of a trap line containing bucket and funnel traps. Each trap site was subjected to active searching, spotlighting, bird surveys and general habitat assessment. Across the site further spotlighting surveys (both driving and on foot) were taken to encompass as broad an area as possible. Six nights of harp trapping was undertaken with traps being positioned in new locations each night.

Anabat were also set to record over six nights in different locations to harp traps to maximize the diversity of bats detected. Active searching and assessments of habitat quality were undertaken across the site during walk overs and traverses throughout the project area. Incidental observations were recorded throughout the entire time ecologists were on site.

Based on vegetation and structural features, six subjective fauna habitats (or broad vegetation groups (Eyre et al. 2012) have been identified on survey area 2 (**Table 17**). Three of these habitats include remnant vegetation, while three are modified. With the exception of non-remnant habitats, vegetated areas within survey area 2 are in good condition and provide a variety of niches for vertebrates. Exotic pasture grasses, which can significantly reduce habitat values, are largely absent from remnant habitats. Further, vegetation in survey area 2 is contiguous with remnant vegetation on surrounding land (including Barakula State Forest), forming one of the largest areas of remnant habitat in the bioregion (EPA, 2008). Large intact patches of vegetation in high condition, such as the area which includes survey area 2, are more likely to harbour rare or uncommon taxa. Based on habitat condition, habitat diversity and the extent of vegetation, it is expected that vertebrate diversity will be high.

Areas of advanced regrowth are common in survey area 2, particularly in the west. These habitats, which are approximating remnant vegetation in height and structure, hold similar value for fauna species as adjacent and connected remnant habitats and these habitats have largely been included as remnant vegetation in vegetation mapping identified in **Figure 9**. Many of the vertebrate species recorded from remnant habitats were also noted in advanced non-remnant vegetation, including many EVNT taxa. In terms of fauna value, these advanced areas of regrowth have the same conservation value as remnant habitats and should be treated similarly.

Other areas of less advanced regrowth are present in the southeast and southwest of survey area 2. While some EVNT taxa have been recorded in these habitats, they are structurally less complex and provide fewer sheltering opportunities. In their current state, these areas are of less conservation value to fauna than remnant or advanced regrowth. Should early regrowth be retained and managed appropriately, it is expected that these areas will continue toward remnant status and eventually provide habitat for a suite of EVNT taxa. These areas may provide an ideal opportunity as habitat offset.

Table 17. Fauna habitats (Broad Vegetation Groups) on survey area 2

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
OPEN GRASSY WOODLANDS		
11.3.25 11.3.4	Dunmall's snake (*Furina dunmalli*) (marginal), brigalow scaly-foot (*Paradelma orientalis*), squatter pigeon (*Geophaps scripta scripta)*, black-chinned honeyeater (*Melithreptus gularis*)	 A tall (to ~25 m) non-continuous (~50% cover) canopy dominated by Queensland blue gum (*Eucalyptus tereticornis*) and rough-barked apple *(Angophora floribunda*). Larger canopy trees and old stages have abundant hollows, including very large hollows, which are likely to provide shelter and nesting opportunities for a variety of fauna taxa. Mid-storey shrubs, typically regrowth or sprouting canopy elements supplemented by *Acacia crassa* and tantoon *Leptospermum polygalifolium*, are scattered or sometimes clumped in low lying areas where water can pool or soil moisture is retained. The ground stratum consists of dense clumping grasses and sedges including spiny-head mat-rush *(Lomandra longifolia*)*,* blady grass *(Imperata cylindrica*)*,* giant spear grass *(Heteropogon triticeus*)*,* spreading windmill grass *(Chloris divaricata*) and barbed wire gass *(Cymbopogon refractus*). These habitats, while less favourable for many ground dwelling vertebrates (particularly reptiles), are favoured by medium to large mammal species (e.g., bettongs, bandicoots, macropods etc). Fallen debris, while present, is scattered, and usually clumped in association with large fallen limbs or beneath old decaying stags. Exfoliating bark is not abundant, although some senescing trees may have large sheaths of peeling bark.
WOODLANDS		
11.5.1, 11.5.21, 11.7.7, 11.7.4, 11.7.6,	**Brigalow scaly-foot (*Paradelma orientalis*) (confirmed), golden-tailed gecko (*Strophurus taenicauda*) (confirmed),** Dumnall's snake (*Furina dunmalli*),	Woodland areas dominate survey area 2, and represent the most structurally complex habitat present. Slight variation in habitat structure warrants the recognition of three habitat associations under the broader woodland designation. Each of these, while subtly different, is likely to harbour similar vertebrate communities and is therefore treated as one habitat type for the purpose of this assessment. *Association A: woodlands* The tall (~22 m) canopy varied in density from relatively open to near continuous, but on average had a cover of approximately 40%. Common canopy species include narrow-leaved ironbark *(Eucalyptus crebra*) with scattered Smooth barked apple *(Angophora leiocarpa*), although in some locations other species such as poplar box *(Eucalyptus populnea*) dominate. Hollow bearing trees were common, although individual trees with abundant hollows were rare. Large hollows were generally uncommon, while medium and

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
	south-eastern long-eared bat (*Nyctophilus corbeni*) (confirmed), glossy black-cockatoo (*Calyptorhynchus lathami*) (confirmed; association B only), black-chinned honeyeater (*Melithreptus gularis*) (confirmed), little pied bat (*Chalinolobus picatus*) (confirmed)	smaller hollows were more commonly noted. Sub-canopy trees and tall shrubs are common although often clumped, and typically include species such as white cypress pine *(Callitris glaucophylla*) and bull-oak *(Allocasuarina luehmannii*). Smaller shrubs such as acacia spp., paperbark *(Melaleuca decora*) (scattered), quinine berry *(Petalostigma pubescens*) and red ash (*Alphitonia excelsa*) are also present. Combined these shrub and sub-canopy elements provide patches of vertical structure interspaced with more open areas. The predominantly native ground strata included low scrabbling shrubs such as leucopogon, interspersed with native grasses to a density of near 50%. In areas where canopy elements were sparse, grasses and native herbs were more abundant. Fallen debris varied. In some locations fallen debris was uncommon, often in areas where the canopy was more open and scattered. However, in areas where the canopy is dense, fallen debris can be extremely abundant. Historic selective logging or thinning in remnant woodland to the east of Bottle Tree Creek has contributed to an abundance of ground debris. The dominant substrate in these habitats was hard grey clay, although deep soil cracks were uncommon. *Association B: rocky woodland* Association B is largely restricted to two smaller creeklines running west off Bottle Tree Creek. The longest stretch can be located from just east of the site boundary to near the middle of Lot 16AU38, on the creek which passes by the existing house. The second, smaller stretch runs along the creekline which cuts through the northwestern boundary of Lot 17AU199. The creeks in these areas have exposed the rocky substrate, forming a deep (~ 3 m), narrow (~8 m) gorge with abundant fissures and overhangs. These are likely to provide habitat for a number of vertebrate species which might otherwise be scarce. Large specimens of woolly oak (*Allocasuarina inophloia*) are scattered along the gorge, the only location where this species was noted. Finally, larger canopy tree species, particularly *Angophora leiocarpa*, are present along the gorge and contained higher densities of large hollows. *Association C: sandy hummock grass woodland* Areas of deep yellow sands are associated abundant hummock grass (*Triodia scariosa*), Yellow Bloodwood (*Corymbia bloxsomei*; a canopy tree) and low shrubs (particularly Cheel's westringia (*Westringea cheelii*), *leucopogon* sp and *Micromyrtus sessilis*). The sandy substrates provide an easy medium for burrowing species (e.g., burrowing frogs), while an increase in shrub density provides additional foraging and sheltering opportunities for small insectivorous birds (e.g., fairy-wrens). Spinifex, or hummock grass, provides an excellent refuge for terrestrial animals often promotes an increase in prey availability such as termites (Abensperg-Traun and Milewski 1995). As such, areas dominated by spinifex have abundant and diverse ground vertebrate communities, although few spinifex specialists are known to occur within the region.
HEATH		

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
11.7.5	None	Heath habitats, which are restricted to a small area in the central west, are typified by the lack of canopy trees and presence of a very dense woody shrub layer. Common shrub species include broombush (*Melaleuca uncinata*), *Micromyrtus sessilis* and *Hakea purpurea*. Hollows and ground debris such as timber or rocks are largely absent, although the thick vegetation provides good cover for ground dwelling species. 
REGROWTH SHRUBLAND		
Regrowth 11.5.1, 11.7.4	**Golden-tailed gecko (*Strophurus taenicauda*), (confirmed),** brigalow scaly-foot (*Paradelma orientalis*), dunmall's snake (*Furina dunmalli*), **black-chinned honeyeater (confirmed)**	Historically cleared, these habitats have only scattered large emergent trees (narrow-leaf ironbark (*Eucalyptus crebra*)) over a dense, approximately 2 m tall, shrub layer. Few hollows are present. Shrub species include sticky leaved wattle *(Acacia ixiophylla),* crowded-leaf wattle *(Acacia conferta*) and banana leaf wattle (*Acacia crassa*). The ground strata varies, but on balance consists of sparse native grasses surrounded by open ground and shallow leaf litter. Ground debris, such as logs and rocks are scattered. Some areas mapped in the vegetation assessment as 'cleared/pastoral' have a native ground cover and regrowth shrub elements (particularly white cypress pine *Callitris glaucophylla*). These areas are structurally similar to habitats that are known to support rich bird and reptilian communities, and in the context of fauna values distinctly different to areas of high grazing activity (see 'pastoral land' below). 
ARTIFICIAL WATERBODIES		
N/A		A large artificial dam, which has been stocked with Perch. Some floating lilies grow in the shallow waters around the edge, but are limited in extent. The dam is largely surrounded by exotic pasture. The dam provides habitat for a diversity of aquatic birds such as

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		ducks, darters, dotterels, terns and grebes.
PASTURE LAND		
N/A; non-remnant		Pasture land habitat, in the context of the fauna assessment, is restricted to habitats in the south around the farm dams. Grazing cattle was regularly recorded from this area. While habitat may have scattered trees (predominantly narrow-leaf ironbark *Eucalyptus crebra*), the area was dominated by exotic pasture grasses. Fallen debris and timber is limited and hollows are largely absent. The area does have the highest abundance of mistletoe (*Amyema pendula*) observed on the property. Some vertebrate species may take advantage of the simplified habitat structure (e.g., nankeen kestrel (*Falco cenchroides*), Australian pipit (*Anthus australis*), masked lapwing (*Vanellus miles*), but these habitats are of low conservation value. The soils associated with these habitats are loamy sands with abundant rock float and lack the structure provided by heavy cracking clay soils (vertosols) that are typical of the Condamine flood plain and other areas previously occupied by brigalow. The above pastoral grazing areas are in contrast to other regions of 'pasture' mapped during the vegetation assessment (e.g., along the very western boundary of the property). These modified habitats have native grasses more abundant shrubs, and are with areas that can support a rich avian and reptilian community.

Riparian Values

The predominant habitat along Bottle Tree Creek is open grassy woodlands, although denser woodland habitats extended to near the creek bank in some areas forming a broad ecotone between the two habitat types. While the abundance of hollows per tree in areas of open grassy woodlands is not high, this habitat was more likely to contain large hollows suitable for arboreal fauna such as common brush-tail possum (*Trichosurus vulpecular*), sugar glider (*Petaurus breviceps*) and southern boobook (*Ninox novaeseelandiae*). The predominance of red forst gum (*Eucalyptus tereticornis*) in these habitats also provides abundant foraging opportunities for koala (*Phascolarctos cinereus*), although the species was not detected despite targeted trunk inspection and scat searches.

The bird community inhabiting riparian vegetation along Bottle Tree Creek is likely to be less diverse than in the more structurally complex woodland vegetation. However, the creekline contains red forst gum (*Eucalyptus tereticornis*), a tree species which can flower prolifically and provide abundant resources during periods with other nectivorous resources can be scarce (late winter). Prolific flowering events would attract a diverse set of nectivorous birds including honeyeaters and lorikeets that otherwise might be uncommon or absent from the property. Bird communities during flowering would swell significantly, and within the broader vegetation matrix these riparian habitats contribute to overall bird values and provide an important seasonal resource.

A thick dense grass cover reduces basking opportunities for reptiles, and reptile communities within riparian vegetation are expected to be less diverse and abundant than surrounding woodland habitats. However, some species are much more common and require riparian habitats including the eastern water skink (*Eulamprus quoyii*) and eastern water dragon (*Intellagama lesueurii*). These species are likely to be restricted to the immediate vicinity of the creek. Eastern water dragons are considered to be an indicator of riparian condition and have declined in the eastern portion of the bioregion (EPA 2008b).

Dense grasses advantage some ground dwelling mammals, particularly medium sized mammals such as eastern brown bandicoot (*Isoodon macrourus*) and rufous bettong (*Aepyprymnus rufescens*) which are indicators of grassy woodland condition. Habitat along Bottle Tree Creek appeared excellent for these species. While neither were observed during these surveys, both can be difficult to detect in their thick grassy habitats. Both species are uncommon in the region.

While attracted to water for breeding, most amphibian species in the region are more abundant in water disconnected from creeklines due to their burrowing nature. Nevertheless, some very abundant species such as broad-palmed rocket-frog (*Litoria latopalmata*), green-striped frog (*Cyclorana alboguttata*), New Holland frog (*Cyclorana novaehollandiae*) and ruddy tree frog (*Litoria rubella*) are likely to occur along Bottle Tree Creek. Unfortunately, cane toads (*Rhinella marina*) were abundant around the artificial dams on survey area 2 and along Bottle Tree Creek. This pest

species is otherwise uncommon in the region but may increase in response to disturbance on-site (M. Sanders *pers obs*).

Some REs associated with riparian habitats (RE 11.3.4) are considered to be 'of concern', and as such, have declined within the bioregion. Further, many remaining riparian habitats are highly modified by weeds, grazing or other anthropic disturbance. Good examples of open grassy woodlands contiguous with surrounding vegetation, such as those observed on survey area 2 are uncommon.

Habitat along Bottle Tree Creek is consistent with known habitat for several EVNT species. Those considered most likely to occur based on distribution and local abundance include square-tailed kite (*Lophoictinia isura*), little pied bat (*Chalinolobus picatus*), and black-chinned honeyeater (*Melithreptus gularis*); the latter two recorded from immediately adjacent woodland habitats. While habitats are suitable for a number of other taxa (e.g., regent honeyeater (*Anthochaera phrygia*), grey goshawk (*Accipiter novaehollandiae*), yakka skink (*Egernia rugosa*), these species are uncommon, sporadic or vagrants in the region and not considered likely. Some species, such as common death adder (*Acanthophis antarcticus*), Dunmall's snake (*Furina dunmalli*) and squatter pigeon (*Geophaps scripta scripta*) are less common in the local area; their occurrence along Bottle Tree Creek cannot be discounted.

Fauna Communities and Taxa of interest

Surveys identified a total of 180 species of vertebrate on survey area 2, including 16 frogs, 29 reptiles, 118 birds and 17 mammals. A number of species noted during the surveys are not regularly recorded in the local area including diamond dove (*Geopelia cuneata*), bush stone-curlew (*Burhinus grallarius*) and black-eared cuckoo (*Chalcites osculans*). Common and widely distributed species included ornate burrowing frog (*Platyplectrum ornatum*), green-striped frog (*Cyclorana alboguttata*), ruddy treefrog (*Litoria rubella*), dubious dtella (*Gehyra dubia*), wood gecko (*Diplodactylus vittatus*), tommy roundhead (*Diporiphora australis*), eastern mulch-slider (*Lerista fragilis*), scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*), variegated fairy-wren (*Malurus lamberti*), inland thornbill (*Acanthiza apicalis*), yellow thornbill (*Acanthiza nana*), speckled warbler (*Pyrrholaemus sagittatus*), weebill (Smicrornis brevirostris), striated pardalote (*Pardalotus striatus*), white-eared honeyeater (*Lichenostomus leucotis*), brown-headed honeyeater (*Melithreptus brevirostris*), grey shrike-thrush (*Colluricincla harmonica*), rufous whistler (*Pachycephala rufiventris*), and grey fantail (*Rhipidura albiscarpa*).

Three exotic species, cane toad (*Rhinella marina*), dog/dingo (*Canis lupus*), and European brown hare (*Lepus europeaus*) have been located on survey area 2. However it is expected that feral cat (*Felis catus*), and possibly feral pig (*Sus scrofa*), could also occur.

In addition to the EVNT species discussed in the section below, four bioregional significant species (as defined under the Brigalow Belt Biodiversity Planning Assessment; EPA 2008a) were recorded from survey area 2 namely salmon-striped frog (*Limnodynastes salmini*), eastern water dragon

(*Intellagama lesueurii*), bush stone-curlew (*Burhinus grallarius*), and speckled warbler (*Pyrrholaemus sagittatus*).

'Back on Track' species identified on the site are glossy-black-cockatoo (*Calyptorhynchus lathami*), golden-tailed gecko(*Strophurus taenicauda*) and brigalow scaly-foot (*Paradelma orientalis),* south-eastern long-eared bat *(Nyctophilus corbeni*) and little pied bat (*Chalinolobus picatus)* (DERM 2010a).

No culturally significant species were recorded from survey area 2 (NC Act 1992). The short-beaked echidna (*Tachyglossus aculeatus*), which can occur in a vast spectrum of habitats, is widespread and well known from the local area. It is expected to occur on survey area 2, although its abundance may be low. Vegetation along Bottle Tree Creek, which has abundant *Eucalyptus tereticornis*, is suitable for koala (*Phascolarctos cinereus*). However recent records of this species from the local area are scarce, most date back to the late 1980's. The closest record of koala (*Phascolarctos cinereus*) (1987) is located approximately 6 km south of survey area 2 on Dogwood Creek. Platypus (*Ornithorhynchus anatinus*) is considered unlikely to occur.

Threatened Fauna Species

February 2013 surveys at survey area 2 located six threatened species protected under state or federal legislation. Based on local records and habitat suitability, another two species have some potential to occur, as detailed in **Table 18**. Brief notes on the occurrence, or likely occurrence, of these species are discussed below. The location of survey records is shown in **Figure 13**.

Table 18. Detected and potential Threatened fauna species on survey area 2, February 2013.

Scientific Name	**Common Name**	**Status**			**Occurrence ****	**Core Habitat Known (Ha)**	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
		NC Act	**EPBC Act**	**BoT**				
Strophurus taenicauda	Golden-tailed gecko	NT	N/A	M	Known	1356.7	768.1	50.6
Paradelma orientalis	Brigalow scaly-foot	V	V	M	Known	444.4	806.4	914.5
Furina dunmalli	Dunmall's snake	V	V	M	Possible	0	1238.2	0
Acanthophis antarcticus	Death adder	NT	-	M	Possible**	0	1376.9	0
Lophoictinia isura	Square-tailed kite	NT	-	-	Possible	0	87.3	1289.6
Calyptorhynchus lathami	Glossy black-cockatoo	V	N/A	H	Known	109.6	0	1022.6
Melithreptus gularis	Black-chinned honeyeater	NT	N/A	-	Known	722.1	645.1	0
Geophaps scripta scripta	Squatter pigeon	V	V	M	Possible	0	1030.2	324.4
*Nyctophilus corbeni**	South-eastern long-eared bat	LC	V	M	Known	701.6	662.8	0

Scientific Name	Common Name	Status			Occurrence **	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
		NC Act	EPBC Act	BoT				
Chalinolobus picatus	Little pied bat	NT	N/A	M	Known	887.8	524.3	0

* Species previously listed as *Nyctophilus timoriensis sensu lato* under legislation.
V = vulnerable, NT = near threatened, LC = least concern.
BoT (Back on Track): H= High, M= Medium
**Known = A species record exists in the survey area. Likely = A species record exists within close proximity to the survey area and suitable habitat is present. Possible = A record is not present within close proximity to the survey area however suitable habitat is present.

Habitat for a number of other species, particularly rough collared frog (*Cyclorana verrucosa*) and grey snake (*Hemiaspis damelii*), is marginal due to sub-optimal soil structure and current information suggests there are no local records. These species have been excluded from the assessment at this property as they are considered unlikely to occur.

***Golden-tailed gecko* (*Strophurus taenicauda*):** Twenty-nine individual golden-tailed geckos (*Strophurus taenicauda*), were observed during the February survey on survey area 2. All individuals were located while spotlighting on small (<4 m) shrubs and bushes, predominantly *Acacia*. The species is likely to be common and abundant throughout areas of woodland (including advanced regrowth) (RE 11.5.1, 11.7.4, 11.7.7), and regrowth shrubland, but less common in open grassy woodlands (RE 11.3.4) and absent from cleared land. At least nine other records of the species are known to occur within 15 km of survey area 2, all connected by near contiguous vegetation. The species is likely to be widely distributed and relatively common in the local area.

***Brigalow scaly-foot* (*Paradelma orientalis*):** Two individuals were captured by pitfall at TR03 in woodland vegetation to the northeast of survey area 2. A complex ground strata consisting of abundant fallen debris and/or cracking clays in the absence of dense grass is a common habitat characteristic in many locations inhabited by the brigalow scaly-foot (*Paradelma orientalis*). Fallen timber, left over from historical logging, is particularly abundant in the northeast block (31AU60) of survey area 2, and as such, this area represents optimal on-site habitat. Fallen timber and sheltering opportunities are also present, although less concentrated, throughout woodland (including advanced regrowth) west of Bottle Tree Creek. The species can occur in young regrowth adjacent remnant habitats (M. Sanders *pers obs*) and it is therefore anticipated that this species will be widespread throughout survey area 2; probably occurring in all areas except for cleared grazing land in the south

Important populations for the brigalow scaly-foot (*Paradelma orientalis*) are considered to be any populations located in large contiguous areas of remnant vegetation (SEWPaC 2013). The closest historic records are located approximately 35km to the westnorthwest and 60 km to the east-northeast. Survey area 2 is located between these records, and all three locations are connected by near contiguous vegetation (which includes Barakula State Forest). As such, the population present on survey area 2 should be considered an important population.

***Glossy black-cockatoo* (*Calyptorhynchus lathami*):** The glossy black-cockatoo (*Calyptorhynchus lathami*) inhabits a variety of habitat types, and can be tolerate some fragmentation provided sufficient foraging resources (nearly always species of *Allocasuarina*) and large hollow-bearing trees for nesting are present within the landscape. Within the southern brigalow belt, the species feeds predominantly on two species of casuarina being belah *(Casuarina cristata*) and woolly oak (*Allocasuarina inophloia*) - although other species can be taken occasionally. Only woolly oak (*Allocasuarina inophloia*) was located within survey area 2, and it was restricted in its occurrence to a western anabranch off Bottle Tree Creek. This creekline, which passes by the existing house, forms a deeply incised gorge with exposed sandstone west of the artificial dam. Here, along with scattered woolly oak (*Allocasuarina inophloia*), were large smooth barked apple (*Angophora leiocarpa*) containing hollows, although large hollows suitable for nesting were scarce.

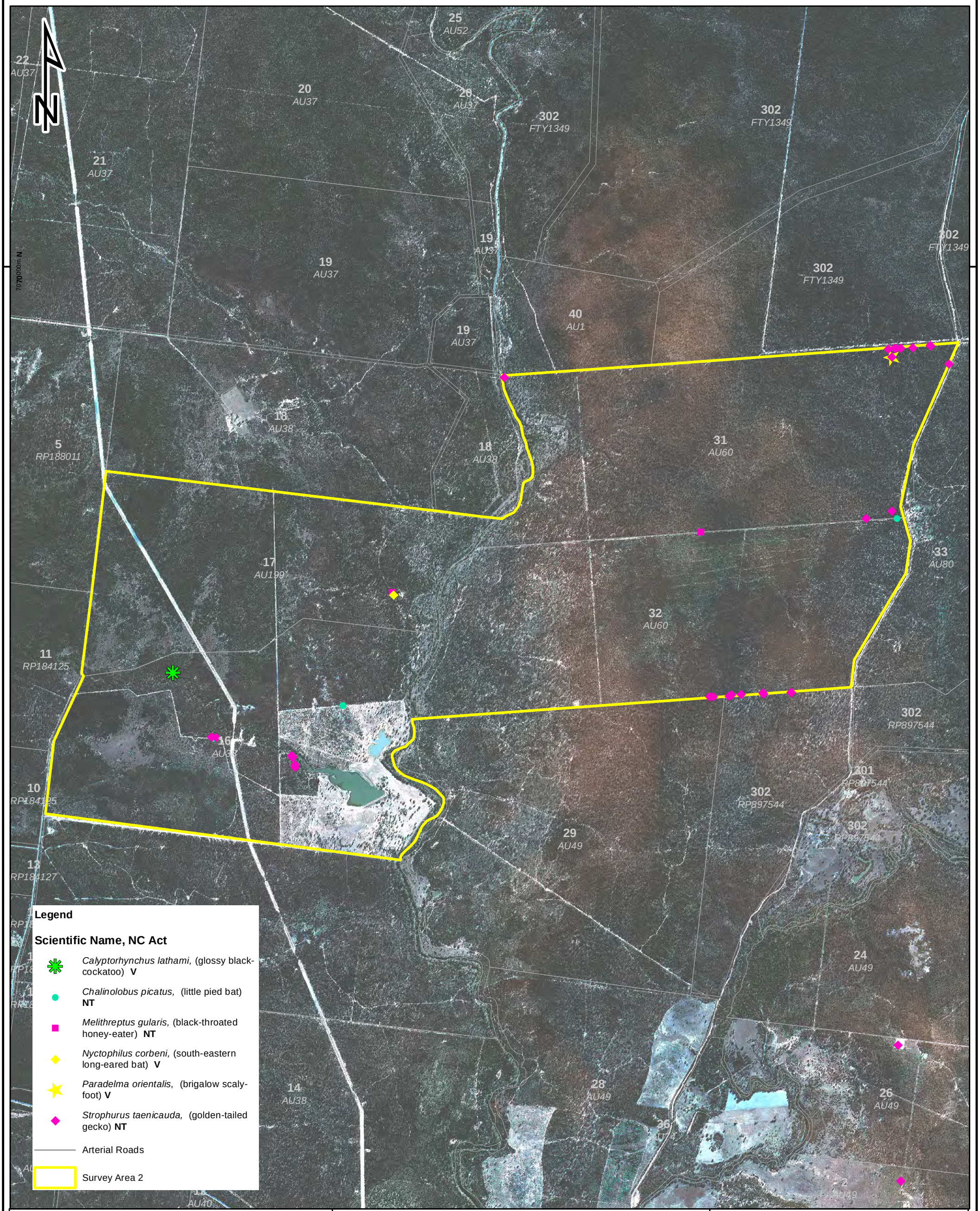
Evidence of feeding activity was located below two individual woolly oak (*Allocasuarina inophloia*) along the gorge by evidence of orts (chewed remnants of casuarina cones). It seems likely that further work would locate other feed trees throughout this habitat. Determining if these feed trees are used sporadically (e.g., when other resources low), or if they constitute an important regular source for the local population, would require further survey effort.

***Black-chinned honeyeater* (*Melithreptus gularis*):** The black-chinned honeyeater (*Melithreptus gularis*) was recorded twice during February surveys, once on either side of Bottle Tree Creek (**Figure 13**). Both records were noted on the basis of call, and as such, it is not known if these records represent one individual or a small group of individuals. The species is highly mobile, and records probably represent the same individual/group as it moves throughout the landscape.

On both occasions the black-chinned honeyeater (*Melithreptus gularis*) was located in vegetation dominated by narrow-leaf ironbark (*Eucalyptus crebra*), a tree species not usually associated with prolific flowering and abundant nectivorous resources. Habitats of higher value on survey area 2 are associated with the open grassy woodlands (RE 11.3.4) where Queensland blue gum (*Eucalyptus tereticornis*) is dominant.

***South-eastern long-eared bat* (*Nyctophilus corbeni*):** The south-eastern long-eared bat (previously *N. timoriensis* sensu lato, now *N. corbeni*) was captured by harp trap to the west of Bottle Tree Creek in advanced regrowth surrounded by remnant vegetation. It is not possible to identify this species using current ANABAT technology, and must be captured for positive identification.

The single female was captured in (RE 11.5.1) narrow-leaf ironbark (*Eucalyptus crebra*) and smooth barked apple *(Angophora leiocarpa*) woodland on sandy soils with an understory or secondary canopy of bull-oak (*A. luehmanii*) and white cypress pine (*Callitris glaucophylla*). Similar habitats are widespread throughout survey area 2, and the species is expected to occur in most habitats except regrowth shrubland and cleared land. While the use of remnant heath is unclear, it is expected to occur in open grassy woodlands, using Bottle Tree Creek as a foraging and navigation flyway.



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

Scource; Ecosmart Ecology 2013.

Figure 13. Records of EVNT Fauna Species on survey area 2.

Client
Coffey Environments

0 700 1,400 2,100 2,800
Meters

Scale	Drawn By	Checked	File Path	Date	
1:33,297	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Most records of the south-eastern long-eared (*Nyctophilus corbeni*) bat in New South Wales and Queensland coincide with large contiguous patches of vegetation ≥70km^2. Survey area 2 contributes to a much larger, near contiguous patch of remnant vegetation extending west and north into Barakula State Forest, and as such, this area may be an important stronghold for the species. The closest historical record of the species is approximately 10km to the northwest and is connected to survey area 2 by near contiguous remnant vegetation. It is likely that the species is distributed throughout this larger habitat matrix, extending to the north and west to include Barakula State Forest.

A clear definition of an 'important population' for the south-eastern long-eared bat (*Nyctophilus corbeni*) is not provided, however given most known populations occur in large patches of near contiguous vegetation, the local population could represent a significant stronghold for the species.

***Dunmall's snake* (*Furina dunmalli*):** No Dunmall's snakes (Furina dunmalli) were located during the survey. However, the species is known to inhabit vegetation consistent with survey area 2. It is a cryptic and genuinely scarce species, even in areas where it is known to occur. It can therefore be easily overlooked during short one-off surveys. There are only a few records of the species in the surrounding area, the closest located approximately 35 km to the southwest.

If present, the Dunmall's snake (*Furina dunmalli*) could inhabit remnant and advanced regrowth on survey area 2. While slightly less suitable due to less fallen debris, the species might also occur in open grassy woodlands associated with Bottle Tree Creek. It is not expected that the species will occur in cleared land, and its occurrence in regrowth shrubland is unlikely.

Common death adder (Acanthophis antarcticus): No common death adders (*Acanthophis antarcticus*) were located during surveys. However the habitat within the survey area provides suitable vegetation and cover for the species to occur. The species known range encompass survey area 2, although the species is rarely detected on the western side of the Great Dividing Range. This is likely due to it being a cryptic and genuinely scarce species, even in areas where it is known to occur. It can therefore be easily overlooked during short one-off surveys. There are only a few records of the species in the surrounding area, the closest located approximately 60 km to the southeast.

If present, the common death adder (*Acanthophis antarcticus)* could inhabit remnant and advanced regrowth on survey area 2. The species might also occur in open grassy woodlands associated with Bottle Tree Creek. It is not expected that the species will occur in cleared land.

***Squatter pigeon* (*Geophaps scripta scripta*):** The southern subspecies of squatter pigeon (*Geophaps scripta scripta*) is tolerate of habitat disturbance, at least in the northern portions of its range, and can be found in cleared grazing land along roads and tracks. Based on habitat preference alone, it is possible that the species could occur in cleared land associated with current grazing activities.

In the southern portion of its range, the species has declined significantly. There are only a few scattered records in proximity to survey area 2; one located approximately 12 km to the northwest

and a second 8 km to the south, southeast. This suggests that the species, while possible, is unlikely to be resident.

Square-tailed Kite* (*Lophoictinia isura*)*: The square-tailed kite is relatively tolerant of habitat disturbance and is has been recorded to nest and forage around the edges of towns and along roads when adjacent habitat is suitable. Given its habitat preferences for open woodlands it is likely that individuals could occur within survey area 2.

Records of the species occur within 15 km of survey area 2, with multiple other records from within the adjacent Barakula State Forest. Slightly further to the south ~50 km there are many more records of square-tailed kites (*Lophoictinia isura*) indicating the species is not uncommon in the area.

Little pied bat* (*Chalinolobus picatus*)*: The little pied bat (*Chalinolobus picatus*) was recorded at five locations on survey area 2, two were captured in harp traps and three were detected on the ANABAT system. The species can inhabit a variety of woodland and forest types, and as such, is likely to occur throughout areas of remnant and/or advanced regrowth vegetation. Vegetation along Bottle Tree Creek (i.e., open grassy woodlands) in particular, provides excellent foraging opportunities and abundant hollows suitable for roosting. Disturbed habitats such as regrowth shrubland and cleared land, is less valuable to the species.

The closest known record of little pied bat (*Chalinolobus picatus*) to survey area 2 is located less than 10km to the northwest and is connected by near contiguous habitat. Records are also present to the east within Barakula State Forest. The species is likely to occur throughout the local area within this larger matrix of remnant vegetation.

Migratory Fauna Species

Four migratory fauna species have been observed within survey area 2:

- Eastern great egret, *Ardea modesta* (recognised as migratory under the EPBC Act as *Ardea alba*)
- White-bellied sea-eagle, *Haliaeetus leucogaster*.
- White-throated needletail, *Hirundapus caudacutus*.
- Rainbow bee-eater, *Merops ornatus*.

The eastern great egret (*Ardea modesta*) and white-bellied sea-eagle (*Haliaeetus leucogaster*) are species associated with aquatic habitats. Both species were observed around the large artificial farm dam adjacent the existing house. Both species are likely to be restricted to this, and other similar, artificial waterbodies. While the eastern great egret (*Ardea modesta*) may be a regular inhabitant or visitor the survey area 2, the white-bellied Sea-eagle (*Haliaeetus leucogaster*) is likely to be sporadic in its occurrence.

White-throated needletails (*Hirundapus caudacutus*) are an aerial pursuit species that can be observed over almost all land-based habitats, including urbanisation. They are thought to roost

aerially, although there are some records of the species roosting in trees (Higgins 1999). Breeding occurs in the northern hemisphere. It is therefore unlikely that this species will regularly utilise, or rely, on on-ground habitat characteristics at survey area 2.

Rainbow bee-eaters (*Merops ornatus*) are commonly observed within the region and inhabit a variety of habitats ranging from open woodlands to disturbed grazing land, but are generally uncommon or absent from dense vegetation. The species was only recorded occasionally on survey area 2, and observations may have represented individuals or small groups traversing over a broader area. On survey area 2 the species is most likely to occur in disturbed areas, including cleared land and regrowth shrubland. Some areas of regrowth shrubland mapped as 'cleared/pastoral' (see **Figure 11**) along the western boundary are typical of habitats in which this species can be regularly observed.

Based on assessment provided within Appendix E, survey area 2 is considered unlikely to provide important habitat for migratory fauna species.

5.6.2 Survey area 9

General Description

Survey area 9 represents the most southerly property proposed for development, south of Cecil Plains. The property centres on the broad flood plain of the Condamine River which forms the property's eastern boundary. Riparian vegetation of the river forms component of a major north-south trending wildlife corridor with passes through the project development area. Away from the riparian habitats, the vegetation has been highly fragmented, comprising isolated fragments of recent and advanced regrowth vegetation. The survey area occupies 2950 ha, of which 636 ha (21 %) is remnant vegetation, 156 ha of recent regrowth vegetation (5 %), 36 ha (1%) of derived grassland with a balance of 2132 ha (73 %) cleared vegetation.

Associated Ecological Communities and Regional Ecosystems

Reference to **Table 3** indicates a total of 35 floristic survey sites recorded during field survey including 13 sites undertaken for biocondtion using EEM methodology (DERM 2011c), four secondary survey sites and 18 descriptive quaternary sites.

EPBC Listed Ecological Communities: The brigalow ecological community was recorded on this property with a single occurrence, mapped in association with RE11.4.3, adjacent to a roadside in the central portion of the property. The occurrence is described in detail with the RE 11.4.3 description in **Table 19**.

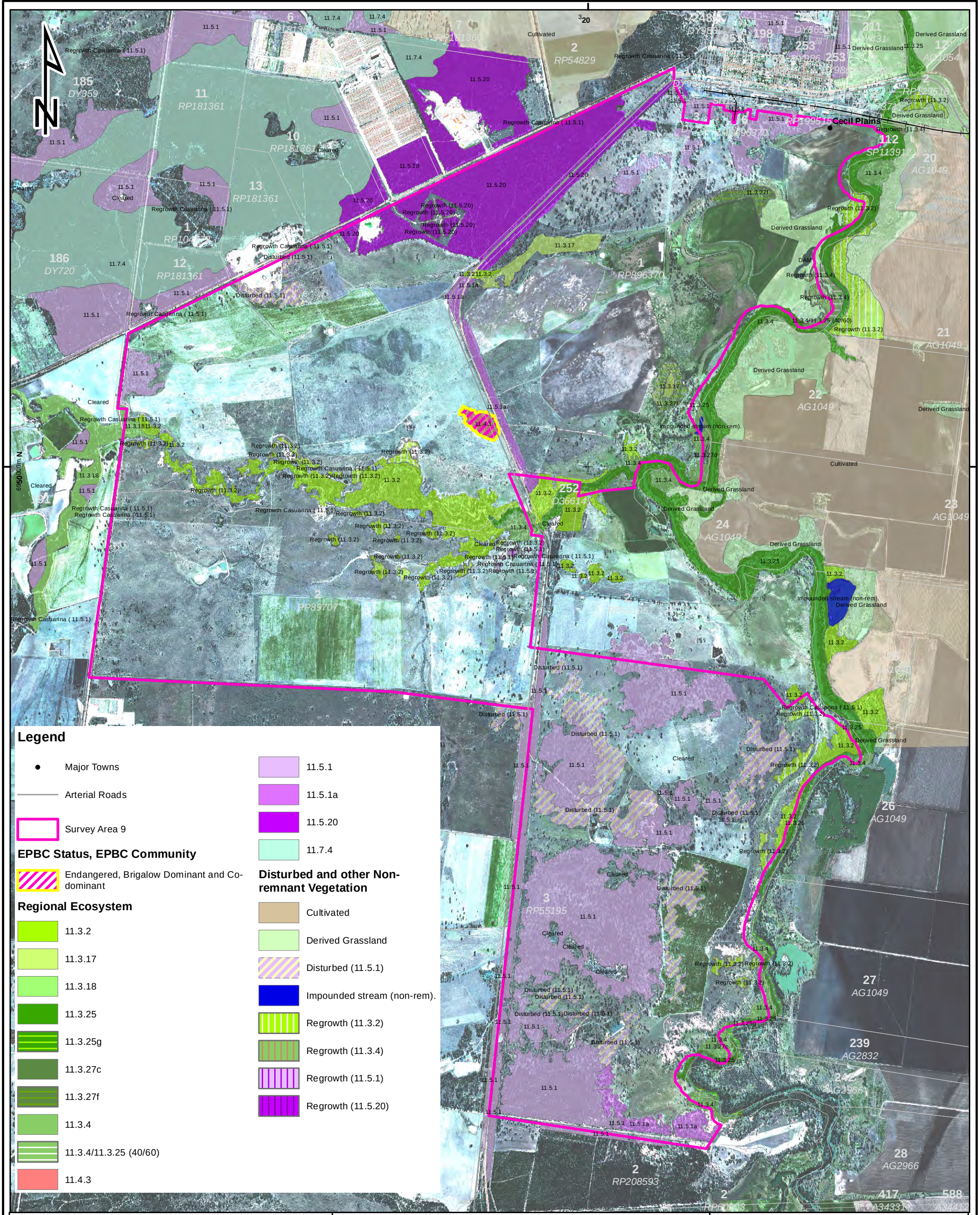
Regional Ecosystems: A total of nine regional ecosystems were identified on survey area 9. The surveyed extent of regional ecosystems with comparisons to certified RE mapping is provided within **Table 19.** Summary site data is provided in **Appendix B** and floristic descriptions for REs identified on the site are provided below. It should be noted that remnant vegetation defined within the 3D mapping database (3D Environmental 2013a) cludes areas that would be considered 'mature regrowth' within datasets provided by EHP (2012b). Mapping of REs is represented wthin

Figure 14 with biodiversity status of vegetation shown in **Figure 15.** Revised mapping has significantly increased resolution of existing mapping databases (EHP 2012a and EHP 2012b), identifying 5.4 ha of RE11.4.3 and 14.6 ha of RE11.3.17, neither of which are represented in EHP databases with the exception of 1.8 ha of RE11.4.3 ha recognised in the mature regrowth Database (EHP 2012b). Revised mapping has also separated heterogeneous riparian vegetation (REs 11.3.4, 11.3.25 and 11.3.27c/f) within EHP datasets into individual RE components with significant variations in the extent of individual REs noted.

Table 19. Regional ecosystems identified during field survey on survey area 9.

Regional Ecosystem	**Bio-Status**	**Extent within Property (Field Suvey)(Ha)**	**Extent Within Property (EHP 2012a)**	**Extent Within Property (EHP 2012b) Mature Regrowth**	**Total (EHP 2012a and 2012b)**
11.3.4	Of Concern	16.7	25.1	26.7	51.8
11.3.25 / 11.3.25g	Of Concern	16.6	27.9	58.7	86.6
11.3.17	Endangered	14.6	0	0	0
11.3.2	Of Concern	89.6	0	116.2	208.5
11.3.18	No concern at present	2.7	0	0	0
11.3.27c/ 11.3.27f	Of Concern	13.0	2.8	3.0	5.8
11.4.3**	Endangered **	5.4	0	1.8	1.8
11.5.1/ 11.5.1a	No concern at present	359.0	331.7	483.1	814.8
11.5.4	No concern at present	0	85.8	130.7	216.5
11.5.20	Endangered	121.2	0	0	0
Derived Grassland	Non-remnant	36.3	0	0	0
Recent regrowth and other disturbed vegetation	Non-remnant	156.3	0	NA	0
Cleared Land	Non-remnant	2131.6	2490.1	NA	2490.1

**Brigalow (*Acacia harpophylla* dominant and co-dominant) Community – EPBC Act



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

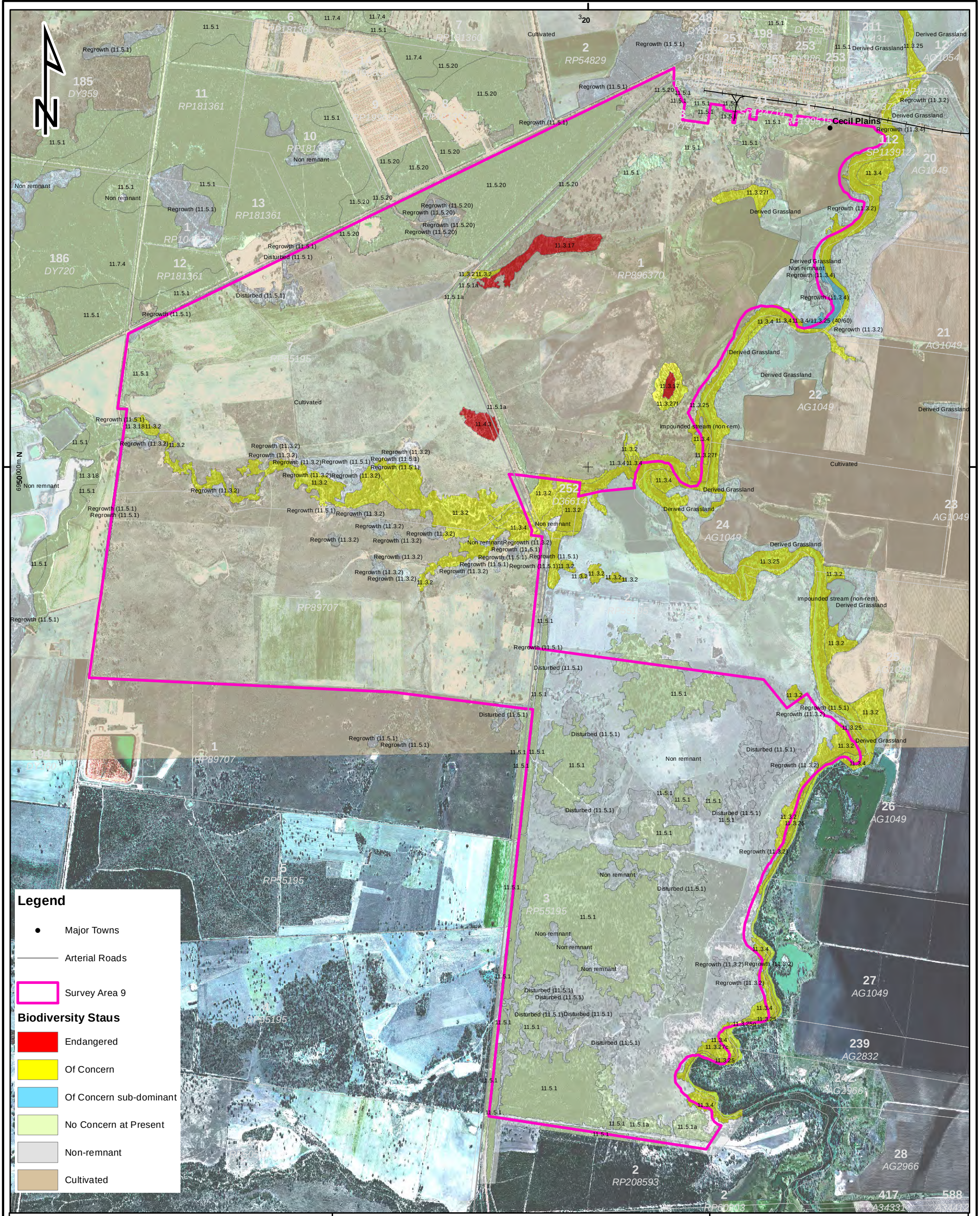
Figure 14. Distribution of regional ecosystems and ecological communities in survey area 9

Client
Coffey Environments

0 700 1,400 2,100 2,800
Meters

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:30,142	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4



NOTES:

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

Figure 15. Biodiversity status of vegetation in survey area 9

Client

Coffey Environments

0 700 1,400 2,100 2,800

Meters

Scale	1:30,142	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	Date	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Floristic Habitat Descriptions

Table 20 provides floristic descriptions for the eight REs recorded on survey area 9 during the course of the survey. Habitat values for threatened flora species are indicated with further expansion provided in following sections. A total of 168 flora species were recorded on survey area 9, which includes 30 exotic species, three of which are declared under the LP Act.

Threatened Flora Species

No flora species listed as threatened under the NC Act or EPBC Act were identified during the survey although the site contains potential habitat for a range of threatened flora species. These species, with potential habitat wihin the property are provided in **Table 21**. Further information on MNES species potentially occurring within survey area 9 is provided within **Appendix A.**

Table 20. Significant floristic habitats contained within Survey area 9.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.2	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba*), finger panic grass (*Digitaria porrecta)* and toadflax (*Thesium australe).*	***Eucalyptus populnea woodland on alluvial plains.***  This community is consistently dominated by poplar box (*Eucalyptus populnea*) with a canopy height ranging between 10-16m and a mean crown cover of 41%. Associated canopy trees are Queensland blue gum (*Eucalyptus tereticornis*) and belah (*Casuarina cristata*). A sparse second tree layer comprises the above canopy species. The shrub layer is generally poorly developed with scattered poplar box saplings and occasional shrubs of velvet pear (*Opuntia tomentosa**). The condition of the groundcover is affected by infestations of African love grass (*Eragrostis curvula**), lippia (*Phyla canescens*), maynes pest (*Verbena aristigera**), and harissa cactus (*Harissia martini**), which contribute to a mean exotic cover of 35%. Dominant graminoids species are *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea,* and *Paspalidium* sp., with common native herbs of *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis*. Overall the alluvial woodland habitats surveyed are in good condition. There is some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers. The presence of African love grass and other exotics suggests impacts of previous grazing pressure. However a lack of recent grazing and favourable summer rainfall conditions have resulted in dense ground cover and robust species richness.
11.3.4	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba) Rutidosis lanata,* Blake's spikerush (*Eleocharis blakeana)* and *Fimbristylis vagans.*	***Eucalyptus tereticornis* and/or *Eucalyptus spp. tall* woodland on alluvial plains.**  This community occurs on alluvial terraces and overflow depressions along with the Condamine River frontage. The canopy is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and/or Queensland blue gum *(E. camaldulenisis)* although rough-barked apple *(Angophora floribunda),* poplar box (*E. populnea*) and Moreton Bay ash (*Corymbia tessellaris*) are locally common. The second tree layer is sparse and comprises the above canopy species and the sparse shrub layer of between 1-4 m features *Acacia salicina,* and *A. stenophylla*. The ground layer is degraded through the widespread floodplain infestations of lippia (*Phyla canescens*).

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.17	Provides potential habitat for Belson's panic (*Homopholis belsonii)* and *Solanum stenopterum.*	***Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains**  This community occurs on alluvial plains. The canopy which is dominated by poplar box (*Eucalyptus populnea*), ranges between 16-26m in height with a mean PPC of 40%. Additional trees in the canopy layer are belah (*Casuarina cristata*), narrow leaf ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus woollsiana*). The second tree layer is well developed and comprises the above canopy species together with western rosewood (*Alectryon oleofolius*), weeping pittosporum (*Pittosporum angustifolium*) and willow wattle (*Acacia salicina*). These species also are characteristic of a mid dense shrub layer which may also include showy wattle (*Acacia decora*), and wilga (*Geijera salicifolia*). Exotic ground covers, in particular lippia (*Phyla canescens**), contribute to approximately 50% of the overall cover, with scattered infestations of harissa cactus (*Harissia martini**), noogoora bur (*Xanthium occidentale**), and Maynes pest (*Verbena aristigera**), African love grass (*Eragrostis curvula**), paspalum (*Pasplalum dilatatum**), and giant panic (*Magathrysus maximus* var. *maximus**). Native grasses and sedges dominate the native ground cover.
11.3.18	Provides potential habitat for Cobar greenhood orchid (*Pterostylis cobarensis)*	***Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium**  RE 11.3.18 forms at the western boundary of Survey area 9 where a small area intrudes into the property boundary from a much larger polygon which is mapped to the west. The habitat is continuous with and transitional to the floristically similar RE11.3.2 which is much more extensive to the east within survey area 9 . The habitat was not sampled during field survey although observation in survey area F indicates *Eucalyptus populnea* dominates the canopy with associated *Callitris glaucophylla*. Further survey work is required to provided detailed floristic description.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.25/ 11.3.25g	No EVNT flora taxa are considered likely to be associated with this RE	***Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland*. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.**  This RE is associated with the riparian margins of the major drainage lines of Condamine River and tributaries. It is a fringing open forest ranging from 16-28 metres and a mean crown cover of 46%. Dominant canopy trees are Queensland blue gum *(Eucalyptus tereticornis),* Queensland blue gum *(Eucalyptus camaldulensis),* rough barked apple (*Angophora floribunda*) and Moreton bay ash (*Corymbia tessellaris*). A sparse sub-canopy is dominated by the above species with occasional willow wattle (*Acacia salicina*) and cooba (*Acacia stenophylla*). Shrub cover is very sparse (0-5% cover) with scattered willow wattle, cooba and prickly mimosa (*Acacia farnesiana**). The sparse ground cover which averages at 23% is attributed to scouring of groundcover species from recent flood events. Mean cover is dominated by exotic species with grasses such as giant panic (*Megathyrsus maximus var. maximus**), purple top Rhodes grass (*Chloris virgata**), and couch grass (*Cynodon dactylon**). Exotic cover is likely to increase in the riparian zone following summer growth. Natives such as mat rush (*Lomandra longifolia*) and blady grass (*Imperata cylindrica*) and sedge (*Cyperus* sp.) characterise the native component of the groundcover.The association 11.3.25g represents open water associated with riverine systems.
RE11.4.3	Provides potential habitat for Belson's panic (*Homopholis belsonii), Xerothamnella herbarceae* and *Solanum stenopterum.*	***Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains.**  This RE is restricted on the site to a small remnant on an elevated clay depression. It manifests as open forest between 15-24 m in height and dominated by brigalow (*Acacia harpophylla*). A sparse second tree layer of brigalow, grey box (*Eucalyptus woollsiana*) and supplejack (*Ventilago viminalis*) occurs over a very sparse shrub layer of caperberry (*Capparis* sp.), turkey bush (*Eremophila desertii*) and brigalow (*Acacia harpophylla)*. The ground cover is 58% vegetative and has been impacted by grazing pressure with significant areas of bare ground. Cover is dominated by native perennial grasses and sedges with slender chloris (*Chloris divaricata*) being the most abundant species. Species diversity is high with 47 species recorded of which seven are naturalised. Exotic cover is limited to scattered button grass (*Dactyloctenium radulans**), gomphrena weed (*Gomphrena celesioides**), amaranthus (*Amaranthus viridus**), and occasional plants of prickly pear (*Opuntia stricta**). Despite an ongoing impact of grazing, the remnant patch surveyed was in moderate condition displaying a healthy canopy and

<table>
<tr><th colspan="3">HABITAT</th></tr>
<tr><th>RE</th><th>Possible EVNT taxa</th><th>Description</th></tr>
<tr><td></td><td></td><td>subcanopy, a species diverse groundcover, and a large amount of fallen woody debris. Ongoing impacts from grazing are however manifest in a poorly developed shrub layer.</td></tr>
<tr><td>11.5.1/ 11.5.1a</td><td>Provides potential habitat for Cobar greenhood orchid (Pterostylis cobarensis) general habitat for lobed blue grass (Bothriochloa biloba).</td><td>Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains/remnant surfaces.

This woodland ecosystem occurs on sandy soils of old loamy plains that overlap with alluvial sediments of the Condamine River Flood Plain. The canopy height ranges between 14-20m with a mean crown cover of 38% dominated by narrow leaf ironbark (Eucalyptus crebra) with associated white cypress (Callitris glaucophylla). Less common associates are poplar box (Eucalyptus populnea), and Queensland blue gum (Eucalyptus tereticornis) and Moreton Bay ash (Corymbia tessellaris). The sparse second tree layer has an average height of 8.5 m and is dominated by bulloak (Allocasuarina Luehmannii), white cypress (Callitris glaucophylla), narrow leaf ironbark, and with less frequent paperbark (Melaleuca decora). An upper and lower shrub layer ranges between 5-30% in cover with bull oak predominating across all sites surveyed.

A diverse ground layer is in good condition with cover totally dominated by natives. Characteristic species are wire grass (Aristida caput-medusae), fimbristylis (Fimbristylis dichotoma), and beard grass (Chrysopogon fallax). Frequent species include Aristida calycina, Commelina lanceolata, Eragrostis sororia, Lomandra leucocephala subsp. leucocephala, and the fern Cheilanthus sieberi.

Selective removal of narrow leaf ironbark for fencing posts and grazing has impacted this ecosystem. A dominance of wire grass (Aristida) species in the groundcover suggestive of previous grazing pressure. A lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of a healthy native dominated groundcover and high species richness.

The variant RE11.5.1a possesses a canopy cover that is dominated by poplar box (Eucalyptus populnea) often with a shrub layer of Allocasuarina littoralis (photograph on right).</td></tr>
</table>

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.5.20	Not known to provide specific habitat for EVNT flora species.	***Eucalyptus moluccana* or *E. microcarpa* or *E. woollsiana* woodland to open-forest.** RE 11.5.20 is represented on the site by a woodland of 16-23 m in height dominated by grey box (*Eucalyptus woollsiana*) with associated narrow leaf ironbark (*E. crebra*). It occurs on low rises of old loamy plains. These tree species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.). A native groundcover is dominated by many-headed wire grass (*Aristida caput-medusae),* wire grass *(Aristida calycina),* love grass (*Eragrostis lacunaria*), barbed wire grass *(Cymbopogon refractus),* paspalidium *(Paspalidium sp.),* and windmill grass (*Chloris truncata*). 
Derived grassland	Potential habitat for finger panic grass (*Digitaria porrecta), Cymbonotus maidenii,* lobed bluegrass (*Bothriochloa biloba).*	Derived grasslands form a significant habitat along the floodplain of the Condamine River. They generally result from clearing of native woodland habitats, typically RE11.3.4 and 11.3.2, often with retention of native ground covers. Typical ground cover species include *Erichloa crebra,* Queensland blue grass (*Dicanthium sericeum)* which tends to dominate in some areas, *Panicum decompositum, Digitaria brownii, Eulalia aurea* and Paspalidium sp. Whist native groundcover is typically robust, lippia (*Phyla canescens*) contributes to a mean exotic cover of 23%, becoming dominant in some locations where heavy grazing is apparent. Ground cover herbs include *Chrysocephalum apiculatum, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis* and *Cyperus sp.* 

* Exotic or Naturalised species.

Table 21. Potential habitats for threatened species within survey area 9.

Species	NC Act	EPBC Act	BoT	Habitat	Core Habitat Possible (Ha)	General Habitat (Ha)
Homopholis belsonii (Belson's panic)	V	B	-	Core habitat potentially contained within REs 11.3.17, 11.4.3 with general habitat contained within 11.5.1 and 11.3.2 and 11.3.25	20.1	469.7
Solanum stenopterum	V	V	H	Core habitat potentially contained within REs 11.3.17, 11.4.3 with general habitat contained within regrowth (11.3.2).	50.9	33.9
Xerothamnella herbacea	E	E	-	Core habitat potentially contained within REs 11.4.3	5.4	0
Thesium australe (toadflax)	V	V	-	Core habitat potentially contained within REs 11.3.2 with general habitat contained in derived grassland.	89.6	70.2
Rutidosis lanata	E	Not Listed	-	Core habitat potentially contained within REs 11.3.2, 11.3.4 and11.3.17.	121.8	0
Digitaria porrecta (finger panic grass)	NT	E	-	Core habitat potentially contained within REs 11.3.2 and general habitat within derived grassland.	89.6	70.2
Bothriochloa biloba (lobed blue grass)	Not listed	V	-	Core habitat potentially contained within REs 11.3.2 with general habitat containe within RE11.5.1 and derived grassland.	137.2	402.4
Cymbonotus maidenii	E	Not Listed	M	General habitat provided by RE11.3.2 and derived grassland.	0	36.3
Peterostylis cobarensis (Cobar greenhood orchid)	Not Listed	V	-	Core habitat potentially contained within RE11.5.1. Survey completed outside optimal period for detection.	421.4	0
Eleocharis blakeana (blake's spikerush)	NT	Not Listed	M	Core habitat potentially contained within RE11.3.27d, 11.3.27c and 11.3.25 and general contained with derived grassland and regrowth 11.3.2.	141.4	73.4
Fimbristylis vagans	NT	Not Listed	-	Core habitat potentially contained within RE11.3.27d, 11.3.27c, 11.3.25 and 11.3.2 and 11.3.4. General habitat contained with in regrowth (RE11.3.2).	138.9	38.9

E = Endangered, V = vulnerable, NT = near threatened

BoT (Back on Track); H = High, M = Medium

Exotic (Pest) Flora Species

Habitats within survey area 9, particularly those associated alluvial and clay soils (RE11.3.2, 11.3.4, 11.3.25) possess degraded groundcover with a number of environmental weeds dominating which include African love grass (*Eragrostis curvula*), lippia (*Phyla canescens*), maynes pest (*Verbena aristigera*), and harissa cactus (*Harissia martini*). Noogoora bur (*Xanthium occidentale*), paspalum (*Paspalum dilatatum**), and giant panic (*Magathrysus maximus* var. *maximus**) tend to pervade groundcovers within RE11.3.25. Harissa cactus (*Harissia martini*), prickly pear (*Opuntia stricta)* and velvet tree pear *(Opuntia tomentosa)* are the only species declared under the Land Protection (Pest and Stock Route Management) Act, 2002 identified as occurring on the property, being listed as Class 2 pests. They are scattered broadly throughout remnant and non-remnant habitats although tend to more prevalent within REs 11.4.3a, 11.3.4, 11.3.25 and RE11.3.17. Populations of these species can be identified during preclearance surveys and mitigations applied to prevent further spread (Section 17.6.3 of Surat Gas Project EIS, 2012).

Fauna habitats

Survey Area 9 Methodology: Survey area 9 had restricted access resulting in assessment being undertaken through three spotlighting surveys in six locations adjacent to Millmerran-Cecil Plains Road. Diurnal assessment involved site traverses within one kilometre of eastern side of Millmerran-Cecil Plains Road. During which time active searching was undertaken and incidental observations of fauna were recorded. Habitat quality was assessed during site walk throughs for the likelihood assessment of EVNT species

Based on vegetation and structural features, eight subjective fauna habitats have been identified on survey area 9 (**Table 22**). Six of these habitats include remnant vegetation, while two are modified or artificial.

A large portion of survey area 9 is non-remnant vegetation. These habitats, which are concentrated in the northern portion of the property, lack habitat complexity and are dominated by exotic pasture grasses. Vertebrate diversity in these habitats is expected to be low.

Most remnant habitat on survey area 9 is located in the south and consists of RE 11.5.1. This RE shows considerable variation in its structure, and contributes to two fauna habitat types. Vegetation in the south is relatively open, and as such, likely to be inhabited by vertebrate communities with some tolerance to the open habitats created after clearing.

Table 22. Significant fauna habitats on survey area 9.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
OPEN GRASSY WOODLANDS		
11.5.1 11.3.2 11.3.4 11.3.18	grey snake (*Hemiaspis damelii*) (Likely), **rough collared frog (*Cyclorana verrucosa*) (confirmed),** glossy black-cockatoo (*Calyptorhynchus lathami*) (possible)	Open grassy woodlands are the most common remnant vegetation on survey area 9, consisting of RE 11.5.1 (part), RE 11.3.2 and RE 11.3.4. A small area of RE11.3.18 is also mapped in the western portion of the property although was not subject to detailed assessment and has been included the broader open grassy woodlands group. Scattered through the grassy open woodlands (in RE 11.5.1) is woolly oak (*Allocasuarina inophloia*), a species which provides foraging resources for the glossy black-cockatoo (*Calyptorhynchus lathami*). *Open grassy woodland – non riparian* Open grassy woodlands are common in the southern portions of survey area 9. The habitats have a sparse canopy which can be clumped, but does not generally overlap. Hollows of varying size are scattered throughout the community and provide nesting and roosting opportunities for a variety of fauna including arboreal mammals, nocturnal birds, parrots etc. Generally there is little to no mid canopy whilst the ground stratum is dominated by thick native grass. Fallen debris is uncommon. Ground dwelling vertebrates in this community are not expected to be highly diverse. Woodlands dominated by polar box (*Eucalyptus populnea*) (RE 11.3.2) are located on alluvial soils which are more likely to flood following heavy rain. Water on these alluvial plains provided suitable habitat and breeding opportunities for a diverse range of amphibians. *Open grassy woodland - riparian* Open grassy woodland habitats are also located along the Condamine River and Surveyors Creek, associated with RE 11.3.4. While similar in structure to above, these habitats are dominated by Queensland blue gum (*Eucalyptus tereticornis*) which provides: • Abundant hollows of varying sizes for arboreal mammals, nesting birds and bats. • Foraging opportunities for koala (*Phascolarctos cinereus*). • Abundant nectar and pollen resources when in bulk flower (typically late winter). Riparian grassy woodlands have clay soils, and can have a broad ecotone with wetland habitats (see below). Grey snake  

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		(*Hemiaspis damelii*) and rough collared frog (*Cyclorana verrucosa*) are likely to move throughout the wetland/riparian grassy woodland matrix.
WOODLANDS		
11.5.1	grey snake (*Hemiaspis damelii*) (likely) **koala (*Phascolarctos cinereus*)(confirmed) rough collared frog (*Cyclorana verrucosa*) (confirmed)**	Trees in woodlands habitats (predominantly narrow-leaf ironbark (*Eucalyptus crebra*)) are denser and their canopy is more likely to overlap than open grassy woodlands. While hollows are still present, visual inspection suggest they are less abundant. Woodlands also have a thicker understorey, with scattered or clumped shrubs (e.g., false sandlewood (*Eremophila mitchellii*)) and recruiting canopy species. Greater complexity in the shrub and canopy layers is likely to favour smaller bird species such as speckled warblers and fairy-wrens and increase bat diversity. Unlike open grassy woodlands, the ground strata within woodlands consists of a matrix of low native grass and open bare ground. Fallen timber and debris is relatively common, increasing ground complexity and providing sheltering opportunities. These habitats are likely to support a greater range of small terrestrial vertebrates.  A unique patch of dense paperbark (*Melaleuca decora*) with Queensland blue gum (*Eucalyptus tereticornis*) emergents is present in the south west corner of survey area 9. When flowering, typically late winter, large Queensland blue gum (*Eucalyptus tereticornis*) trees are likely to attract many nectivorous birds including lorikeets and honeyeaters. This tree species is also a known feed tree for koala (*Phascolarctos cinereus*), which was observed in this habitat.
BULLOAK/IRONBARK WOODLAND		
11.5.1/ 11.5.20	Bulloak jewel (*Hypochrysops piceatus*) (possible) **rough collared frog (*Cyclorana verrucosa*) (confirmed)**	A small area of bull-oak (*Allocasuarina luehmannii*) with emergent narrow-leaf ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus woollsiana*) is located in the north of survey area 9 between the Cecil Plains-Tara Rd and Millmerran-Cecil Plains Rd. The bull-oak (*Allocasuarina luehmannii*) in this area is of considerable size and can often densely packed, forming a continuous canopy of approximately 16 m. Moderate to small hollows are present, although large hollows are scarce. Most hollows occur in emergent eucalypts, although hollows are also present in larger old-growth bulloaks. Exfoliating bark is common, largely restricted to large dead or senescing bulloak (*Allocasuarina luehmannii*) trees. The shrub layer is relatively open, predominantly clumps of recruiting bulloak (*Allocasuarina luehmannii*) or narrow-leaf ironbark (*Eucalyptus crebra*). The native grass (e.g., *Aristida* spp) groundcover is sparse; most of the area has open bare patches of ground covered by a layer of smaller fallen debris (i.e., twigs and fallen leaves). Large fallen debris such as logs are also abundant.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		Arboreal hollow-obligate mammals are not expected to be abundant in this habitat, although some smaller hollows may provide shelter for a variety of insectivorous bats. Arboreal reptiles have opportunity to shelter under exfoliating bark, and the abundant ground debris provides sheltering opportunities for ground dwelling fauna. Notably, this area is consistent with bulloak jewel (*Hypochrysops piceatus*) habitat and their larval attendant ant was located during surveys (although no bulloak jewel (*Hypochrysops piceatus*) were observed). Frogs, particularly burrowing species, are likely to use areas of pooling water following rainfall. 
BRIGALOW/ BELAH		
11.4.3 11.3.17	**rough collared frog (*Cyclorana verrucosa*) (confirmed)**	A small restricted patch of brigalow (11.4.3) is located just north of Surveyors Creek, to the west of the Millmeran-Cecil Plains Road. This habitat has a dense overlapping canopy of brigalow (*Acacia harpophylla*) with little or no mid-storey and an open ground stratum dominated by native grasses. Fallen timber is abundant and soil cracks are present, both providing shelter opportunities for terrestrial mammals. Hollows are not common. Exfoliating bark, which can be used by arboreal reptiles and selected bat species, was abundant. This isolated habitat, with its apparent lake of visible hollows suggests the area is not highly valuable for arboreal mammals. However field survey located a diverse (three species) and abundant (12 individuals) range or arboreal mammals. Some more extensive areas of belah dominant woodland (RE11.3.17) are present on the property but were not sampled during the fauna survey. These are included in the brigalow habitat type. 
11.3.27	rough collared frog (*Cyclorana verrucosa*) (likely)	Freshwater wetlands are known to occur in two locations on survey area 9, RE11.3.27f in the northern half of the property and 11.3.27c in the southeast corner of the property. These areas are both vegetated swamps with varying amounts of open water and a diverse range of aquatic vegetation on dark clay soils. RE11.3.27f contains Queensland blue gum (*Eucalyptus tereticornis*) open-woodland fringing swamps and occurs on depressions on floodplains associated with old drainage courses that are intermittently flooded. Hollows, including large hollows, are particularly abundant in the large Queensland blue gum (*Eucalyptus tereticornis*); arboreal mammals and hollow-nesting birds may be common in this habitat. Further, this tree species provides abundant nectar and pollen resources to birds and flying-fox species when in flower (typically late winter). Migratory species. This RE may contain habitat for a number of migratory bird species including eastern great egret (*Ardea modesta)* and cattle egret (*Ardea ibis)* although migratory species were not

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		observed during the survey. RE11.3.27c is a mixed grassland/sedgeland that occurs on closed depressions on alluvial plains that are intermittently flooded. Frog abundance and diversity is likely to be high in and around wetland habitats, and these areas will attract a variety of wetland bird species. Access to the broader Condamine River flood plain was restricted due to flooding. It is likely that additional areas of wetland habitat, which may not include remnant habitats, are present within survey area 9. 
DERIVED GRASSLANDS		
N/A; non-remnant; derived native grasslands (veg code ARG)	**rough collared frog (*Cyclorana verrucosa*) (confirmed)** five-clawed worm-skink (*Anomalopus mackayi*) (possible) grey snake (*Hemiaspis damelii*) (likely)	Derived native grasslands are previously grassy woodlands that have been thinned. While these no longer constitute remnant status under the VM Act, they are structurally and functionally similar to native grasslands, and as such, highly significant in the local area. Derived grasslands have native grass cover exceeding 50% and often include Cyperus sp, Eragrostis sp and Asteraceae spp. Occurring on alluvial clay plains, these habitats form deep soil cracks during dry conditions, but can have small areas of pooling water following rainfall. 
ARTIFICIAL WATERBODIES		
N/A; non-remnant	**rough collared frog (*Cyclorana verrucosa*) (confirmed)**	A large artificial dam was present in the north of survey area 9, largely surrounded by black soil and exotic pasture. The deep open water provides habitat for a variety of wetland bird species which might otherwise be absent from the property. Other smaller artificial dams are scattered through the southern portion of survey area 9. These may also provide some habitat for waterfowl and migratory bird species although these were not observed during the survey.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
CLEARED LAND		
N/A; non-remnant	**rough collared frog (*Cyclorana verrucosa*) (confirmed)**, Glossy black-cockatoo (*Calyptorhynchus lathami*) (possible)	A large portion of non-remnant grazing land, dominated by exotic pasture grasses, is present on survey area 9. Areas of pooling surface water can be found throughout these grasslands in areas with dark clay soils, such as on the Condamine flood plain, Surveyors creek, or immediately south of the large artificial dam. These waterbodies provide breeding opportunity for frog species and the rough collared frog (*Cyclorana verrucosa*) was abundant throughout survey area 9 in cleared land. A non-remnant stand of belah (*Casuarina cristata*) to the immediate south of the large artificial dam provides possible foraging resources for the glossy black-cockatoo (*Calyptorhynchus lathami*). Limited searching in this area failed to locate foraging remains, although the search was restricted due to flooding. 

Riparian Values

The Condamine River is fringed by open grassy woodlands consisting of RE 11.3.4/11.3.25 - eucalyptus woodland fringing drainage lines/tall eucalyptus woodland on alluvial plains. These habitats are dominated by Queensland blue gum (*Eucalyptus tereticornis*) which provides a number of unique resources for fauna species:

- Large trees form abundant hollows, and these habitats provide excellent opportunities for arboreal mammals, nesting birds and roosting bats.
- When flowering, typically late winter, Queensland blue gum (Eucalyptus tereticornis) stands can provide a rich source of nectar and pollen. This seasonal or ephemeral resource may facilitate an influx in honeyeaters, lorikeets and flying-foxes.
- Koalas *(Phascolarctos cinereus*) are known to preferentially feed on Queensland blue gum (*Eucalyptus tereticornis*). The species is known to occur along the Condamine River system, and while not recorded in riparian habitats on survey area 9 (largely due to access constraints preventing suitable searches) during these surveys, the species is expected to occur. Koalas (*Phascolarctos cinereus*) have been recorded from contiguous habitats dominated by Queensland blue gum (*Eucalyptus tereticornis*) in the southeast corner of survey area 9.

Wetland habitats (RE 11.3.27), which often occur within the immediate river flood plain and connect to riparian vegetation are of particular interest. These areas are more likely to support semi-aquatic vertebrates (i.e., frogs) and aquatic invertebrates, both are potential prey items for wetland birds (e.g., egrets, ibis and herons) and predatory snakes (e.g., grey snake (*Hemiaspis damelii*), keelback (*Tropidonophis mairii*)).

Riparian vegetation associated with the river provides a near contiguous narrow corridor through an otherwise fragmented and highly modified landscape. Many mobile species including larger mammals, birds and bats may use this corridor as a movement conduit through the landscape. This corridor is of high conservation value.

Significant fauna taxa that might occur within or utilise riparian vegetation includes little pied bat (*Chalinolobus picatus*), koala (*Phascolarctos cinereus*), square-tailed kite (*Lophoictinia isura*), squatter pigeon (*Geophaps scripta scripta*), grey snake (*Hemiaspis damelii*), rough collared frog (*Cyclorana verrucosa*) and black-chinned honeyeater (*Melithreptus gularis*).

Fauna Communities and Taxa of interest

Surveys identified a total of 108 species of vertebrate on survey area 9, including 19 frogs, 9 reptiles, 68 birds and 12 mammals. Common and widely distributed species included ornate burrowing frog (*Platyplectrum ornatum*), green-striped frog (*Cyclorana alboguttata*), rough collared frog (*Cyclorana verrucosa*), scarlet-sided pobblebonk (*Limnodynastes terraeraginae*), chubby gungan (*Uperoleia rugosa*), beeping froglet (*Crinia parinsignifera*), striated pardalote (*Pardalotus*

striatus), willie wagtail (*Rhipidura leucophrys*), weebill (*Smicrornis brevirostris*), scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*), squirrel glider (*Petaurus norfolcensis*), swamp wallaby (*Wallabia bicolor*), and eastern grey kangaroo (*Macropus giganteus*).

Four exotic species, cane toad (*Rhinella marina*), dog/dingo (*Canis lupus*), feral cat (*Felis catus*), and European brown hare (*Lepus europeaus*) have been located on survey area 9. Feral pig (*Sus scrofa*) was reported on the property by the floristic survey team.

In addition to the EVNT species discussed in the section below, three bioregionally significant species (as defined under the Brigalow Belt Biodiversity Planning Assessment; EPA 2008b) were recorded from survey area 9 including common brushtail possum (*Trichosurus vulpecula*), eastern water dragon (*Intellagama lesueurii*), and speckled warbler (*Pyrrholaemus sagittatus*).

No Back on Track species were recorded on survey area 9. It is not expected that any would occur frequently, however there is the potential for glossy black-cockatoo (*Calyptorhynchus lathami*).

Two koalas (*Phascolarctos cinereus*), considered a culturally significant species and Vulnerable under the EPBC Act, were detected in Queensland blue gum (*Eucalyptus tereticornis)* in the southern portion of the property. Nine koala (*Phascolarctos cinereus*) records occur in within 10 km of survey area 9. The short-beaked echidna (*Tachyglossus aculeatus*), also a culturally significant species, has not been detected on survey area 9 but is widespread, common and well known from the local area. It is expected to occur. Platypus (*Ornithorhynchus anatinus*) is considered unlikely to occur.

Threatened Fauna Species

February surveys at survey area 9 located two threatened species protected under state or federal legislation (**Table 23**) with distribution of species records shown in **Figure 16**. Based on local records and habitat suitability, another three have potential to occur. Brief notes on the occurrence, or likely occurrence, of these species is discussed below.

Table 23. Detected and potential Threatened fauna species located on survey area 9, February 2013.

Scientific Name	**Common Name**	**Status**			**Occurrence***	**Core Habitat Known (Ha)**	**Core Habitat Possible (Ha)**	**General**
		NC Act	**EPBC Act**	**BoT**				
Hypochrysops piceata	Bulloak jewel	E	-	H	Possible	0	483.1	0
Cyclorana verrucosa	Rough collared Frog	NT	-	-	Known	277.9	114.7	440.9
Melithreptus gularis	Black-chinned honeyeater	NT	-	-	Possible	0	633.7	0
Calyptorhynchus lathami	Glossy black-cockatoo	V	-	H	Possible	0	20.1	493.7
Geophaps scripta	Squatter	V	V	M	Possible	0	620.7	0

Scientific Name	Common Name	Status			Occurrence*	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General
		NC Act	EPBC Act	BoT				
scripta	Pigeon				(transient)			
Lophoictinia isura	Square-tailed kite	NT	-	-	Possible	0	46.3	592.8
Chalinolobus picatus	Little pied bat	NT	N/A	M	Possible	0	639.1	0
Phascolarctos cinereus	Koala	LC	Vul	-	Known	Not assessed		
Hemiaspis damelii	Grey Snake	E	N/A	M	Likely	0	337.9	480.4

E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.
BoT (Back on Track); H = High, M = Medium
*Known = A species record exists in the survey area. Likely = A species record exists within close proximity to the survey area and suitable habitat is present. Possible = A record is not present within close proximity to the survey area however suitable habitat is present.

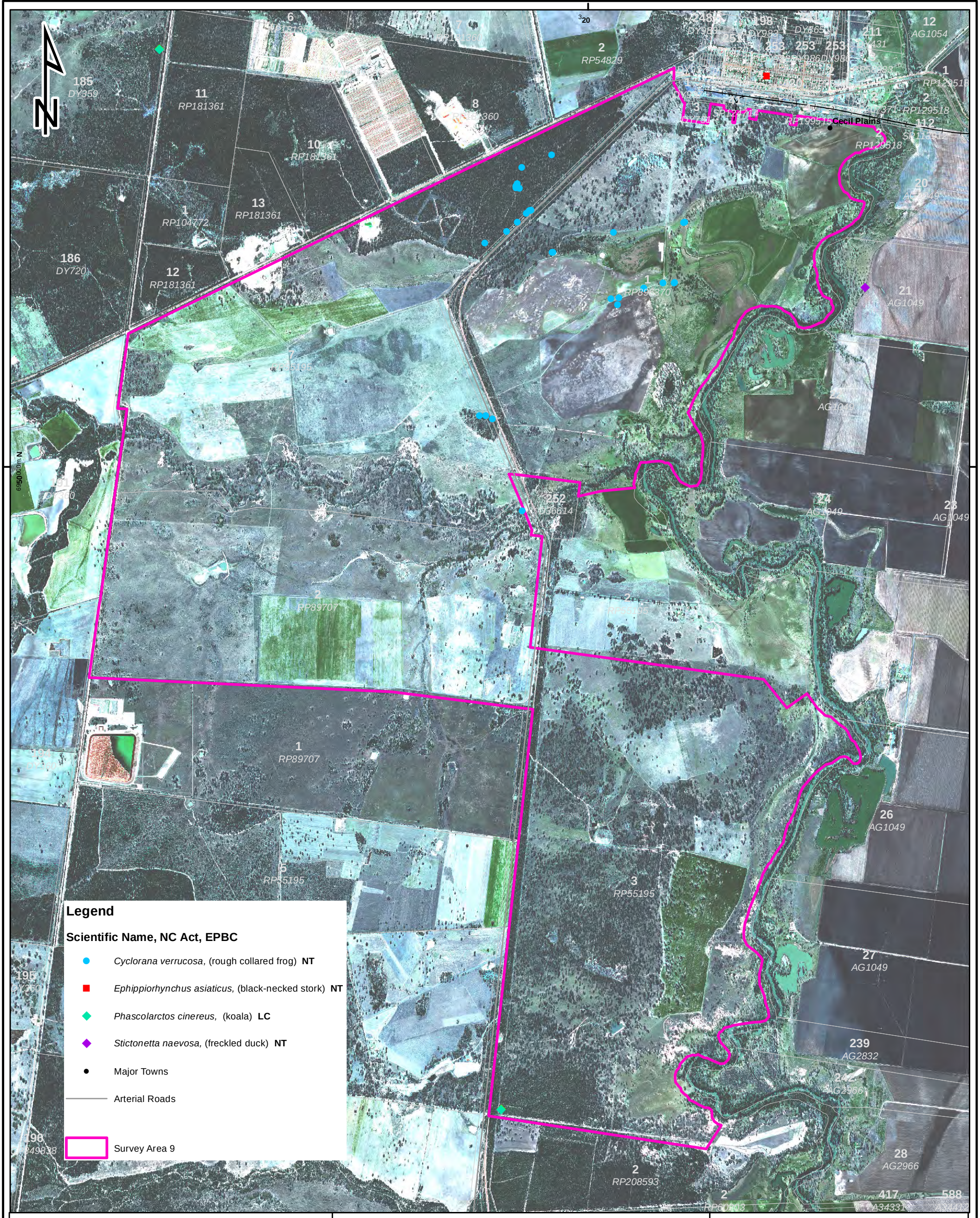
Local records of black-necked stork (*Ephippiorhynchus asiaticus*) and freckled duck (*Stictonetta naevosa*) (**Figure 16**) are either pre-1980 or have a low spatial accuracy. They may represent transient individuals but are unlikely to represent permanent or semi-permanent populations. They are not expected to occur with any regularity. Habitat for a number of other EVNT species is marginal and current information suggests there are no local records. These species have been excluded from the assessment but may require assessment if individuals are located during future activities.

Bulloak jewel (*Hypochrysops piceatus*)*:* A dense stand of old-growth bull-oak (*Allocasuarina luehmannii*) is located at the northern end of survey area 9. This area has several characteristics in common with areas inhabited by the bulloak jewel (*Hypochrysops piceatus*); the bulloak (*Allocasuarina luehmannii*) trees are large and mature, containing hollows in which the larvae can shelter; and the area has abundant fallen debris which may be important for its larvae attendant ant, Anonychomyrma sp. (itinerans group). The butterfly is thought to only lay its eggs on the bulloak (*Allocasuarina luehmannii*) trees when this ant species is present (Braby 2004).

Habitat values in this area for the bulloak jewel (*Hypochrysops piceatus*) was noted during the initial EIS, although larval attendant ants were not recorded until recent surveys. The discovery of this ant increases the value of this vegetation for the species and its likely occurrence.

No bulloak jewel (*Hypochrysops piceatus*) have been recorded from survey area 9 however conditions during the surveys were not suitable for detection. Further work would be required on hot sunny days when weather conditions are suitable for activity, in order to ascertain its presence.

Rough collared frog (*Cyclorana verrucosa*)*:* Twenty-nine individual rough collared frogs (*Cyclorana verrucosa*) were observed while spotlighting on survey area 9 in the February survey. All individuals were located on the ground while spotlighting. The species is common and abundant throughout areas of open grassy woodlands and in cleared land where water pools. The species is likely to be less abundant away from alluvial areas (i.e., within 11.5.1), but still has some potential to occur. Accordingly, the mapping of core habitats for this species on survey area 9 is



NOTES:

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

Source; ESE, Queensland Wetland Database

Figure 16. Records of EVNT fauna species on survey area 9.

Client

Coffey Environments

0 700 1,400 2,100 2,800

Meters

Scale	Drawn By	Checked	File Path	Date	
1:30,142	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

difficult, due to the wide spread habitat use, particularly in times of optimal weather conditions. Only areas of tilled land should be excluded as unsuitable.

At least 39 other records of the species are known to occur within 20km of survey area 9. The species is likely to be widely distributed and relatively common in the local area.

Black-chinned Honeyeater (*Melithreptus gularis*): No black-chinned honeyeaters (*Melithreptus gularis*) were observed on site, however suitable habitat is present in the open grassy woodland and woodland habitats, particularly in areas dominated by Queensland blue gum (*Eucalyptus tereticornis*) (i.e., RE 11.3.4, 11.3.27). While these habitats are suitable, the species is uncommon within the local area, represented by one record within 40 km and five records within 100km of survey area 9.

Glossy black-cockatoo (*Calyptorhynchus lathami*): No Glossy black-cockatoo (*Calyptorhynchus lathami*) were observed on site, however suitable habitat is present scattered through the grassy open woodlands (in RE 11.5.1) is Woolly oak (*Allocasuarina inophloia*), a species which provides foraging resources for the glossy black-cockatoo (*Calyptorhynchus lathami*). Records of the specie due occur in proximity to survey area 9 with five records occurring within 25 km to the east of the study area.

Squatter pigeon (*Geophaps scripta scripta*): No squatter pigeon (*Geophaps scripta scripta*) were observed on site, however suitable habitat is present as the grassy open woodlands (RE 11.5.1) The southern subspecies of squatter pigeon (*Geophaps scripta scripta*) is tolerant of habitat disturbance, at least in the northern portions of its range, and can be found in cleared grazing land along roads and tracks. Based on habitat preference alone, it is possible that the species could occur in cleared land associated with current grazing activities.

In the southern portion of its range, the species has declined significantly. There are no records in proximity to survey area 9; the closest records occurring 60 km south, just outside of Wondul Range National Park in farm land.

Square-tailed Kite (*Lophoictinia isura*): The square-tailed Kite (*Lophoictinia isura*) has not been recorded from survey area 9, however suitable habitat is present (particularly in riparian areas). Square-tailed kites (*Lophoictinia isura*) can be tolerable of habitat disturbance and are known to nest and forage around the edges of towns and along roads when adjacent habitat is suitable.

Records of the species occur do not occur far from survey area 9, the closest approximately Lake Broadwater 20 km to the north (near Lake Broadwater).

Little pied bat (*Chalinolobus picatus*): Bat survey techniques have not been undertaken on survey area 9, and it is not therefore known if the species occurs. Riparian and woodland habitats similar to those on survey area 2 are inhabited by the species and habitats are therefore suitable. Hollows are abundant, particularly in areas dominated by Queensland blue gum (*Eucalyptus tereticornis*) providing roosting opportunities for the species.

Koala (*Phascolarctos cinereus*): Two Koalas (*Phascolarctos cinereus*) were found during nocturnal surveys of survey area 9 and scats were found during active searches, all in association with tall Queensland blue gum (*Eucalyptus tereticornis)*.

Grey snake (*Hemiaspis damelii*): The grey snake (*Hemiaspis damelii*) is a frog predator that predominantly occurs on dark cracking clays similar to those found within Condamine flood plain. Records are known to occur from remnant habitats, of which locations such as RE 11.3.27 are

ideal. Many lower-lying areas of non-remnant or derived grassland also provide suitable habitat. While the species can be detected through spotlighting, it is easily overlooked during short one-off surveys and the lack of records in the current survey is not sufficient evidence to conclude the species is absent.

The closest historical record of grey snake (*Hemiaspis damelii*) to survey area 9 is from Lake Broadwater 25km to the northeast.

Migratory Fauna Species

One migratory species has been observed within survey area 9, Latham's snipe (*Gallinago hardwickii*). Latham's snipe is known to utilize wet paddocks, seepage areas and long grasses associated with artificial waterbodies. The individual seen was recorded at night in a wet paddock with long grass approximately 280 m from the large dam in the north of the property. It is likely that other individuals were present in nearby vegetation and on other wetland areas. The species is likely to be sporadic in its occurrence on survey area 9, fluctuating in response to heavy rainfall and flood conditions.

Based on information provided in Appendix E, survey area 9 is not considered likely to host an important population of migratory species.

5.6.3 Survey area 8

General Description

Survey area 8 lies to the the immediate south of Lake Broadwater Conservation Park, a Category A ESA with its western boundary adjoining Kumbarilla State Forest. Long Swamp also intrudes into the northeastern boundary of the property. The property occupies the transition from flood plain to rangeland habitats with alluvial flats in its eastern section and indurated sandstone rises in its westt. Heavy fragmentation of vegetation has been incurred by prior agricultural activity in the east whilst habitats in the west are fragmented by numerous clearings adjacent to the state forest boundary. The survey area occupies 9222 ha, of which 2015 ha (22 %) is remnant vegetation, 1091 ha of recent regrowth vegetation (12 %), 266 ha (3%) of derived grassland with a balance of 5851 ha (73 %) cleared of vegetation.

Associated Ecological Communities and Regional Ecosystems

Reference to **Table 3** indicates a total of 26 floristic survey sites recorded during field survey including ten secondary survey sites, 2 tertiary sites and 14 descriptive quaternary sites.

EPBC Listed Ecological Communities: A single polygon of advanced brigalow regrowth (regrowth >15 yrs old) representing 2.1 ha of the brigalow ecological community is identified on survey area 8.

Regional Ecosystems: A total of four regional ecosystems were identified during field survey and mapping revision with the surveyed extent of regional ecosystems with comparisons to certified RE mapping being provided within **Table 24.** Summary site data is provided in **Appendix H** and floristic descriptions for REs identified on the site are provided below. It should be noted that remnant vegetation defined within the 3D mapping database (3D Environmental 2013a) includes areas that would be considered 'mature regrowth' within datasets provided by EHP (2012b). Mapping of REs is represented wthin **Figure 17** with biodiversity status of vegetation shown in **Figure 18.** Comparison between revised and certified mapping (EHP 2012a and 2012b) shows general agreement in the extent of REs associated with Land Zone 5 (i.e RE11.5.1 and 11.5.20) although certified RE mapping fails to recognise the extent of habitats on Land Zone 7 (RE11.7.4). Revised mapping also indicates that the endangered RE11.3.17 is not present on the site and that the extent of RE11.3.2 (of concern) is over-represented in certified mapping databases.

Table 24. Regional ecosystems identified during field survey on survey area 8.

Regional Ecosystem	Bio-Status	Extent within Property (Field Suvey)(Ha)	Extent Within Property (EHP 2012a)	Extent Within Property (EHP 2012b) – Mature Regrowth	Total Extent Within Property (EHP 2012a and 2012b)
11.3.2	Of Concern	0	53.0	141	184
11.3.4	Of Concern	16.7	0	0	0
11.3.17	Endangered	0	27.5	30	57.5
11.3.18	No concern at present	0	8.6	35	43.6
11.5.1/ 11.5.1a	No concern at present	826.6	783.7	64	847.7
11.5.4	No concern at present	0	937.0	117.0	1054.0
11.5.20	No Concern at present	357.1	288.0	71.0	359.0
11.7.4	No Concern at present	813.1	0	0	0
Regrowth Brigalow (>15yrs old)*	Non-remnant	2.13	0	0	0

Regional Ecosystem	Bio-Status	Extent within Property (Field Suvey)(Ha)	Extent Within Property (EHP 2012a)	Extent Within Property (EHP 2012b) – Mature Regrowth	Total Extent Within Property (EHP 2012a and 2012b)
Derived Grassland	Non-remnant	266.0	0	0	0
Recent regrowth and other disturbed vegetation	Non-remnant	1091.7	0	NA	0
Cleared Land	Non-remnant	5851.2	7096.0	NA	7096.0

*Brigalow Ecological Community

Floristic Habitat Descriptions

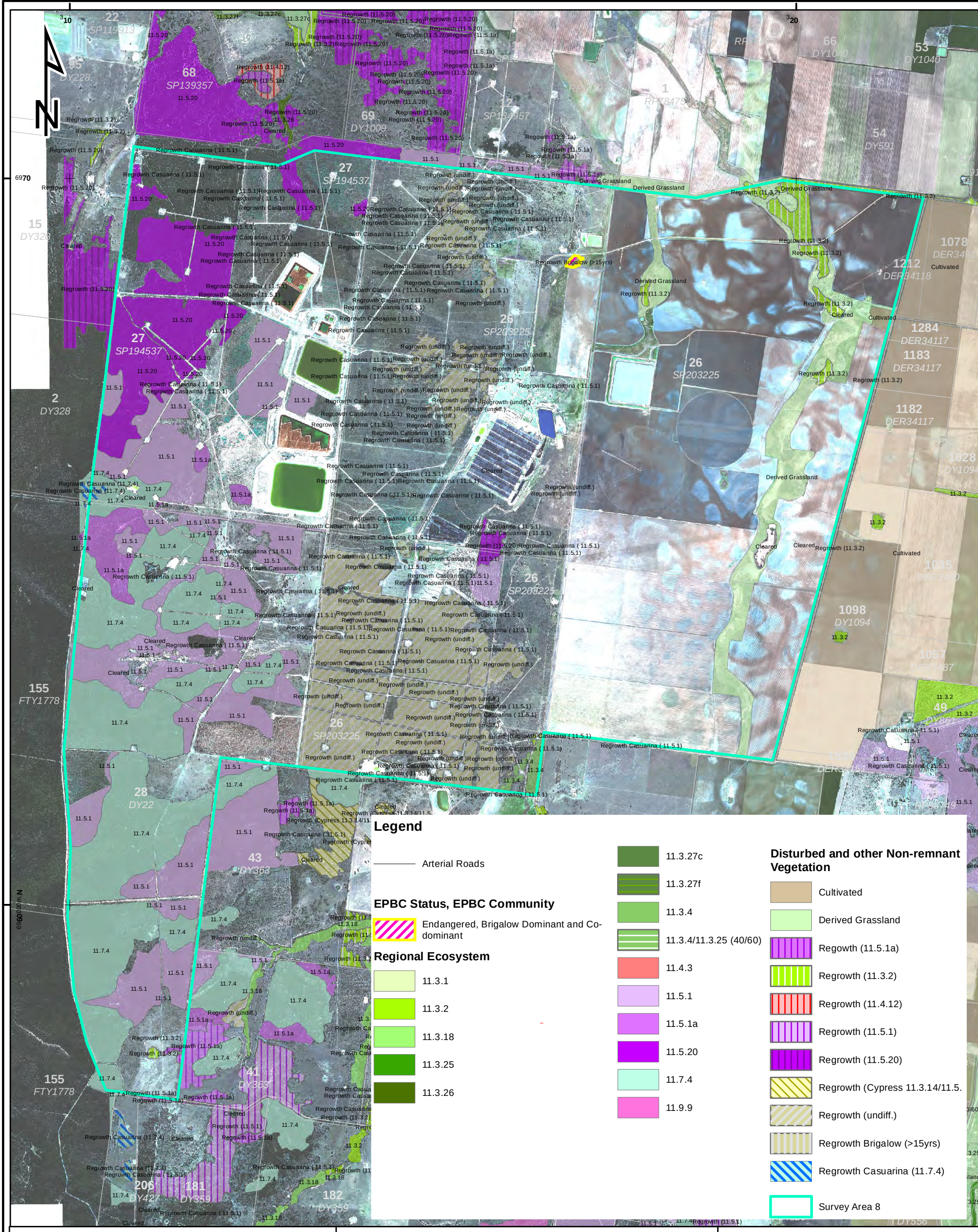
Table 25 provides floristic descriptions for the four REs and significant regrowth habitats recorded on survey area 8 during the course of the survey. Habitat values for threatened flora species are indicated with further information provided in following sections. A total of 113 flora species were identified in surveys undertaken on survey area 8. This includes 5 exotic species with two of these declared weeds under the LP Act. The relatively small contribution native flora makes to the species assemblage reflects the predominance of sampling within undisturbed habitats on the western margins of the property.

Threatened Flora Species

No flora species listed as threatened under the NC Act or EPBC Act were identified during the survey although the site contains potential habitat for a range of threatened flora species. Those species considered to have suitable habitat on the property are provided in **Table 26**. Further information on threatened species potentially occurring within survey area 8 is provided within **Appendix C.**

Exotic (Pest) Flora Species

Within survey area 8, those habitats associated with land zone 5 (RE11.5.1, 11.5.20) and land zone 7 (RE11.7.4) are largely free from exotic species with the exception of scattered plants prickly pear (*Opuntia stricta),* a class 2 pest under the LP Act. The most extensive infestations of exotic species occur on alluvial habitats adjacent to Long Swamp where lippia (*Phyla canescens*) is a prominent component of the ground cover and velvet tree pear (*Opuntia tomentosa),* a class 2 weed species which forms an occasional shrub. Populations of these species can be identified during preclearance surveys and mitigations applied to prevent further spread (Section 17.6.3 of Surat Gas Project EIS, Arrow 2012).



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

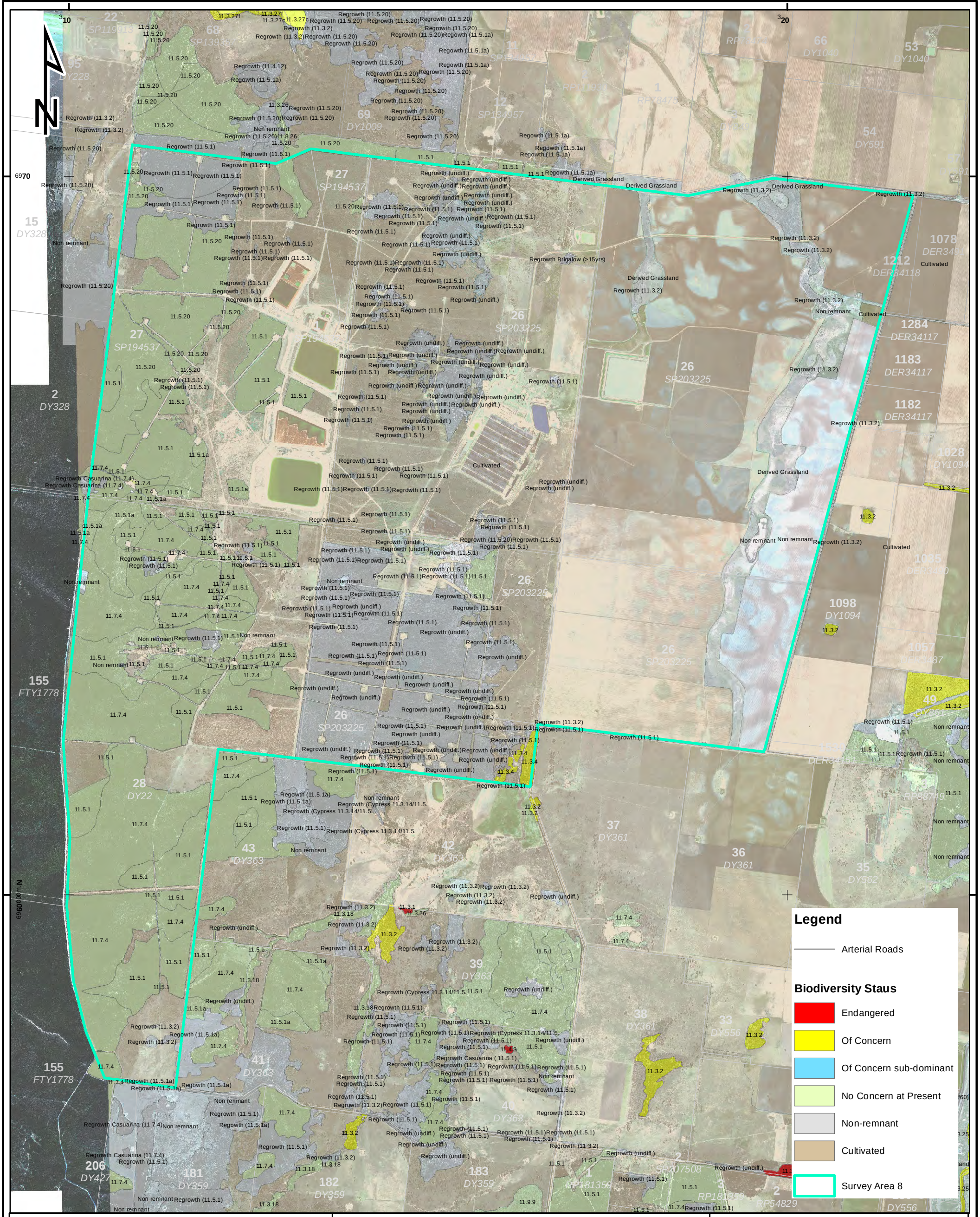
DIGITAL CADASTRAL DATA BASE
© The State of Queensland (Department of Natural Resources) [2012]

Figure 17. Distribution of regional ecosystems and ecological communities within survey area 8

Client
Coffey Environments

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:48,855	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4



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

DIGITAL CADASTRAL DATA BASE
© The State of Queensland (Department of Natural Resources) [2012]

Figure 18. Biodiversity status of vegetation in survey area 8.

Client
Coffey Environments

0 700 1,400 2,100 2,800
Meters

Scale	Drawn By	Checked	File Path	Date	
1:48,855	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Fauna Habitats

Survey area 8 Methodology: No systematic surveying of survey area 8 was undertaken. This site was assessed via habitat assessment methods only. A total of 12 habitat assessments were undertaken across the site.

Large areas of remnant habitat occur on the eastern portion of survey area 8 and were visually assessed during the survey. However access constraints due to flooding prevented detailed inspection of derived grasslands on the east, although similar habitats were inspected off Percy Jurgs Rd (the southern boundary of survey area 8). Non-remnant regrowth habitats near the centre of the property have not been inspected.

Remnant vegetation in the west of survey area 8 includes a mosaic of RE 11.5.1, 11.5.20 and 11.7.4. These communities are structurally very similar, and consequently treated as one broad habitat type. A description of habitats for fauna species is provided in **Table 27**.

Table 25. Significant floristic habitats contained within survey area 8.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.5.1/ 11.5.1a	Provides potential habitat for Cobar greenhood orchid (*Pterostylis cobarensis)* and general habitat for lobed blue grass *(Bothriochloa biloba).*	***Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.**  Extensive areas of RE11.5.1 occupy the loamy flats of survey area 8. Almost universally, the habitats have been subject to heavy timber extraction to the degree that the majority of the previous ironbark canopy (*Eucalyptus crebra)* has been extracted resulting in a low even canopy of bull oak with scattered residual emergent trees. In this relatively poor state of preservation, many of these habitats are barely of remnant status. In better preserved locations, the canopy comprises narrow leaved ironbark (*Eucalyptus crebra)*, scattered *Eucalyptus woolsiana* with a low, mid-dense sub-canopy layer of *Allocasuarina Luehmannii* and *Callitris glaucophylla*. A sparse shrub layer of *Allocasuarina Luehmannii Melaleuca decora* and *Callitris glaucophylla* occurs over a native dominant groundcover of *Aristida caput-medusae,* wire grass *(Aristida calycina),* barbed wire grass *(Cymbopogon refractus),* paspalidium *(Paspalidium sp.),* and windmill grass (*Chloris truncata*).
11.5.20	Not known to provide specific habitat for EVNT flora species.	***Eucalyptus moluccana* or *E. microcarpa* or *E. woollsiana* woodland to open-forest.** RE 11.5.20 is represented on the site by a woodland of 16-23 m in height dominated by grey box (*Eucalyptus woollsiana*) with associated narrow leaf ironbark (*E. crebra*). It occurs on low rises of old loamy plains. These tree species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.). A native groundcover is dominated by many-headed wire grass (*Aristida caput-medusae),* wire grass *(Aristida calycina),* love grass (*Eragrostis lacunaria*), barbed wire grass *(Cymbopogon refractus),* paspalidium *(Paspalidium sp.),* and windmill grass (*Chloris truncata*).

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.7.4	Provides potential habitat for *Calotis glabrescens,* Kogan waxflower (*Philotheca sporadica),* Tara wattle (*Acacia lauta)* and plunkett mallee (*Eucalyptus curtisii).*	***Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia spp., Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust.** The dominant habitat type on the low indurated sandstone rises on the western margins of survey area 8 where it forms a low, relatively uniform habitat. The dominant canopy tree, *Eucalyptus crebra* forms heights of up to 23 m in better preserved locations. Co-dominant canopy trees include brown bloodwood *(Corymbia trachyphloia),* smooth barked apple (*Angophora leiocarpa)* and peppermint (*Eucalyptus exserta).* A secondary tree layer of *Callitris glaucophylla, Acacia conferta, Alphitonia excelsa* and stringy barked sheoak (*Allocasuarina inophloia*) is prominent in some localities. The sparse native dominant grassy groundcover *Aristida caput-medusae, Gahnia aspera* and *Xanthorrhoea johnstonii* in some locations. 
RE11.3.4	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba) Rutidosis lanata, Eleocharis blakeana* and *Fimbristylis vagans.*	***Eucalyptus tereticornis* and/or *Eucalyptus spp. tall* woodland on alluvial plains.** Only minor scattered and highly disturbed fragments of this habitat are present on site where it occupies loamy outwash on the outer margins of the Condamine River Floood Plain. The canopy is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and/or Queensland blue gum *(E. camaldulensis)* although mixes with poplar box (*Eucalyptus populnea)* and and Moreton Bay ash (*Corymbia tessellaris*). The second tree layer is sparse and comprises the above canopy species and the sparse shrub layer of between 1-4 m is dominated by *Acacia stenophylla*. The ground layer is dominated by native species.
Brigalow regrowth (>15 yrs old).	Provides potential habitat for *Xerothamnella herbacea and* Belson's panic (*Homopholis belsonii).*	This community was not surveyed intensively during field survey although was observed from an adjacent roadside location. The age of regrowth was determined through analysis of historical aerial photography and observation of general field characteristics. Brigalow (*Acacia harpophylla)* dominates the canopy, with >30 % canopy cover estimated. Canopy height is estimated at 5 – 8 m, which is typical of regrowth brigalow habitats of this age. The condition and composition of of the groundcover has not been assessed.

HABITAT			
RE	**Possible EVNT taxa**	**Description**	
Derived grassland	Potential habitat for finger panic grass (*Digitaria porrecta), Cymbonotus maidenii,* lobed bluegrass (*Bothriochloa biloba).*	Derived grasslands form a significant habitat along the floodplain of the Condamine River although in this location, they fringe wetland habitats formed by Long Swamp. Typical ground cover species include *Erichloa crebra,* Queensland blue grass (*Dicanthium sericeum)* which tends to dominate in some areas, *Panicum decompositum, Eriochloa procera, Digitaria brownii* and *Eulalia aurea*. Whist native groundcover is typically robust, lippia (*Phyla canescens*) contributes to a mean exotic cover of 23%, becoming dominant in some locations where heavy grazing is apparent. Ground cover herbs include *Chrysocephalum apiculatum, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis* and *Cyperus sp.*	

Table 26. Potential habitats for threatened species within survey area 8.

Species	NC Act	EPBC Act	BoT	Habitat	Core Habitat Possible (Ha)	General Habitat (Ha)
Digitaria porrecta (*finger panic grass*)	NT	E	-	General habitat potentially contained within derived grassland	0	369.0
Bothriochloa biloba (lobed blue grass)	Not listed	V	-	Core habitat possible contained with RE11.3.4 and general habitat contained within derived grassland and RE11.5.1.	103.9	1276.6
Cymbonotus maidenii	E	Not Listed	M	General habitat provided by derived grassland.	0	369.3
Peterostylis cobarensis (Cobar greenhood orchid)	Not Listed	V	-	Core habitat potentially contained within RE11.5.1. Survey completed outside optimal period for detection.	907.3	0
Kogan waxflower (*Philotheca sporadica)*	V	V	-	Core habitat potentially contained within RE11.7.4. General habitat potentially contained within RE11.5.1	936.1	907.3
Tara wattle *(Acacia lauta)*	V	V	-	Core habitat potentially contained within RE11.7.4 and 11.5.1. General habitat contained within regrowth 11.5.1.	1738.3	244.5
Calotis glabrescens	NT	Not Listed	-	General habitat potentially contained within RE11.5.1 and 11.7.4.	0	1928.2
Plunket mallee *(Eucalyptus curtisii)*	NT	Not Listed	-	Core habitat potentially contained within RE11.7.4 and general habitat contained within RE11.5.1	936.1	909.9

E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.
BoT (Back on Track); M = Medium

Table 27. Significant fauna habitats on survey area 8.

<table>
<tr><th colspan="3">HABITAT</th></tr>
<tr><th>Representative RE's</th><th>Possible EVNT taxa</th><th>Description</th></tr>
<tr><td colspan="3">WOODLAND/FOREST</td></tr>
<tr><td>11.5.1
11.5.20
11.7.4</td><td>koala (Phascolarctos cinereus) (known), brigalow scaly-foot (Paradelma orientalis) (likely), dunmall's snake (Furina dunmalli) (possible), golden-tailed gecko (Strophurus taenicauda) (likely), square-tailed kite (Lophoictinia isura) (possible), little pied bat (Chalinolobus picatus) (possible), south-eastern long-eared bat (Nyctophilus corbeni) (possible), black-chinned honeyeater (Melithreptus gularis) (possible)</td><td>Woodland and forest habitats on survey area 8 are in excellent condition, and have highly diverse vertical and horizontal structure. These habitats are likely to have high vertebrate diversity and be inhabited by a number of EVNT taxa.

Dominant canopy trees within the woodland/forest habitat include narrow-leaf ironbark (Eucalyptus crebra) and grey box (Eucalyptus woollsiana). When flowering, some of these trees (particularly Eucalyptus woollsiana) provide nectar for insectivorous birds and could attract species such as black-chinned honeyeater (Melithreptus gularis). Grey box (Eucalyptus woollsiana) can also be used by koala (Phascolarctos cinereus).

Although large hollows are typically restricted to isolated stags and scattered Angophora, medium- to small-sized hollows are abundant. These provide opportunities for arboreal mammals and particularly bats; the latter group in particular could be very abundant and diverse. It is highly likely the little pied bat (Chalinolobus picatus) will occur in these habitats, and given survey area 8 is near-contiguous with the adjacent state forest, the south-eastern long-eared bat is also possible. Woollyoak (Allocasuarina inophloia), a feed tree of the glossy black-cockatoo (Calyptorhynchus lathami), is common in RE 11.7.4.

The shrub layer ranges from relatively open to relatively dense. Common shrubs include white cypress pine (Callitris glaucophylla), Acacia spp, Acacia Luehmannii and paperbark (Melaleuca decora). Exfoliating bark and shelter for arboreal reptiles, including golden-tailed gecko (Strophurus taenicauda), is abundant throughout the vegetation. The complex shrub layer is also ideal for insectivorous birds.

The field inspection located at least one area with abundant mistletoe (Amyema quandang). This species, which commonly grows on Acacia species, is known to attract painted honeyeater (Grantiella picta) when in fruit.

The ground strata is quite variable. Areas of 11.5.1 and 11.5.20 have scattered native grasses with open ground and abundant fallen debris. Lower lying sections have evidence of pooling water which could attract frog species. In addition to abundant fallen debris and scattered tussock grass, RE 11.7.4 can have large surface stones and rocks, which provide added sheltering opportunities for terrestrial vertebrates. Ground dwelling vertebrates are likely to be well represented and possible/probable EVNT taxa include brigalow scaly-foot (Paradelma orientalis) and Dunmall's snake (Furina dunmalli). While the habitats look good for a number of other EVNT taxa (e.g., death adder), their occurrence in the area is rare.

 
  </td></tr>
</table>

DERIVED GRASSLANDS		
11.3.27 + non-remnant areas were surface water pools	rough collared frog (*Cyclorana verrucosa*) (likely), grey snake (*Hemiaspis damelii*), (likely) five-clawed worm-skink (*Anomalopus mackayi*) (Possible)	A long linear stretch of derived grasslands is located in the eastern portion of survey area 8, associated with Long Swamp. This area is devoid of all most canopy trees and has little or no shrub cover. These communities have native grass covers exceeding 50% on deep cracking clays. At the time of inspection, the area was flooded and would have provided suitable habitat for a diverse range of waterbirds (e.g., herons, egrets, and ibis) and frogs. It is likely that this area would be inhabited by the rough collared frog (*Cyclorana verrucosa*), possibly inhabited by grey snake (*Hemiaspis damelii*) (a frog predator), and although uncommon in the region, Australian painted snipe (*Rostratula australis*). When not holding water, the clays are likely to form deep soil cracks, providing habitat for grassland specialists. This could include the five-clawed worm-skink (*Anomalopus mackayi*) and Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*).

Fauna Communities and Taxa of interest

Surveys identified a total of 37 species of vertebrate on survey area 8, including 1 amphibian, 3 reptiles, 29 birds and 4 mammals. A number of common species noted during the surveys including broad palmed rocketfrog (*Litoria latopalmata*) dubious dtella (*Gehyra dubia*), noisy miner (*Manorina melanocephala*), striped honeyeater (*Plectorhyncha lanceolata*), white-eared honeyeater (*Lichenostomus leucotis*), eastern yellow robin (*Eopsaltria australis*), speckled warbler (*Pyrrholaemus sagittatus*), red-necked wallaby (*Macropus rufogriseus*) and eastern grey kangaroo (*Macropus giganteus*).

Two exotic species, dog/dingo (*Canis lupus*), and feral pig (*Sus scrofa*) were located on survey area 8. However it is expected that many including feral cat (*Felis catus*), could occur.

One bioregional significant species (as defined under the Brigalow Belt Biodiversity Planning Assessment; EPA 2008a) was recorded from survey area 8, speckled warbler (*Pyrrholaemus sagittatus*).

No 'Back on Track' species were detected on survey area 8 although several are considered to potentially occur (see **Table 28**).

No culturally significant species were recorded from survey area 8 (NC Act 1992). The short-beaked echidna (*Tachyglossus aculeatus*), which can occur in a vast spectrum of habitats, is widespread and well known from the local area. It is expected to occur on survey area 8, although its abundance may be low. Vegetation on site, which includes *Eucalyptus woollsiana*, is suitable for koala (*Phascolarctos cinereus*). However recent records of this species from the local area are scarce, most date back to the late 1980's. Two survey records of koala are located in survey area 8 (Qld Wetlands Database) with several additional records located approximately 5 km north of survey area 8 around Lake Broadwater. Platypus (*Ornithorhynchus anatinus*) is considered unlikely to occur.

Threatened Fauna Species

February 2013 surveys at survey area 8 did not locate any threatened species protected under state or federal legislation. Based on local records and habitat suitability, another 11 species have some potential to occur, as detailed in **Table 28**. Brief notes on the occurrence, or likely occurrence, of these species are discussed below. The location of survey records is shown in **Figure 19**.

Table 28. Detected and potential Threatened fauna species on survey area 8, February 2013.

Scientific Name	**Common Name**	**Status**			**Occurrence****	**Core Habitat Known**	**Core Habitat Possible**	**General Habitat**
		NC Act	**EPBC Act**	**BoT**				
Cyclorana verrucosa	rough collared frog	NT	-	-	Known	192.2	443.3	2383.7
Strophurus taenicauda	golden-tailed gecko	NT	N/A	M	Known	326.5	2426.9	836.7

Scientific Name	Common Name	Status			Occurrence**	Core Habitat Known	Core Habitat Possible	General Habitat
		NC Act	EPBC Act	BoT				
Paradelma orientalis	brigalow scaly-foot	V	V	M	likely	0	2349.7	1240.5
Furina dunmalli	dunmall's snake	V	V	M	Possible	0	2317.6	0
Hemiaspis damelii	grey snake	E		M	Likely	0	405.2	1434.2
Anomalopus mackayi	five-clawed Worm-skink	E	V	H	Possible	0	292.6	0
Lophoictinia isura	square-tailed kite	NT	-	-	Possible (transient)	4.12	19.2	2315.6
Calyptorhinchus lathami	glossy black-cockatoo	V	-	H	Likely	106.9	2.1	2577.1
Melithreptus gularis	black-chinned honeyeater	NT	-	-	Possible	0	2336.8	0
Phascolarctos cinereus	koala	LC	V	-	Known	Not assessed		
*Nyctophilus corbeni**	south-eastern long-eared bat	LC	V	M	Likely	0	2130.9	0
Chalinolobus picatus	little pied bat	NT	N/A	M	Likely	0	2338.9	0

* Species previously listed as *Nyctophilus timoriensis sensu lato* under legislation.
E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.

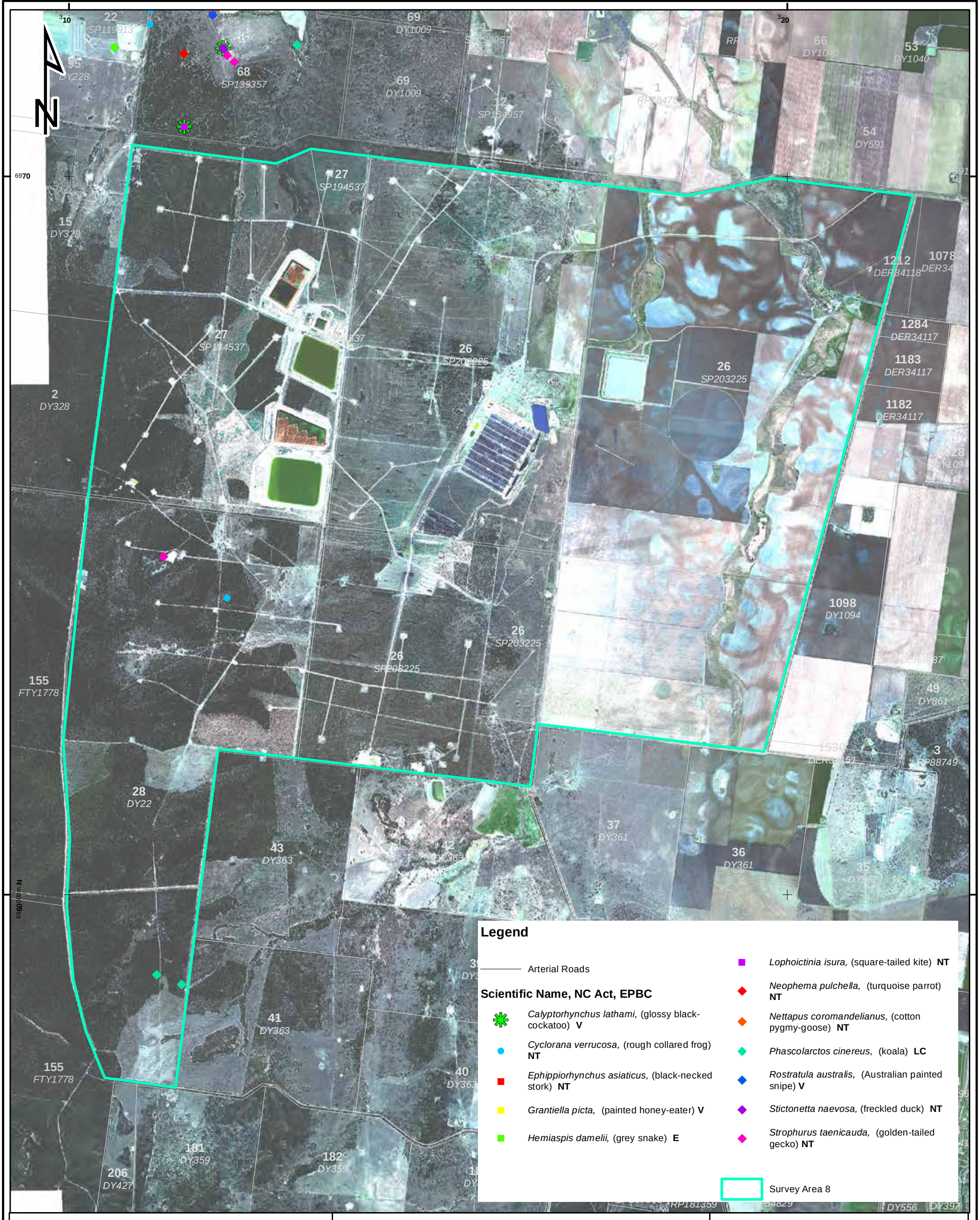
BoT (Back on Track); H = High, M = Medium

**Known = A species record exists in the survey area. Likely = A species record exists within close proximity to the survey area and suitable habitat is present. Possible = A record is not present within close proximity to the survey area however suitable habitat is present.

Local records of black-necked stork (*Ephippiorhynchus asiaticus*), freckled duck (*Stictonetta naevosa*) glossy black-cockatoo (*Calyptorhynchus lathami*), painted honeyeater (*Grantiella picta*), turquoise parrot (*Neophema pulchella*), cotton pygmy goose (*Nettapus coromandelianus*) and Australian painted snipe (*Rostratula australis*) (**Figure 19)** are either pre-1980, have a low spatial accuracy or are associated with Lake Broadwater. They may represent transient individuals but are unlikely to represent permanent or semi-permanent populations.

Rough collared frog (*Cyclorana verrucosa*): Commonly observed around Lake Broadwater in remnant vegetation and surrounding cleared (non-tilled) land. A single record of the species from survey area 8 probably under-represents its abundance and distribution; they are likely to be relatively common in low-lying areas with clay soils.

Golden-tailed gecko (*Strophurus taenicauda*): Golden-tailed geckos are well known from Lake Broadwater, and have been previously recorded from this property on at least one occasion. They are likely to be more widely distributed within survey area 8 than currently suggested by records, but may occur at relatively low densities. Areas where the species may be more abundant are likely to be dominated by acacia sp, and as such, could include areas of regrowth or disturbed habitat.



Legend

Arterial Roads

Scientific Name, NC Act, EPBC

- *Calyptorhynchus lathami,* (glossy black-cockatoo) **V**
- *Cyclorana verrucosa,* (rough collared frog) **NT**
- *Ephippiorhynchus asiaticus,* (black-necked stork) **NT**
- *Grantiella picta,* (painted honey-eater) **V**
- *Hemiaspis damelii,* (grey snake) **E**
- *Lophoictinia isura,* (square-tailed kite) **NT**
- *Neophema pulchella,* (turquoise parrot) **NT**
- *Nettapus coromandelianus,* (cotton pygmy-goose) **NT**
- *Phascolarctos cinereus,* (koala) **LC**
- *Rostratula australis,* (Australian painted snipe) **V**
- *Stictonetta naevosa,* (freckled duck) **NT**
- *Strophurus taenicauda,* (golden-tailed gecko) **NT**

Survey Area 8

NOTES:

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

Source; ESE, Queensland Wetland Database

Figure 19. Records of EVNT fauna species on survey area 8

Client

Coffey Environments

0 900 1,800 2,700 3,600

Meters

Scale	Drawn By	Checked	File Path	Date	
1:48,855	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Brigalow scaly-foot (*Paradelma orientalis*): Records of the brigalow scaly-foot are known from large forest tracks to the immediate west of survey area 8. These habitats are near-contiguous with vegetation within the property. Areas with exposed rock outcrops, abundant fallen debris and a mosaic of native grass and bare ground are ideal for this species. The species has a high probability of occurring on survey area 8.

Dunmall's snake (*Furina dunmalli*): The Dunmall's snake is scarce throughout it range, and therefore difficult to predict. Areas of vegetation within survey area 8 are consistent with its known range, and are near-contiguous with the immediately adjacent state forest.

Grey snake (*Hemiaspis damelii*): Grey snakes are often recorded to the north at Lake Broadwater. A frog predator, this species is most likely to occur on cracking clays, but may occur in other low-lying areas where surface water can pool. Within survey area 8, areas of best habitat are located in the east, associated with derived grasslands. The species will not utilise tilled land, but may otherwise occur in disturbed areas.

Five-clawed worm-skink (*Anomalopus mackayi*): Five-clawed Worm-skinks occur in native grasslands. Habitat consistent with this species preferences occur in the east of survey area 8, associated with long swamp. The influence of flooding in these derived grasslands on this species occurrence is unclear.

Square-tailed kite (*Lophoictinia isura*): While not previously recorded from within survey area 8, square-tailed kites have been recorded 500m to the north as well as around Lake Broadwater. The species can often be observed over large tracts of forest vegetation, but is also tolerant of some habitat loss; at least some pairs are known to nest and forage around the edges of towns and along roads when adjacent habitat is suitable. While it seems probably that this species will occur over survey area 8, there is no current evidence to suggest the area is regularly used and most records may represent transient individuals.

Glossy black-cockatoo (*Calyptorhinchus lathami*): Glossy black-cockatoo records are known from only a few kilometres to the north at Lake Broadwater. The species, which feed almost exclusively on *Allocasuarina* seeds, may be attracted to large individual Woolly Oak (*Allocasuarina inophloia*) which are scattered throughout survey area 8 (particularly in areas with rock outcrop).

Black-chinned honeyeater (*Melithreptus gularis*): Black-chinned honeyeaters can be nomadic and move large distances. The species is known from within 50km of survey area 8, and may occur when canopy trees are in prolific flower. Areas of Queensland blue gum (*Eucalyptus tereticornis*) may be particularly attractive in the late winter months.

Koala (*Phascolarctos cinereus*): Koala's have been recorded twice within survey area 8, both in the southern portion of the land where Queensland blue gum (*Eucalyptus tereticornis*) is slightly more abundant. However the species is probably more widespread than currently known, and could occur throughout areas of remnant habitat accessing pockets of suitable feed trees. Further work would be required to understand the distribution and abundance of this species in survey area 8.

South-eastern long-eared bat (*Nyctophilus corbeni*): The south-eastern long-eared bat appears to be an area dependant species, requiring large tracts of near-contiguous vegetation. Vegetation within survey area 8, which is consistent with other areas where this species has been recorded, is immediately adjacent to a large area of state forest. Furthermore, recent surveys have located the species on survey area F, approximately 3.5 km to the south (Coffey *pers. comm*). These factors suggest that the species has a high probability of occurring.

Little pied bat (*Chalinolobus picatus*): The little pied bat inhabits forest vegetation. Large areas of remnant forest or woodland habitat on survey area 8 are consistent with this species preference, and it is well known from the local area (e.g., Lake Broadwater). The species is not likely to regularly occur in derived grassland habitats.

Migratory Fauna Species

One migratory fauna species have been observed within survey area 8:

- Rainbow Bee-eater, *Merops ornatus*.

Rainbow Bee-eater, *Merops ornatus*: Rainbow bee-eaters (*Merops ornatus*) are commonly observed within the region and inhabit a variety of habitats ranging from open woodlands to disturbed grazing land, but are generally uncommon or absent from dense vegetation. The species was only recorded twice on survey area 8, and observations may have represented individuals or small groups traversing over a broader area. On survey area 8 the species is most likely to occur in disturbed areas, including cleared.

From assessments made within Appendix E, important populations of migratory species are not likely to occur within survey area 8.

5.6.4 Survey area 7

General Description

Survey area 7 lies to the east of Dalby with its western boundary fringed by Kumbarilla State Forest. The riparian corridor of Wilkie Creek divides the property roughly into two halves with the floodplain forming a relatively broad expanse in the central portion of the property. A number of broad swampy drainage depressions are formed on the property which form part of the drainage network of Wilkie Creek. The property has been heavily fragmented with extensive clearing associated with prior agricultural activities. Survey area 7 occupies a total area of 3416 ha, although only 2753 ha is contained within the project development area and subject to assessment. Within assessed areas and based on revised mapping, survey area 7 contains 199 ha (7.2 %) of remnant vegetation, 34 ha (1.2%) of recent regrowth vegetation with a balance of 91.6% of the survey area that is cleared of vegetation. The survey area also contains 12.7 ha (0.4%) of vegetation listed as endangered under the EPBC Act, as further described below.

Associated Ecological Communities and Regional Ecosystems

Reference to **Table 3** indicates a total of 22 floristic survey sites recorded during field survey including eight secondary survey sites, and 14 descriptive quaternary sites.

EPBC Listed Ecological Communities: Whilst the most extensively fragmented of all properties proposed for development, it contains the most extensive representation of EPBC Act listed ecological communities of all. Within the property are:

- Weeping Myall Woodlands (Endangered).
- Coolibah –Black Box Woodlands (Endangered).
- Regrowth habitats of brigalow of sufficient development to be representative of the Brigalow Ecological Community.

The extent and distribution of EPBC significant habitats is described in relation to REs below.

Regional Ecosystems: A total of six REs are identified survey area 7. The surveyed extent of regional ecosystems with comparisons to certified RE mapping is provided within **Table 29.** Summary site data is provided in **Appendix H** and floristic descriptions for REs identified on the site are provided below. It should be noted that remnant vegetation defined within the 3D mapping database includes areas that would be considered 'mature regrowth' within datasets provided by EHP (2012b). Mapping of REs is represented wthin **Figure 20** with biodiversity status shown in **Figure 21.** Inconsistencies in RE mapping between revised mapping datasets and certified datasets (EHP 2012a and 2012b) are readily apparent. The most significant departures are the mapping of 55 ha of RE11.3.17 (endangered biodiversity status) along the Wilkie Creek riparian fringe in EHP data, which was not identified during field survey nor in revised mapping; and the recognition of 15 ha of RE11.3.3, 11.7 ha of which forms the Coolibah-Black Box Woodlands Ecological Community, within the revised mapping dataset. RE11.3.3 is not recognised in certified RE mapping.

Table 29. Regional ecosystems identified during field survey on survey area 7.

Regional Ecosystem	Bio-Status	Extent within Property (Field Suvey)(Ha)	Extent Within Property (EHP 2012a)	Extent Within Property (EHP 2012b)	Total Extent Within Property (EHP 2012a and 2012b)(Ha)
11.3.3*	Of concern	15.2 (11.7)*	0	0	0
11.3.2	Of concern	0	23.7	24.7	48.4
11.3.4	Of concern	54.4	0	0	0
11.3.14	No concern at present	18.7	0	0	0
11.3.17	Endangered	0	29.3	25.7	55.0

Regional Ecosystem	Bio-Status	Extent within Property (Field Suvey)(Ha)	Extent Within Property (EHP 2012a)	Extent Within Property (EHP 2012b)	Total Extent Within Property (EHP 2012a and 2012b)(Ha)
11.3.25	Of concern	5.5	0	0	0
11.3.27c	Of concern	4.1	0	0	0
11.5.1/ 11.5.1a	No concern at present	0	46.1	79.0	146.1
11.5.20	No concern at present	6.6	0	0	0
11.10.1d	No concern at present	100.2	0	0	0
11.7.4	No concern at present	0	62.4	29.2	131.6
Weeping Myall**	Non-remnant (Arbitrary status)	0.9	0	NA	NA
Regrowth Brigalow (> 15yrs) ***	No concern at present	0.9	0	NA	0
Recent regrowth and other disturbed vegetation	Non-remnant	33.5	0	NA	0
Cleared Land	Non-remnant	2520	2557.6	NA	2557.6

* Extent of Coolibah – Black Box Woodlands TEC where patch size > 5 ha.
** Weeping Myall Woodlands Ecological Community (not assigned an RE in EHP 2012d).
***Brigalow Ecological Community

Floristic Habitat Descriptions

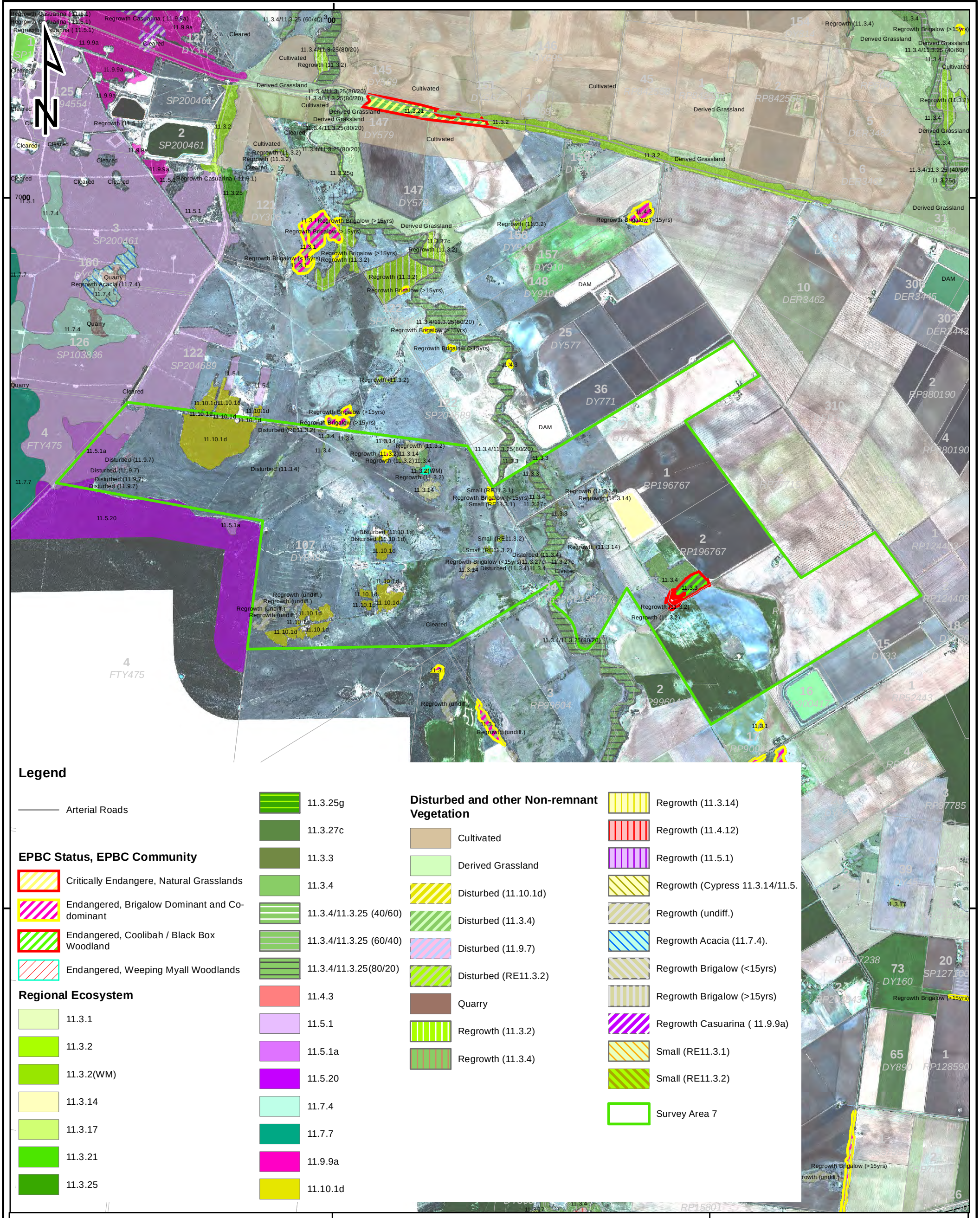
Table 30 provides floristic descriptions for the six REs and three ecological communities recorded on survey area 7 during the course of the survey. Habitat values for threatened flora species are indicated with further expansion provided in following sections. A total of 100 flora species were recorded during habitat assessments on survey area 7 comprising 87 native species and 13 exotic species which includes two species declared under the LP Act.

Threatened Flora Species

No flora species listed as threatened under the NC Act or EPBC Act were identified during the survey although the site contains potential habitat for a range of threatened flora species. These species, with potential habitat wihin the property are provided in **Table 31**. Further information on MNES species occurring within survey area 7 is provided within **Appendix C.**

Exotic (Pest) Flora Species

Within survey area 7, those habitats associated with land zone 10 (RE11.10.1d) and a lesser extent land zone 5 (RE11.5.1 are largely free from exotic species with the exception of scattered occurences of prickly pear (*Opuntia stricta),* a class 2 pest under the LP Act. Riparian habitats are degraded with infestations of (*Phyla canescens*) and other environmental weeds such as *Megathrysus maximus var. maximus*. Velvet tree pear (*Opuntia tomentosa),* a class 2 weed species forms an occasional shrub in alluvial habitats including RE11.3.25, 11.3.4, 11.3.3 and Weeping Myall Woodlands. Populations of these species can be identified during preclearance surveys and mitigations applied to prevent further spread (Section 17.6.3 of Surat Gas Project EIS, 2012).



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

DIGITAL CADASTRAL DATA BASE
© The State of Queensland (Department of Natural Resources) [2012]

Figure 20. Distribution of regional ecosystems and ecological communities on survey area 7

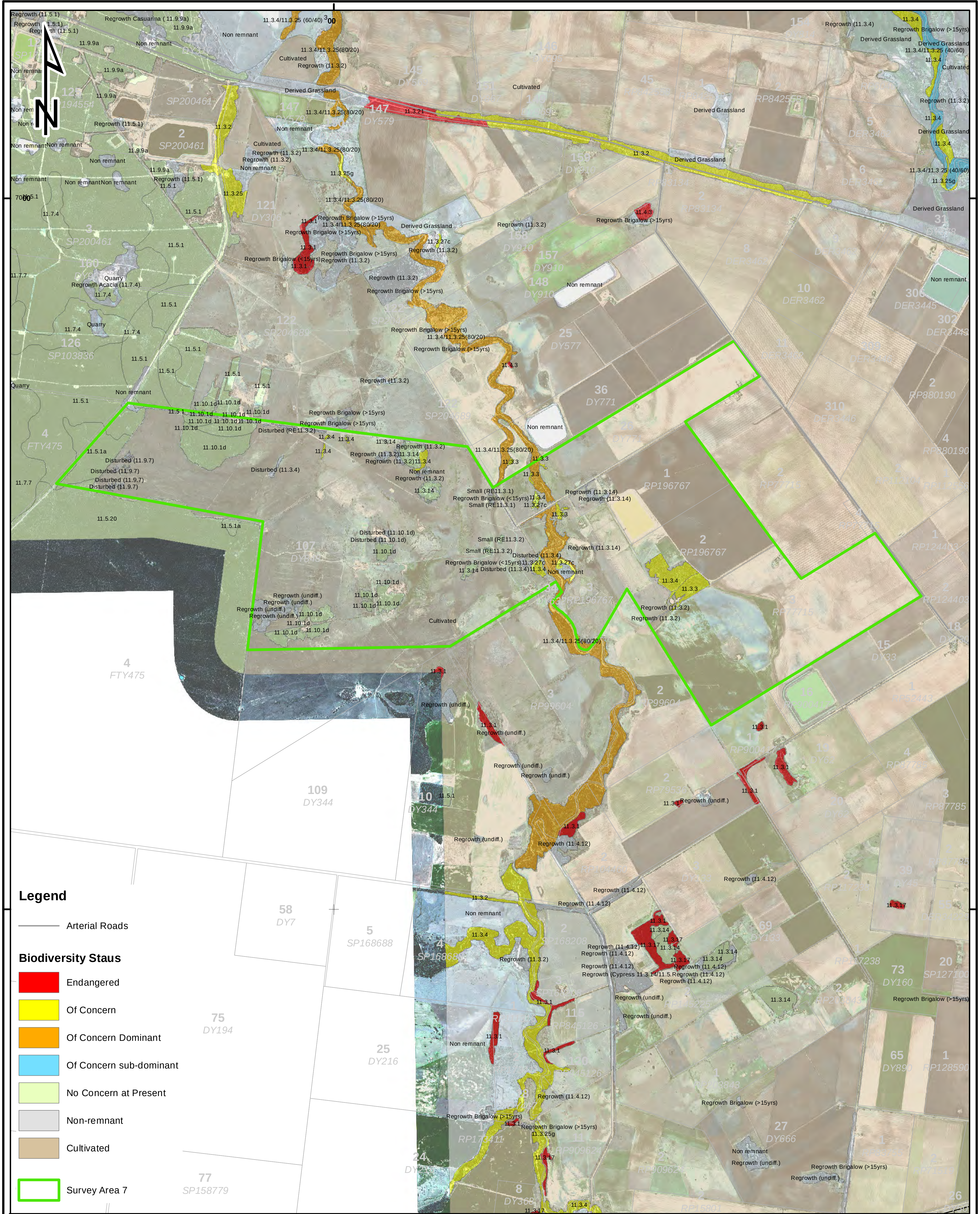
Client
Coffey Environments

0 900 1,800 2,700 3,600
Meters

Scale	1:49,388	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	Date	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



N O T E S:

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

DIGITAL CADASTRAL DATA BASE

Figure 21. Biodiversity status of vegetation in survey area 7

Client

Coffey Environments

0 900 1,800 2,700 3,600

Meters

3D Environmental
Vegetation Assessment
& Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale 1:49,388	**Drawn By** DG	**Checked** DS	**File Path** C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	**Date** 2/05/2013	A4

Table 30. Significant floristic habitats contained within survey area 7.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.3	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba*), finger panic grass (*Digitaria porrecta), Cyperus clarus, Eleocharis blakeana*.	***Eucalyptus coolabah woodland on alluvial plains.***  This woodland/open forest ecosystem is restricted in distribution occurring on alluvial overflow channels associated with major drainage lines within survey area 7. It occupies a relatively broad swampy flat (11.7 ha) to the east of Wilkie creek where the patch size is sufficient to warrant classification as the coolabah – black box ecological community. A number of minor slivers adjacent to riparian woodlands (RE11.3.25 and 11.3.4) or Wilkie Creek are not of sufficient patch size to qualtify for EPBC status. Coolibah (*Eucalyptus coolabah)* dominates a canopy which ranges between 8 and 19 m in height with cover ranging between 40 and 61%. A discontinuous second tree layer also features coolabah, and a sparse shrub layer consists of scattered coolabah saplings, river cooba (*Acacia stenophylla*) and belah (*Casuarina cristata*). The ground layer exhibits relatively poor condition throughout with heavy invasion of lippia (*Phyla canescens**) and couch grass (*Cynodon dactylon**). Native sedge, grass and forb species characteristic of the palustrine wetland habitat are out competed by lippia and impacted by past grazing pressure, reaching on average 39% total ground cover. Typical native species include *Eleocharis* spp., *Marsilea hirsuta, Eclipta procera, Cyperus concinnus,* and *Crinum* sp. Evidence of disturbance is also present through dead canopy trees which occur throughout. Large boled trees with spreading crowns typical of good condition remnant habitat are occasional within the habitat.
11.3.4	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba) Rutidosis lanata, Eleocharis blakeana* and *Fimbristylis vagans.*	***Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland*. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains. *Eucalyptus tereticornis* and/or *Eucalyptus spp. tall* woodland on alluvial plains.*** This community occurs on alluvial terraces and overflow depressions along Wilkie Creek where it fringes RE11.3.25. The canopy is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and/or Queensland blue gum *(E. camaldulenisis)* although rough-barked apple *(Angophora floribunda),* poplar box (*Eucalyptus populnea*) and Moreton Bay ash (*Corymbia tessellaris*) are locally common. The second tree layer is sparse and comprises the above canopy species and the sparse shrub layer of between 1-4 m features sally wattle (*Acacia salici, a),* and river myall (*Acacia stenophylla)*. The ground layer is often dominated by exotic species including giant panic (*Megathyrsus maximus var. maximus).*

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.14	Not known to provide specific potential for EVNT species occurrence.	**Eucalyptus spp., Angophora spp., Callitris spp. woodland on alluvial plains** RE11.3.4 occupies shallow sandy rises which rise above drainage depressions on the northern boundary of the property. The habitat comprises open forest (18-22 m) dominated by *Eucalyptus tereticornis* and *Angophora floribunda* with a dense native groundcover of *Lomandra longifolia*. From limited inspection, the ground cover was formed predominantly with native graminoids.
11.3.25/ 11.3.25g	No EVNT flora taxa are considered likely to be associated with this RE.	***Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland*. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.** Queensland blue gum (*Eucalyptus tereticornis* or *Eucalyptus camaldulensis)* to 30 m are the dominant canopy species, merging with a range of other eucalypts including *Angophora floribunda, Corymbia tessellaris* and *Corymbia intermedia.* Coolibah (*Eucalyptus coolabah*) forms an occasional species, merging with RE11.3.3 in some areas. Sparse shrub layers are typically formed by *Acacia stenophylla* and *Acacia salicinia.* Ground cover is typically formed by *Lomandra longifolia* with *Panicum spp., Eragrostis spp., Dichanthium sericeum, Bothriochloa decipiens, Chrysopogon filipes, Atriplex muelleri, Salsola kali, Tetragonia tetragonioides, Crinum uniflorum* and *Marselia* spp. Exotic species include giant panic (*Megathyrsus maximus* var. maximus)* and noogoora bur (*Xanthium occidentale).* The ecosystem also includes riverine waterbodies which are mapped as RE11.3.25g. Impounded waterbodies are mapped as non-remnant where they discernable.
11.3.27c	Provides potential habitat for *Cyperus clarus* and *Eleocharis blakeana*	**Palustrine wetland (vegetated swamp).** This habitat represents the overflow channels of Wilkie Creek which hold surface water on a seasonal basis. Those generally host native aquatic macrophytes such as *Ottellia ovalifolia, Damasonium minus, Azolla pinnata* and *Ludwigia pepaloides* subsp*. montevidensis.* Some of these features had been artificially dammed and exist in highly modified condition.
11.5.20	Not known to provide specific habitat for EVNT flora species.	***Eucalyptus moluccana* or *E. microcarpa* or *E. woollsiana* woodland to open-forest.** RE 11.5.20 was not sampled in detail, and is restricted to a narrow intrusion fringing with the adjacent state forest. On site, the ecosystem is represented by a woodland of 16-23 m in height dominated by grey box (*Eucalyptus woollsiana*) with associated narrow leaf ironbark (*E. crebra*). It occurs on low rises of old loamy plains. These tree species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.). A native groundcover is dominated by many-headed wire grass (*Aristida caput-medusae),* wire grass *(Aristida calycina),* love grass (*Eragrostis lacunaria*), barbed wire grass *(Cymbopogon refractus),* paspalidium *(Paspalidium sp.),* and windmill grass (*Chloris truncata*).

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.10.1d	Provides potential low quality habitat for Tara wattle and *Eucalyptus virens*	***Eucalyptus crebra* woodland on coarse grained sandstone.**  A number of broad low rises are formed in the central western portion of survey area 7, manifest as exposures of subtly outcropping coarse grained sandstone. The dominant habitat type comprises woodland of narrow leaved ironbark (*Eucalyptus crebra)* reaching hieghts of up to 18 m. A second tree layer of *Callitris glaucophylla, Allocasuarina luehmannii* and *E. crebra* is generally present with a shrub layer of *Callitris glaucophylla* and *Acacia conferta*. Sparse native dominated groundcover is present. The habitat has been heavily impacted by timber collection with few mature canopy trees remaining.
Weeping Myall	Provides potential habitat for lobed bluegrass (*Bothriochloa biloba*), finger panic grass (*Digitaria porrect),* toadflax (*Thesium australe)* amongst a range of other EVNT taxa	***Weeping Myall Woodlands.***  It should be noted that there is no RE associated with this community and it has been mapped as non-remnant in the RE mapping databases (both certified and revised mapping databases). This very restricted community occurs on alluvial plains in association with poplar box woodlands (RE11.3.2). It is a woodland ranging between and 8-12 m in height with a cover of 52%. The upper stratum is dominated by weeping myall (*Acacia pendula*) with scattered trees of poplar box (*Eucalyptus populnea*) and Queensland blue gum (*Eucalyptus tereticornis*). A sparse second tree layer and shrub layer is limited to occasional shrubs of weeping myall. The ground layer is dense and in good condition with a mean PFC of 86%, which is dominated (81%) by native species. Graminoids species such as *Panicum decompositum, Walwhalleya subxerophila*, and *Paspalidium* sp. dominate the cover with common native perennial herbs including *Commelina lanceolata, Pratia* sp., *Marselia drumondii*, and *Murdania gramineum*. Exotic species contribute 19% to the groundcover and are represented by lippia (*Phyla canescens**), with some limited occurrences of purple top Rhodes grass (*Chloris virgata**), and couch grass (*Cynodon dactylon**). The site is diverse supporting 53 species of which 46 are native and seven are naturalised. The majority of the species diversity occurs in the ground layer. The Weeping Myall Ecological Community is consistent with the EPBC description (TSSC 2008ac) existing as a small remnant in which it forms the dominant overstorey species and representing over 50% of trees present. Weeping myall also forms the subcanopy and shrub layers with patch size mapped as over 0.5 ha (0.86 ha). The community surveyed is in good condition with robust ground cover, high species diversity, healthy mature weeping myall trees which were recruiting in the lower structural layers. There is a low incidence of exotic species throughout.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
Regrowth Brigalow (> 15yrs)	Potential habitat for Belson's panic (*Homopholis belsonii)* and *Xerothamnella herbacea*	***Regrowth Brigalow > 15 yrs age.*** A single minor occurrence of regrowth brigalow of sufficient extent and development to warrant classification as an EPBC significant habitat is indicated on **Figure 20**. This habitat, which formed by a tall mix of brigalow and belah was subject to limited floristic sampling.

Table 31. Potential habitats for threatened species within survey area 7.

Species	Status			Habitat	Core Habitat Possible (Ha)	General Habitat (Ha)
	NC Act	EPBC Act	BoT			
Digitaria porrecta (*finger panic grass*)	NT	E	-	Core habitat potentially contained within RE 11.3.3.	16.0	2.7
Bothriochloa biloba (lobed blue grass)	Not listed	V	-	Core habitat potentially contained within REs 11.3.4, RE11.3.3	77.2	7.4
Eleocharis blakeana	NT	Not Listed	M	Core habitat potentially contained within RE11.3.3, 11.3.27, 11.3.25.	82.3	2.7
Cyperus clarus	NT	Not Listed	-	Core habitat potentially contained within RE 11.3.3	19.2	2.7
Fimbristylis vagans	NT	Not Listed	-	Core habitat potentially contained within RE 11.3.3	81.3	4.3
Tara wattle *(Acacia lauta)*	V	V	-	Core habitat potentially contained within RE11.10.1d	117.9	0
Eucalyptus virens	V	V	-	Core habitat potentially contained within RE11.10.1d	100.2	0
Belson's panic (*Homopholis belsonii)*	V	V	-	Core habitat potentially contained within regrowth brigalow habitat.	0.9	37.9
Xerothamnella herbacea	E	E	-	Core habitat potentially contained within regrowth brigalow habitat.	0.9	3.2

Fauna Habitats

Survey area 7 Methodology: No systematic surveying of survey area 7 was undertaken. This site was assessed via habitat assessment methods only. A total of three habitat assessments were undertaken across the site and as such, terrestrial vertebrate data is less comprehensive. Available information on habitats and possible EVNT taxa is summarised in **Table 32** below. Fauna habitats within survey area 7 can be broadly grouped into four units; woodlands, open grassy woodland (including riparian vegetation), brigalow/belah, and wetlands.

Table 32. Fauna habitats within survey area 7.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
OPEN GRASSY WOODLANDS		
11.3.4, 11.3.2, 11.3.25, 11.9.7, 11.9.9	rough collared frog (*Cyclorana verrucosa*) (likely), grey snake (*Hemiaspis damelii*) (possible)	The tall and open canopy of open grassy woodlands is dominated by Queensland blue gum (*Eucalyptus tereticornis*) and poplar box (*Eucalyptus populnea*); the former more likely to occur in riparian locations. Old senescing trees with abundant hollows are scattered throughout the habitat, and on balance, provide a large number and diverse range of hollows for hollow-obligate fauna. Shrubs such as wilga (*Geijera parvifolia*) and inland rosewood (*Alectryon oleifolius*) are uncommon, while the ground strata consists of dense grasses and herbs; fallen debris is not abundant.  Open grassy woodlands on survey area 7 are on balance, scattered, isolated and small in extent. Small fragments are more likely to be infested by environmental weeds (including exotic pasture grass) and hold significantly lower conservation value for fauna species. As such, much of this habitat will have low conservation value. Vegetation along Willkie Creek, which is dominated by Queensland blue gum (*Eucalyptus tereticornis),* is near continuous along the waterway forming a narrow winding corridor through the landscape. This vegetation may provide a movement route for many taxa, but particularly birds and larger mammals. Queensland blue gum (*Eucalyptus tereticornis*) can flower profusely during late winter, and provides an abundant resource of nectar and pollen to bird and selected mammal species (e.g., flying-fox species). Vegetation dominated by this tree species may attract high numbers of insectivorous birds during flowering events. Low-lying areas within this community will collect water, and therefore this habitat overlaps and forms a broad ecotone with many wetland habitats (see below). These areas are expected to provide ideal habitat for rough collared frog (*Cyclorana verrucosa*) and grey snake (*Hemiaspis damelii*).
WOODLANDS		
11.3.14, 11.5.1a, 11.5.20, 11.10.1d	golden-tailed gecko (*Strophurus taenicauda*) (likely), brigalow scaly-foot (*Paradelma orientalis*)	Woodlands have a canopy which can include poplar box (*Eucalyptus populnea*)*, spotted gum (Corymbia citriodora*)*, Angophora spp*. These trees occur at higher densities than open grassy woodlands, resulting in a much more continuous canopy cover, although large hollow-bearing trees are slightly less abundant. Nevertheless, there are many sheltering opportunities for medium to small hollow obligate species. The shrub layer can vary in density, but in generally includes a mix of medium-sized white cypress pine (*Callitris glaucophylla*)*, Acacia Luehmannii*, and in some areas *Acacia* species. Exfoliating bark, associated with the *Callitris* and *Acacia* is not uncommon, although scattered.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
	(possible), dunmall's snake (*Furina dunmalli*) (possible), south-eastern long-eared bat (*Nyctophilus corbeni*) (possible), little pied bat (*Chalinolobus picatus*) (likely)	On the ground, tussock grasses are common but rarely form a continuous cover. Fallen debris, including logs, is abundant. Woodland habitats are generally restricted to the western portion of the lot, and are near continuous with much larger tracts of vegetation extending into the adjacent State Forest. This connectivity to nearby habitats increases the value of this vegetation for fauna species. These habitats are typical of those inhabited by golden-tailed gecko (*Strophurus taenicauda*), brigalow scaly-foot (*Paradelma orientalis*), and little pied bat (*Chalinolobus picatus*). A number of other EVNT taxa can also occur in these types habitats, although they are generally less widespread or abundant across the landscape. 
BRIGALOW/BELAH		
Regrowth brigalow (>15 yrs).	glossy black-cockatoo (*Calyptorhynchus lathami*) (possible)	A single small and isolated patch of regrowth brigalow (>15y old) is located near the northern boundary of survey area 7. Due to access constraints these were not visually assessed during the survey. However, given their very small extent, and isolated nature, it is unlikely these areas hold value to fauna species. Their minor extent is unlikely to support permanent populations for most EVNT taxa, and similar patches in the region with a high area-to-edge ratio are infested by exotic pasture grasses. Should larger individual belah (*Casuarina cristata*) be present, these could provide a foraging resource for glossy black-cockatoo (*Calyptorhynchus lathami*), a species that will traverse large distances to access small patches of foraging resources.
WETLANDS		
11.3.27, 11.3.3 + non-remnant areas were surface water pools	rough collared frog (*Cyclorana verrucosa*) (likely), grey snake (*Hemiaspis damelii*) (possible)	Freshwater wetlands are scattered along the Condamine River flood plain. In areas were remnant vegetation remains, these are typically mapped as RE 11.3.27c (pictured). Large trees, usually Queensland blue gum (*Eucalyptus tereticornis*), provide abundant hollows and during winter can flower prolifically. Depending on water depth, wetlands can have a dense cover of native grasses and herbs, or open water. Both provide habitat for a variety of wetland bird species, including ibis, egrets and some ducks. Wetlands with small islands of vegetation and open mud edges, ideal for the scarce Australian painted Snipe (*Rostratula australis*), were not observed although access constraints prevented visual assessment along the length of Willkie Creek. Wetland habitats are also likely to have abundant frog communities including rough collared frog (*Cyclorana verrucosa*) and attract frog predators including grey snake (*Hemiaspis damelii*).

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		Access prevented thorough assessment of potential wetland areas along Willkie Creek, and hence a number of wetland areas may not have been visually assessed. 

Fauna Communities and Taxa of interest

Surveys identified a total of 21 species of vertebrate on survey area 7, including 2 frogs, 18 birds and 1 mammal. Common and widely distributed species included spotted marshfrog (*Limnodynastes tasmaniensis*), broad palmed rocketfrog (*Litoria latopalmata*), galah (*Eolophus roseicapilla*), weebill (*Smicrornis brevirostris*), striated pardalote (*Pardalotus striatus*), magpie-lark (*Grallina cyanoleuca*), and little corella (*Cacatua sanguinea*).

One exotic species, feral pig (*Sus scrofa*), was observed on survey area 7. It is possible a number of other exotic species are likely to occur.

No bioregionally significant species (as defined under the Brigalow Belt Biodiversity Planning Assessment; EPA 2008b) were recorded from survey area 7.

No Back on Track species were recorded on survey area 7 although **Table 33** indicates that a number may occur.

Threatened Fauna Species

February 2013 surveys at survey area 7 located no threatened species protected under state or federal legislation. Based on local records and habitat suitability, seven species have some potential to occur, as detailed in **Table 33**. Brief notes on the occurrence, or likely occurrence, of these species are discussed below.

Table 33. Potential threatened fauna species habitats potentially occurring on survey area 7, February 2013.

Scientific Name	**Common Name**	**Status**			**Occurrence ***	**Core Habitat Known (Ha)**	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
		NC Act	**EPBC Act**	**BoT**				
Cyclorana verrucosa	rough collared frog	NT	-	-	Likely	8.0	130.6	59.3
Hemiaspis damelii	grey snake	E	-	M	Likely	21.8	114.7	0
Strophurus taenicauda	golden-tailed gecko	NT	-	M	Likely	8.0	153.2	125.6
Paradelma orientalis	brigalow scaly-foot	V	V	M	Possible	0	151.4	130.5
Furina dunmalli	dunmall's snake	V	V	M	Possible	0	156.3	0
Nyctophilus corbeni	south-eastern long-eared bat	V	V	M	Possible	0	155.3	0
Chalinolobus picatus	little pied bat	NT	-	M	Likely	0	257.4	0

E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.

BoT (Back on Track); M = Moderate

*Known = A species record exists in the survey area. Likely = A species record exists within close proximity to the survey area and suitable habitat is present. Possible = A record is not present within close proximity to the survey area however suitable habitat is present.

Habitat for a number of other EVNT species is marginal and current information suggests there are no local records. These species have been excluded from the assessment but may require assessment if individuals are located during future activities.

Rough collared frog (*Cyclorana verrucosa*): Both open grassy woodlands and wetlands contain suitable habitat for rough collared frog (*Cyclorana verrucosa*). The species has been recorded within 900 m of the site and nine nine records are known from within 15 km. Low lying areas on cracking clay, particularly those that hold water, will provide ideal habitat for rough collared frog (*Cyclorana verrucosa*).

Grey snake (*Hemiaspis damelii*): The grey snake primarily forages on frog species, and therefore is most likely in habitats similar to the rough collared frog (*Cyclorana verrucosa*). Open grassy woodlands and wetlands will provide ideal habitat for this species. The grey snake (*Hemiaspis damelii*) has been recorded 900 m north of survey area 7 and five other records occur within 15 km of the survey area.

Golden-tailed gecko (*Strophurus taenicauda*): Golden-tailed geckoes (*Strophurus taenicauda*) are likely to occur through woodland habitats across survey area 7, particularly in areas where small Acacia is abundant. The species can therefore, occur in areas with historic disturbance. The species has been been recorded 900 m to the north and and addition 8 records are known within 15 km.

Brigalow scaly-foot (*Paradelma orientalis*): The brigalow scaly-foot (*Paradelma orientalis*) has been recorded on five occasions with 25km of survey area 7. Abundant suitable habitat occurs to the immediate west of the property, associated with state forest. This vegetation, which is consistent with brigalow scaly-foot (*Paradelma orientalis*) habitat preferences, extends onto the western portions of survey area 7.

Dunmall's snake (*Furina dunmalli*): While only a single record of dunmall's snake (*furina dunmalli*) occurs within 50 km (west) of survey area 7, the species is cryptic and rarely located even in areas where it is known to occur. Large patches of near-contiguous vegetation occur between known records and the western portion of survey area 7, which also contains suitable habitat for this speices. It is therefore possible that the species could occur.

South-eastern long-eared bat (*Nyctophilus corbeni*): The closest south-eastern long-eared bat record is located approximately 60 km to the west of survey area 7. Remnant vegetation between the record and survey area 7 is relatively well connected, forming a near-continuous large patch of remnant habitat. It is therefore possible that the species could be present in the western portions of survey area 7.

Little pied bat (*Chalinolobus picatus*): The little pied bat is relatively well known from the local area, with at least five records within 15km. The species inhabits woodlands and is likely in vegetation along the western portions of survey area 7.

Migratory Fauna Species

One migratory fauna species was been observed within survey area 7:

- Rainbow Bee-eater, *Merops ornatus*.

Rainbow Bee-eaters (*Merops ornatus*) are commonly observed within the region and inhabit a variety of habitats ranging from open woodlands to disturbed grazing land, but are generally uncommon or absent from dense vegetation. The species was only recorded once on survey area 7, and may have represented an individual or small group traversing over a broader area. On survey area 7 the species is most likely to occur over woodlands and disturbed areas, such as cleared land.

Based on information provided in Appendix E, it is unlikely that important populations of migratory species occur within survey area 7.

5.6.5 Survey Area F

General Description

Survey area F is located 6 km to the north west of Cecil Plains, occuring within an undulating landscape formed by low scarps and broad residual plains. Associated vegetation is fragmented with much of the flat arable land cleared for pastoral purposes whilst vestiges of remnant vegetation are associated with land zone 7 (ironstone jump-ups). The western boundary of the property is formed by an ephemeral drainage line with southern and eastern boundaries formed by public roads. Based on revised mapping, survey Area F comprises 99 ha of remnant vegetation (22 % of total survey area), 116 ha of recent regrowth vegetation (27% of total survey area) and 226 ha of cleared land (51% of total survey area).

Associated Ecological Communities and Regional Ecosystems

Reference to **Table 3** indicates a total of 10 floristic survey sites recorded during field survey including four secondary survey sites, and 6 descriptive quaternary sites.

EPBC Listed Ecological Communities: The Brigalow ecological community occurs on the property, comprising a single patch of 1.1 ha associated with RE11.4.3.The extent and distribution of EPBC significant habitats is described in relation to REs below.

Regional Ecosystems: A total of four regional ecosystems are identified on survey area F with distribution and biodiversity status shown in **Figure 22** and **Figure 23** respectively. The surveyed extent of regional ecosystems with comparisons to certified RE mapping is provided within **Table 34.** Summary site data is provided in **Appendix H** and floristic descriptions for REs identified on the site are provided below. It should be noted that remnant vegetation defined within the 3D mapping database (3D Environmental 2013) includes areas that would be considered ‘mature regrowth’ within datasets. A comparison between certified RE mapping (EHP 2013) and revised

mapping datasets indicates broad consistency in the distribution and extent of habitats, although EHP mapping does not account for small areas of significant vegetation, RE11.4.3 in particular.

Table 34. Regional ecosystems identified during field survey on Survey area F.

Regional Ecosystem	Bio-Status	Extent within Property (Field Suvey)(Ha)	Extent Within Property (EHP 2012a) (Ha)	Extent Within Property (EHP 2012b) (Ha)	Combined Extent (EHP 2012a and EHP 2012b)
11.3.2	Of concern	0	0	0.5	0.5
11.3.18	No concern at present	2.67	0.7	1.7	2.4
11.4.3**	Endangered	1.1	0	0	0
11.5.1	No concern at present	37.8	15.9	60.3	76.2
11.5.4	No concern at present	0	1	2.6	3.6
11.7.4	No concern at present	57.6	30.7	10.9	41.6
Recent regrowth and other disturbed vegetation	Non-remnant	115.7	0	NA	0
Cleared Land	Non-remnant	226.5	393.1	NA	393.1

**Brigalow Ecological Community

Floristic Habitat Descriptions

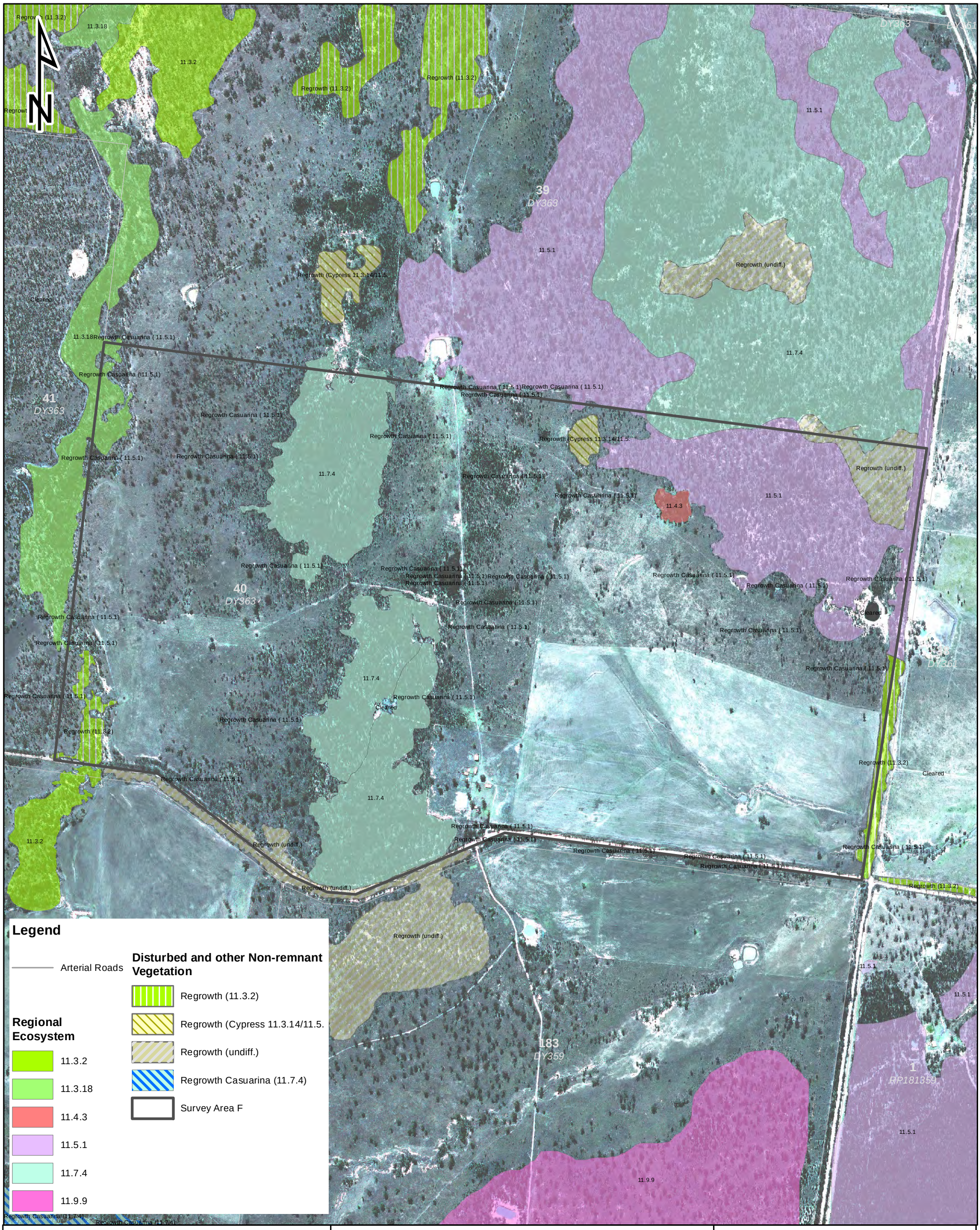
Table 35 provides floristic descriptions for the four REs recorded and ecological communities recorded on survey area F during the course of the survey. Habitat values for threatened flora species are indicated with further expansion provided in following sections. Sixty seven species were identified during the limited floristic survey undertaken on survey area 7. Of these, 8 exotic species including one species declared under the LP Act was recorded.

Threatened Flora Species

No flora species listed as threatened under the NC Act or EPBC Act were identified during the survey although the site contains potential habitat for a range of threatened flora species. These species, with potential habitat wihin the property are provided in **Table 36**. Further information on MNES species occurring within survey area F is provided within **Appendix C.**

Exotic (Pest) Flora Species

Habitats within survey area F possess few weeds although harissa cactus (*Harissia martini*) and velvet tree pear (*Opuntia tomentosa)* both class 2 declared species occur within the small vestige of RE11.4.3. Prickly pear (*Opuntia stricta)* (class 2) also occurs as a scatted plant throughout habitats within the survey area. Populations of these species can be identified during preclearance surveys and mitigations applied to prevent further spread (Section 17.6.3 of Surat Gas Project EIS, 2012).



Legend

Arterial Roads

Regional Ecosystem

- 11.3.2
- 11.3.18
- 11.4.3
- 11.5.1
- 11.7.4
- 11.9.9

Disturbed and other Non-remnant Vegetation

- Regrowth (11.3.2)
- Regrowth (Cypress 11.3.14/11.5.
- Regrowth (undiff.)
- Regrowth Casuarina (11.7.4)
- Survey Area F

NOTES:

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

Figure 22. Regional ecosystems and ecological communities on survey area F

Client

Coffey Environments

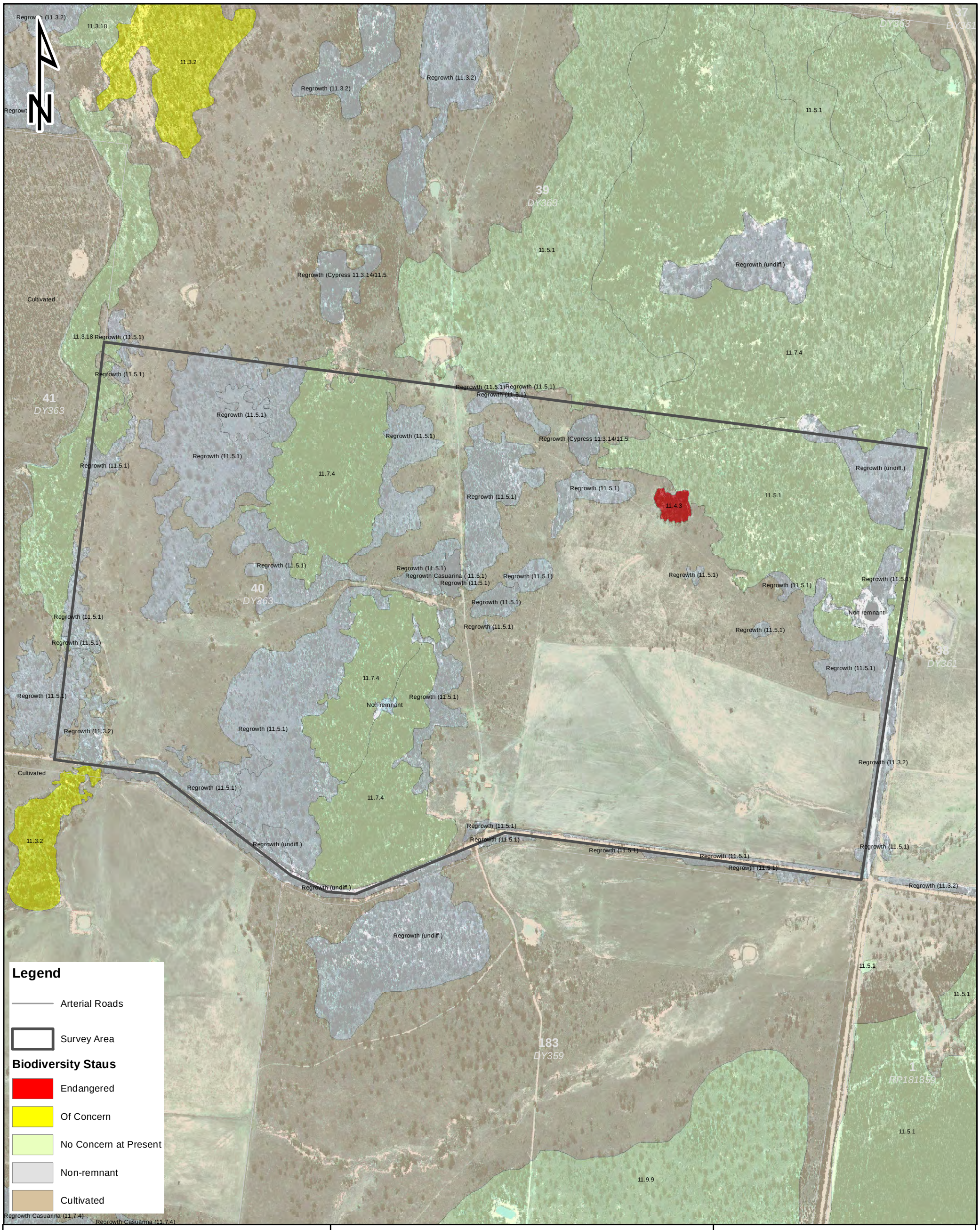
0 300 600 900 1,200

Meters

Scale	Drawn By	Checked	File Path	Date	
1:12,276	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



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

Figure 23. Biodiversity status of vegetation in survey area F

Client
Coffey Environments

0 300 600 900 1,200
Meters

Scale	Drawn By	Checked	File Path	Date	
1:12,276	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Table 35. Significant floristic habitats contained within Viilage F.

HABITAT		
RE	**Possible EVNT taxa**	**Description**
11.3.18	Provides potential habitat for Cobar greenhood orchid (*Pterostylis cobarensis)*	***Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium** RE 11.3.18 forms at the western boundary of Survey area F where it is associated with the flood plain of an ephemeral drainage line. *Eucalyptus populnea* dominates the canopy with associated *Callitris glaucophylla*. *Eucalyptus tereticornis* forms a component on the margins of the drainage channel. A second tree layer dominated by *Callitris glaucophylla* and scattered *Allocasuarina Luehmannii* is apparent. Despite impacts of grazing and some evidence of timber extraction, the ground cover is dominated by native graminoids which include *Aristida caput-medusae* and *Aristida acuta.* 
RE11.4.3	Provides potential habitat for *Xerothamnella herbacea* and Belson's panic (*Homopholis belsonii).*	***Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains.** A small remnant (1.1 ha) associated with a circular clay depression occurs within Property F where is is expressed as an open forest ranging in height from 14 – 18 m with a projected canopy cover dominated by brigalow of 60%. A sparse secondary shrub layer occurs also dominated by brigalow. Despite heavy grazing, both macropod and livestock, native perennial herbs comprise 51% of the vegetative ground covers with exotic grasses 23%. 
11.5.1/ 11.5.1a	Provides potential habitat for Cobar greenhood orchid (*Pterostylis cobarensis)* and general habitat for lobed blue grass *(Bothriochloa*	***Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.** The habitat has been previously described in relation to survey area 8. Survey area F represents a more open expression of the habitat, lacking the dense shrub layer of *Allocasuarina Luehmannii.* The canopy, although relatively tall (20 – 25 m), has been subject to heavy timber extraction and is thus discontinuous. The habitat was not surveyed in detail although native groundcovers dominated by *Aristida caput-medusae* were observed.

HABITAT			
RE	**Possible EVNT taxa**	**Description**	
	biloba).		
11.7.4	Provides potential habitat for *Calotis glabrescens,* Kogan waxflower (*Philotheca sporadica), Pomaderris coomingalensis* and plunkett mallee (*Eucalyptus curtisii).*	***Eucalyptus decorticans* and/or *Eucalyptus spp*., *Corymbia spp., Acacia spp*., *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust.** Previously described in association with survey area 8. Occurences on Survey area have been subject to extensive timber extraction and structural complexity has been heavily reduced which limits the REs habitat potential. The canopy comprises *Eucalyptus crebra*, with a low, mid-dense sub-canopy layer of *Callitris glaucophylla*.The habitat occupies a low scarp with indurated sandstone outcrop exposed at surface.	

Table 36. Potential habitats for threatened species within the Survey area F site.

Species	Status			Habitat	Core Habitat Possible (Ha)	General Habitat (Ha)
	NC Act	EPBC Act	BoT			
Bothriochloa biloba (lobed blue grass)	Not listed	V	-	General habitat contained within RE11.5.1 and regrowth from RE11.3.2.	0	41.8
Eleocharis blakeana	NT	Not Listed	M	Core habitat potentially contained within RE11.4.3. General habitat contained within regrowth from RE11.3.2.	1.1	4.0
Belson's panic (*Homopholis belsonii)*	V	V	-	Core habitat potentially contained within RE11.4.3 and general habitat in RE11.5.1 and Regrowth from RE11.3.2.	1.1	41.8
Xerothamnella herbacea	V	V	-	Core habitat potentially contained within RE11.4.3	1.1	0
Peterostylis cobarensis (Cobar greenhood orchid)	Not Listed	V	-	Core habitat potentially contained within RE11.5.1 and 11.3.18. Survey completed outside optimal period for detection.	40.5	0
Kogan waxflower (*Philotheca sporadica)*	V	v	-	Core habitat potentially contained within RE11.7.4 (low value habitat) and general habitat in RE11.5.1 and 11.3.18.	57.6	40.5

E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.

BoT (Back on Track); M = Medium

Fauna Habitats

Survey area F Methodology: No systematic surveying of survey area F was undertaken. This site was assessed via habitat assessment methods only. A total of three habitat assessments were undertaken across the site and as such, terrestrial vertebrate data is less comprehensive. Available information on habitats and possible EVNT taxa is summarised in **Table 37** below.

Survey area F is located approximately 3km east from the southern tip of survey area 8. Survey area 8 is bordered to its immediate west by large tracts of state forest with remnant habitats. Intervening vegetation between survey area F and survey area 8 comprises a mosaic of open grassy remnant habitats, regrowth, and non-remnant grazing land. No single patch of remnant vegetation between

these properties is isolated by more than 500 m, and most remnant vegetation is naturally relatively open. As such, a high proportion of fauna species inhabiting the local area will be adapted to open habitats, and the intervening disturbance regime is unlikely to have formed a significant movement barrier. Vegetation within survey area F therefore, is not significantly isolated. Three broad vegetation groups for fauna habitats can be recognised on survey area F (**Table 37**).

Fauna Communities and Taxa of interest

Surveys identified a total of 21 species of vertebrate on survey area F, including 2 reptiles, 15 birds and 4 mammals. A number of common species noted during the surveys including dubious dtella (*Gehyra dubia*), Burnett's skink (*Lygisaurus foliorum*) weebill (*Smicrornis brevirostris*), grey-crowned babbler (*Pomatostomus temporalis*), blue-faced honeyeater (*Entomyzon cyanotis*), red-winged parrot (*Aprosmictus erythropterus*), speckled warbler (*Pyrrholaemus sagittatus*), pretty-faced wallaby (Macropus parryi) and eastern grey kangaroo (*Macropus giganteus*).

No exotic species were located on survey area F. However it is expected that many including feral cat (*Felis catus*), and possibly feral pig (*Sus scrofa*), could occur.

One bioregional significant species (as defined under the Brigalow Belt Biodiversity Planning Assessment; EPA 2008a) was recorded from survey area F, speckled warbler (*Pyrrholaemus sagittatus*).

No 'Back on Track' species were detected on site although **Table 38** indicates that several possibly occur.

One culturally significant species was recorded from survey area F (NC Act 1992). The short-beaked echidna (*Tachyglossus aculeatus*), which can occur in a vast spectrum of habitats, is widespread and well known from the local area. Platypus (*Ornithorhynchus anatinus*) is considered unlikely to occur.

Threatened Fauna Species

February 2013 surveys at survey area F located no threatened species protected under state or federal legislation. Based on local records and habitat suitability, four species have some potential to occur, as detailed in **Table 38**. Brief notes on the occurrence, or likely occurrence, of these species are discussed below.

Table 37. Fauna habitats within survey area F.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
OPEN GRASSY WOODLANDS		
11.5.1		Located in the northeast corner of the property, this habitat is dominated by a tall (~20 m) open (~25% cover) canopy of narrow-leaf ironbark (*Eucalyptus crebra*). While still remnant, the vegetation has been thinned, and larger trees have been removed. As such, hollows in large sensing trees are largely absent from the area. Shrubs are limited, and the open conditions have allowed thick native grass cover to proliferate. Fallen debris is uncommon. There is evidence of grazing in this habitat, although seasonally favourable rainfall has masked the effects of grazing on the ground strata. Heavier impacts are likely during prolonged dry periods. The vertebrate community inhabiting this vegetation is likely to be adapted to open, sparsely vegetated areas, and as such, most species will be common and abundant in the local area. The likelihood of any EVNT species is limited.
WOODLANDS		
11.7.4	brigalow scaly-foot (*Paradelma orientalis*) (possible), little pied bat (*Chalinolobus picatus*) (possible)	Showing various signs of disturbance including areas of thinning, this habitat has a tall emergent canopy (~22 m) of narrow-leaf ironbark (*Eucalyptus crebra*) with a secondary dense canopy of white cypress pine (*Callitris glaucophylla)*. While some older trees are present, and stags are scattered throughout the area, generally hollows are poorly represented. Arboreal mammals are not expected to be abundant on survey area F. Shrubs are scattered, predominantly regrowth canopy elements or smaller white cypress pine (*Callitris glaucophylla*). The ground stratum includes native grasses such as *Aristida* spp and barbed wire grass (*Cymbopogon refractus*). The density of native grass varies from areas of high density to areas of moderate to low density, separated by bare ground or shallow leaf litter. In some locations, rocks are exposed on the surface, although most are consolidated. Fallen debris is clumped, common around fallen stags, but otherwise scattered and limited.  Although showing some signs of grazing disturbance, these habitats provide the greatest potential for EVNT taxa, and further trapping work should be done if these habitats are to be disturbed.
BRIGALOW		
11.4.3	Rough collared frog (*Cyclorana verrucosa*) (likely)	A small patch of brigalow on clay soils is located near the centre-north portion of survey area F. The relatively dense (~70% cover) and moderately tall (to ~18 m) brigalow canopy has few hollow-bearing trees, although exfoliating bark is relatively common on standing dead brigalow.

HABITAT		
Representative RE's	**Possible EVNT taxa**	**Description**
		Shrubs are limited, and the native grass cover is sparse (<50%). Fallen timber is abundant. During drying conditions, it is likely that this area will have deep soil cracks, which coupled with the fallen debris, would provide abundant sheltering opportunities for smaller terrestrial vertebrates. Typically, these habitats have rich small, terrestrial vertebrate communities, and is known habitat for a variety of EVNT taxa. However, due to its very limited extent, the likelihood of this area being inhabited by EVNT species is reduced. 

Table 38. Potential Threatened fauna species habitats potentially occurring on survey area F, February 2013.

Scientific Name	Common Name	Status			Occurrence*	Core Habitat Possible (Ha)	General Habitat (Ha)
		NC Act	EPBC Act	BoT			
Cyclorana verrucosa	rough collared frog	NT	-	-	Likely	1.3	182.4
Paradelma orientalis	brigalow scaly-foot	V	V	M	Possible	99.3	115.7
Chalinolobus picatus	little pied bat	NT	-	M	Possible	99.3	0
Nyctophilus corbeni	south-eastern long-eared bat	V	V	M	Known**	96.6	0

E = Endangered, V = vulnerable, NT = near threatened, LC = least concern.
BoT (Back on Track); M = Medium
*Known = A species record exists in the survey area. Likely = A species record exists within close proximity to the survey area and suitable habitat is present. Possible = A record is not present within close proximity to the survey area however suitable habitat is present.
** Reported to occur (Coffey Environments pers. comm.) although location data not verified.

Habitat for a number of other EVNT species is marginal and current information suggests there are no local records. These species have been excluded from the assessment but may require assessment if individuals are located during future activities.

Rough collared frog (*Cyclorana verrucosa*): The small area of brigalow on survey area F with clay soils provides suitable habitat for Rough collared frog (*Cyclorana verrucosa*). There are a number of records of this species within 5 km of the property both to the north and south.

Brigalow scaly-foot (*Paradelma orientalis*): Few records of brigalow scaly-foot occur within proximity of survey area F, the closest 15 km southwest in extensive areas of woodland habitat. Furthermore, grazing impacts to the ground strata are more obvious on this property, reducing the likelihood that remaining vegeation is of high value for the species. While these factors suggest the species may be slightly less likely to occur, habitat is generally suitable and the level of fragmentation (i.e., not separated by more than 500m) is within suitable thresholds for the species. It may therefore occur in remnant woodland habitats on Survey area F.

Little pied bat (*Chalinolobus picatus*): Little pied bats (*Chalinolobus picatus*) can occur in a variety of woodland habitats, including areas similar to those on Survey area F. Nearby records (>15 km) are known from large tracts of vegetation to the west.

South-eastern long-eared bat (*Nyctophilus corbeni*): Initial habitat assessments suggested this species was unlikely to occur. However recent surveys within the property have captured this species (Coffey Environments pers. comm.) and highlights the difficulty associated with using habitat assessment alone as a determinant of presence.

Migratory Fauna Species

No migratory species were recorded from survey area F. It is likely that rainbow bee-eater (*Merops ornatus*) will occur. Based on analysis provided in Appendix E, it is considered unlikely that any important population of migratory species is associated with survey area F.

6.0 Updates to EIS Findings

Section 6 supplements EIS survey findings with additional information based on results of the SREIS. It includes:

1. A comparison of EIS findings with those of the SREIS in light of field survey and additional desktop review (validation of EIS findings). This assessment has been confined to survey area 2 and survey area 9 where assessment has been most comprehensive with comments provided for other properties (**Section 6.1**).
2. Assessment of potential impacts to terrestrial ecological values identified in SREIS surveys (**Section 6.2**) and any relevant mitigation measures identified (**Section 6.3**).
3. An overview of habitat management requirements and recommendations on survey areas 2, 9, 8, 7 and F (**Section 6.4**).
4. Updates to sensitivity assessments for species occuring in the SREIS project development area as well as updates to 'likelihood of occurrence' assessments where these have changed from the original EIS assessment (**Section 6.5**).
5. Information on additional species or ecological communities not identified as occuring within the EIS where the assessment of habitat status in the project development area has been upgraded through either desktop assessment or field survey (**Section 6.6**).

It should be noted that revised criteria for sensitivity assessments, coupled with full profiles and impact significance assessments for MNES species and ecological communities is provided within **Appendix A.** General comments concerning impacts incurred to species and habitats contained within individual survey areas are contained in **Section 7** (Conclusions).

6.1 Validation of EIS Impacts

6.1.1 Survey area 2

Table 39 presents a comparison of EIS findings for a range of sensitive ecological values identified as occuring or potentially occuring on survey area 2. Comparisons between survey findings indicate the following points:

1. Revised vegetation mapping at 1:10 000 scale undertaken in the SREIS has resulted in a threefold and sevenfold increase in the extent of REs 11.3.4 and 11.3.25 respectively. This is largely due to limitations in the spatial scale of certified RE mapping (1: 100 000 scale) which fails to represent finer scale variations in REs. There is also considerable variation in the recognised extent of individual habitats between certified and revised vegetation mapping databases, which directly influences the extent of potential habitat represented for individual flora and fauna species.
2. An assessment of habitat value for sensitive fauna species indicates that comprehensive field survey has resulted in an upgrade of habitat value from ' core habitat possible' to 'core habitat known' for a range of sensitive species identified in field survey. No downgrade of habitat value from 'core habitat possible' to 'general habitat' or 'absence suspected' was facilitated through the results of field survey.

3. An assessment of floristic habitat value indicates that comprehensive field survey has failed to identify any listed species within the survey area. A downgrade in habitat value from 'core habitat possible' to 'general habitat' was undertaken for those species in which comprehensive search were undertaken within suitable habitats, and the species was not found. Other species, where confidence in survey effort and intensity may be lower due to unsuitable seasonal conditions have retained original habitat ranking value.

Table 39. Comparison of EIS and SREIS Assessments for sensitive ecological values on survey area 2.

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
Sensitive Regional Ecosystems* **				
2	RE11.3.4(of concern biodiversity status).	15.1 ha identified as occuring in certified RE mapping (DERM 2009)	56.1 ha identified in revised (1:10 000 scale) mapping	Greater definition provided to mapping of riparian vegetation has resulted in the true extent of this RE on survey area 2 to be identified.
2	11.3.25 (of concern biodiversity status).	4.5 ha identified as occuring in certified RE mapping (DERM 2009)	31.3 ha identified in revised (1:10 000 scale) mapping	Greater definition provided to mapping of riparian vegetation has resulted in the true extent of this RE on survey area 2 to be identified.
Sensitive Fauna Species** **				
2	South-eastern long eared bat (*Nyctophilus corbeni)*	Core habitat possible	Core habitat known.	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix D.**
2	Golden-tailed gecko (Strophurus taenicauda)	Core habitat possible	Core habitat known	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix G.** The survey also identified the suitability of recent regrowth habitats for the species and hence this will need to be accounted for in future assessments.
2	Black –chinned Honeyeater (*Melithreptus gularis)*	Core habitat possible	Core habitat known	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix G.**
2	Brigalow scaly-foot (*paradelma orientalis)*	Core habitat possible	Core habitat known	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
				possible' to 'core habitat known' as per mapping rules provided in **Appendix C.**
2	Little pied bat (*Chalinolobus picatus)*	Core habitat possible	Core habitat known	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix G.**
2	Dunmall's snake (*Furina dunmalli*)	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species is often difficult to detect in trapping surveys, the core habitat possible' habitat assessment has been retained.
2	Squatter pigeon (*Geophaps scripta scripta).*	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species highly mobile, the core habitat possible' habitat assessment has been retained.
2	Death Adder *(Acanthophis antarcticus)*	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species is often difficult to detect in trapping surveys, the core habitat possible' habitat assessment has been retained.
2	Square tailed kite *(Lophoictinia isura)*	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species highly mobile, the core habitat possible' habitat assessment has been retained.
2	Glossy black cockatoo *(Calyptorhynchus lathami)*	Core habitat possible	Core habitat known	Species was confirmed to occur on the property within remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix G.**
Sensitive Flora Species				
2	Cobar greenhood orchid (*Pterostylis cobarensis).*	Core habitat possible	Core habitat possible	Recognition of extensive areas of RE11.5.1 on survey area 2 dramatically increased the mapped extent of 'core habitat possible' for the species from 70 ha (EIS assessment based on certified RE mapping to 892 ha (SREIS assessment based on revised mapping). Despite survey effort, seasonal conditions were not suitable for comprehensive survey and habitat mapping could not be downgraded to 'general habitat).

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
2	Curly bark wattle (*Acacia curranii).*	Core habitat possible	General habitat	Extensive survey within suitable habitats did not locate the species. Hence 'core habitat possible' was downgraded to 'general habitat'.
2	Hando's wattle (*Acacia handonis).*	Core habitat possible	General habitat	Extensive survey within suitable habitats did not locate the species. Hence 'core habitat possible' was downgraded to 'general habitat'.
2	Waaje wattle (*Acacia barakulensis).*	Core habitat possible	General habitat	Extensive survey within suitable habitats did not locate the species. Hence 'core habitat possible' was downgraded to 'general habitat'.
2	Plunkett mallee (*Eucalyptus curtisii)*	Core habitat possible	General habitat	Extensive survey within suitable habitats did not locate the species. Hence 'core habitat possible' was downgraded to 'general habitat'.
2	*Callitris baileyi* (Bailey's callitris)	Core habitat possible	Core Habitat Possible	Callitris species identified on the survey lacked sufficient fertile material to allow the species to be identified with confidence. Core habitat possible has been retained.
2	Sandstone pricklebush (*Apotophyllum teretifolium*)	Core habitat possible	General habitat	Extensive survey within suitable habitats did not locate the species. Hence 'core habitat possible' was downgraded to 'general habitat'.
2	Wardell's wattle (*Acacia wardellii).*	Absence suspected	General habitat	Revision of mapping rules and desktop assessment, coupled with comprehensive field survey for the species resulted in upgrade of habitat mapping from 'absence suspected' to 'general habitat'.
2	Lobed blue grass (*Bothriochloa biloba*)	Core habitat possible	Core habitat possible	Greater definition to mapping of alluvial habitats in survey area 2, particulary through increase in the area of RE11.3.4 from 15 ha to 56 ha significantly increased the mapped extent of 'core habitat possible'. As surveys within RE 11.3.4 were not considered sufficiently comprehensive to discount the species, the 'core habitat possible' assessment for habitats has been retained.

* Based on the highest level of habitat suitability within survey area 2 from EIS datasets.

** Based on the highest level of habitat suitability within survey area 2 from SREIS datasets

*** Of concern or endangered biodiversity status

****Listed as Endangered, Vulnerable, Near Threatened under either NC Act or EPBC Act.

6.1.2 Survey area 9

Table 40 presents a comparison of EIS findings for a range of sensitive ecological values identified as occuring or potentially occuring on survey area 9. Comparisons between survey findings indicate the following points:

1. Revised vegetation mapping at 1:10 000 scale undertaken in the SREIS has refined the extent and location of a number of sensitive REs, as well as EPBC Act significant ecological communities. In particular:
    a. Representation of 14.6 ha of RE11.3.17 (endangered biodiversity status) not recognised in certified RE mapping (EHP 2012a and 2012b).
    b. Representation of 5.1 ha of RE 11.4.3 (endangered biodiversity status) a threatened ecological community (endangered) under the EPBC Act.
    c. General refinement in the extent and spatial distribution in a number of 'of concern' REs including RE11.3.2, 11.3.4, 11.3.25 and 11.3.27.
2. Field survey has resulted in an upgrade of habitat value for rough collared frog (*Cyclorana verrucosa)* from 'core habitat possible' to 'core habitat known'. Refined RE mapping has also recognised small areas of RE11.3.17, which are mapped as 'core habitat possible' for glossy black-cockatoo (*Calyptorhynchus lathamii).* This presents an upgrade from 'general habitat' as assessed in EIS surveys. No downgrade of habitat value from 'core habitat possible' to 'general habitat' or 'absence suspected' for any fauna species was facilitated through assessments made during field survey. As detailed trapping was not undertaken (due to weather constraints), some areas may be modified subsequent to future trapping efforts.
3. An assessment of floristic habitat value indicates that comprehensive field survey has failed to identify any sensitive species within the survey area. 'Core habitat possible' is indicated for two species, Belson's panic (*Homopholis belsonii)* and *Xerothamnella herbacea* which were previously assessed as 'absence suspected'. This is a direct result of a refinement of habitat mapping undertaken within the SREIS survey. No downgrade of habitat value from 'core habitat possible' to 'general habitat' or 'absence suspected' for any species was facilitated through the results of field survey.

Table 40. Comparison of EIS and SREIS Assessments for sensitive ecological values on survey area 9.

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
Sensitive Regional Ecosystems and Ecological Communities* **				
9	RE11.4.3 (endangered biodiversity status; endangered EPBC status)	1:40 000 RE mapping completed for the EIS survey did not recognise this habitat.	5.4 ha of this habitat confirmed to occur in targeted fied survey and refined 1:10 000 scale mapping.	Greater definition provided to mapping of habitats assisted identification of this habitat on the property.
9	RE11.3.17 (endangered biodiversity status)	1:40 000 RE mapping completed for the EIS survey did not recognise this	14.6 ha of this habitat confirmed to occur in targeted fied survey and	Greater definition provided to mapping of habitats assisted identification of this habitat on the property.

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
		habitat.	refined 1:10 000 scale mapping.	
9	RE11.3.2, RE11.3.4, RE11.3.25, RE11.3.27 (of concern biodiversity status)	1:40 000 RE mapping completed for the EIS survey recognised these habitats.	Revised 1: 10 000 scale mapping generally consistent with 1:40 000 scale mapping undertaken for the EIS.	Greater definition provided to habitats in refined 1:10 000 scale mapping assessment resulted in minor redistribution and changes to the extent of these habitats on the property.
Sensitive Fauna Species****				
9	Grey snake (*Hemiaspis damelii)*	EIS habitat mapping did not account for this species and habitats are mapped as 'absence suspected' across the entirety of survey area 9.	Failure to recognise 'core habitat possible' on survey area 9 is likely to be an oversight. Habitat mapping has been updated to reflect 'core habitat possible' within suitable habitats.	Not recorded during field survey although habitat assessed as suitable for the species. Habitats assessed as 'core habitat possible' where suitable habitat features exist (e.g. RE11.4.3, 11.3.17, 11.3.2, derived grasslands). While the mapping is restricted to remnant habitats, the species also has potential to occur in non-remnant habitats on low-lying cracking clays indicated by terrain mapping units Ia -Id, IIa - IId, and IIIa to IIId in the terrain mapping analyisis provided in the Surat Gas EIS (Chapter 12.3.6)..
9	Rough collared frog (*Cyclorana verrucosa)*	Core habitat possible	Core habitat known.	Species was confirmed to occur on the property within both remnant and non-remnant vegetation. Habitat mapping was upgraded from 'core habitat possible' to 'core habitat known' as per mapping rules provided in **Appendix G.**
9	Glossy black cockatoo (*Calypthorhynchus lathamii).*	General habitat	Core habitat possible	Habitat assessment resulted in an upgrade of habitat mapping from 'general habitat' to 'core habitat possible' within suitable habitats (RE11.3.17). 'General habitat' was retained within some habitats (RE11.5.20/ 11.5.1)**.**
9	Brigalow scaly-foot	Core habitat possible	Core habitat possible	Habitat suitability was confirmed during field survey although the species was not recorded. Habitat value mapping for the species has not been changed.
9	Black –chinned Honeyeater (*Melithreptus gularis)*	Core habitat possible	Core habitat possible	Habitat suitability was confirmed during field survey although the species was not recorded. Habitat value mapping for the species has not been changed.
9	Bulloak jewel (*Hypochrsops piceatus*	Core habitat possible	Core habitat possible	Habitat suitability was confirmed during field survey although the

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
				species was not recorded. The larval attendant ant was located during surveys which increases confidence that the species could occur. Habitat value mapping for the species has not been changed.
9	Little pied bat (*Chalinolobus picatus)*	Core habitat possible	Core habitat possible	Habitat suitability was confirmed during field survey although the species was not recorded. Habitat value mapping for the species has not been changed.
9	Dunmall's snake (*Furina dunmalli*)	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species is often difficult to detect in trapping surveys, the core habitat possible' habitat assessment has been retained.
9	Squatter pigeon (*Geophaps scripta scripta).*	Core habitat possible	Core habitat possible	Species was not confirmed during field survey although due to the fact that this species highly mobile, the core habitat possible' habitat assessment has been retained.
Sensitive Flora Species****				
9	Cobar greenhood orchid (*Pterostylis cobarensis).*	Core habitat possible	Core habitat possible	Field survey confirmed habitat suitability although the species was not recorded. 'Core habitat possible' status has been retained recognising further survey is required to identify populations within finalised impact footprints.
9	*Solanum stenopterum*	Core habitat possible	Core habitat possible	Field survey confirmed habitat suitability although the species was not recorded. 'Core habitat possible' status has been retained recognising further survey is required to identify populations within finalised impact footprints.
9	Blake's spikerush (*Eleocharis blakeana)*	Core habitat possible	Core habitat possible	Field survey confirmed habitat suitability although the species was not recorded. 'Core habitat possible' status has been retained recognising further survey is required to identify populations within finalised impact footprints.
9	Lobed blue grass (*Bothriochloa biloba*)	General habitat	General habitat	'General habitat' for the species is identified in both EIS and SREIS mapping datasets. Although the species was not located, pre-clearance survey is required to eliminate the possibility that the species will be impacted by infrastructure footprint.
9	Finger panic grass	General habitat	General habitat	'General habitat' for the species is identified in both EIS and SREIS

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
	(*Digitaria porrecta)*			mapping datasets. Although the species was not located, pre-clearance survey is required to eliminate the possibility that the species will be impacted by infrastructure footprint.
9	Belson's panic (*Homopholis belsonii)*	Absence suspected	Core habitat Possible	Refined vegetation mapping indicates remnant areas of RE11.4.3 and 11.3.17 which provide suitable habitat for the species. These habitats are recognised as 'core habitat possible' indicating that further survey is required to eliminate the possibility that the species will be impacted during development.
9	*Xerothamnella herbacea*	Absence suspected	Core habitat possible	Refined vegetation mapping indicates a remnant area of RE11.4.3 which provides suitable habitat for the species. These habitats are recognised as 'core habitat possible'. Further survey is required to eliminate the possibility that the species will be impacted during development.

Based on the highest level of habitat suitability within survey area 2 from EIS datasets.

** Based on the highest level of habitat suitability within survey area 2 from SREIS datasets

*** Of concern or endangered biodiversity status

****Listed as Endangered, Vulnerable, Near Threatened under either NC Act or EPBC Act.

6.1.3 Survey areas 7, 8 and F.

Whilst comprehensive survey of habitats within these properties was not undertaken, assessment results generally correspond to trends apparent in survey areas 2 and 9. Some pertinent points are noted below:

- Field survey and refinement of vegetation mapping has resulted in recognition of the Weeping Myall Woodlands and Coolibah –Black Box Woodlands Ecological Community in survey area 7. Neither of these were accounted for in either 1:40 000 scale vegetation mapping undertaken within the EIS nor EHP mapping datasets (EHP 2012a and 2012b).
- Small areas of the brigalow ecological community have been recorded on survey area 7, survey area 8 and survey area F which are not recorded in EHP datasets (EHP 2012a and 2012b). These habitats were identified within vegetation mapping produced for the EIS.

Within survey areas, habitat mapping was upgraded for five species based on the incorporation of additional survey records from both field survey and Arrow Databases. These are indicated in **Table 42**. All other habitat mapping values remain unchanged. Although reported to have been

recently captured on survey area F, habitat mapping for south-eastern long-eared bat has not been upgraded to core habitat known as no locational data has been supplied for verification.

Table 41. Updates toEIS and SREIS Assessments for sensitive ecological values on survey areas 7 and 8.

Survey Area	Sensitive Ecological Value	EIS Assessment*	Updated SRIES Assessment**	Comments
Sensitive Regional Ecosystems and Ecological Communities* **				
7	Weeping Myall Woodland Ecological Community	1:40 000 RE mapping completed for the EIS survey did not recognise this habitat.	0.85	Greater definition provided to mapping of habitats assisted identification of this habitat on the property.
7	Coolibah –Black Box Woodlands Ecological Community	1:40 000 RE mapping completed for the EIS survey did not recognise this habitat.	11.5 ha of this habitat confirmed to occur in targeted fied survey and refined 1:10 000 scale mapping.	Greater definition mapping and field survey efforts assisted identification of this habitat on the property.
Sensitive Fauna Species** **				
7	Grey snake (*Hemiaspis damelii)*	Core habitat Possible	Core habitat Known	Not recorded during field survey although AED record on adjacent property resulted in attribution of core habitat known in the northern section of this property.
7	Rough collared frog (*Cyclorana verrucosa)*	Core habitat possible	Core habitat known.	Not recorded during field survey although AED record on adjacent property resulted in attribution of core habitat known in the northern section of this property.
8	Golden-tailed gecko (*Strophurus taenicauda*)	Core habitat possible	Core habitat known	Not recorded during field survey although AED record on adjacent property resulted in attribution of core habitat known in the northern section of this property.
8	Glossy black-cockatoo (*Calyptorhinchus lathami*)	Core habitat possible	Core habitat Known	Not recorded during field survey although Queensland Wetlands Database record on adjacent property resulted in attribution of core habitat known in the northern section of this property.
8	Square tailed kite (*Lophoictinia isura)*	Core habitat possible	Core habitat Known	Not recorded during field survey although Queensland Wetlands Database record on adjacent property resulted in attribution of core habitat known in the northern section of this property.

*Based on the highest level of habitat suitability within survey area 7 and 8 from EIS datasets.

** Based on the highest level of habitat suitability within survey area 7 and 8 from SREIS datasets
*** Of concern or endangered biodiversity status
****Listed as Endangered, Vulnerable, Near Threatened under either NC Act or EPBC Act.

6.1.4 Implications for Impact Management

The following implications for ecological impacts imposed by development activities are apparent from preceding information.

1. Failure to account for fine scale variation in vegetation through refinement of certified RE mapping (EHP 2012a and 2012b) may result in impacts to sensitive REs or EPBC Act listed ecological communities that are not identified in existing mapping databases. Fine scale vegetation mapping should be undertaken prior to development to ensure sensitive areas are adequately identified and accounted for.
2. Whilst comprehensive survey for sensitive flora species may result in downgrade in the recognised value of habitat in some circumstance, it is much more difficult to do so for fauna species where animal mobility and varying seasonal conditions means that species can be much less reliably detected. Hence whilst 'core habitat possible' has been downgraded to 'general habitat' for some flora species in survey area 2, it has not been possible to do so for fauna species.

The results and implications are largely consistent with the desired objective of the 'framework approach', being "once the site is ground truthed, and where further constraints are discovered, the site will re-enter the planning phase and the site adjusted to avoid the initial constraint (Section 1.2)". For both survey area 2 and survey area 9, detailed ground survey has resulted in a greatly refined understanding of the constraints on the site, allowing detailed planning to reduce impacts to sensitive habitats.

Once the most appropriate infrastructure location is identified, the following procedure should be followed:

1. Pre-clearance survey of the proposed infrastructure footprint including an appropriate buffer area.
2. Targeted preclearance survey in all areas identified as 'core habitat known', 'core habitat possible' and 'general habitat' for species indicated within habitat mapping datasets including updated mapping produced for SREIS studies (3D Environmental 2013).

6.2 Additional Potential Impacts Identified During SREIS Assessment

Release of Coal Seam Gas Water into Watercourses: The release of coal seam gas water into riverine systems of the Condamine River (survey area 9) and Bottletree Creek (survey area 2) will artificially regulate the flow in these systems, most noticeably in Bottletree Creek where natural flow regimes are likely to be much lower volume than in the larger Condamine system. Flow regulation,

particularly smoothing of seasonal flow variation, can have a number of impacts on riparian habitats. These impacts may include:

- A simplification of the instream channel environment including a drowning of semi-aquatic vegetation associated with riverine gravel bars, most noticeably habitats dominated by matrush (*Lomandra longifolia)*.
- Simplification of channel form through erosion of meander bends and undercutting of channel banks. This may result in slumping of stream banks and ultimately an increase in treefall and erosion.
- Changes to edaphic condition on the margins of streams which may result in changes to vegetation structure and composition. This may include senescence of some species sensitive to prolonged wetting (potentially smooth barked apple, *Angophora floribunda* on Bottletree Creek) an increase in herbs (and potentially weeds) on the direct margins of the watercourse.
- Decreased amphibian abundance and increased cane toad abundance should creek flows alter from ephemeral to permanent.

Due to the heavily impacted nature of the Condamine River riparian habitats, with dense weed infestations of lippia (*Phyla canescens)* and exotic grasses (e.g. *Megathyrsus maximus var. maximus)* impacts to these habitats will be less noticeable than those incurred on Bottletree Creek where habitats are intact with natural floristic composition and structure. These impacts will also spread throughout habitats downstream from the discharge point for as far as increased flow rates are maintained.

6.3 Additional Mitigation Measures

A number of mitigation measures were identified to assist management of impacts to flora and fauna species. These are discussed throughout profiles presented in **Appendix C** and **D**. Specifically these include:

- Recommendations for survey effort when working within areas of potential habitat for flora and fauna species. These are targeted towards detection of specific growth forms for flora (herb, grasses, shrubs and trees) and survey methods tailored toward detection of individual fauna species.
- Develop fire plans for production facilities. Where fire susceptible EVNT species are identified in areas adjacent to facilities, wells and pipeline infrastructure, minimise the fragmentation of populations and adjacent habitat to allow natural fire movement.

6.4 Management of Habitats in Survey Areas

The following section provides an overview of recommended management procedures for survey areas.

6.4.1 Management of Habitats in Survey Area 2

These surveys have shown that survey area 2 has high fauna values; it is known to provide habitat for at least 6 EVNT fauna taxa, including two MNES species; is likely to provide habitat for a number of other threatened species; has high vertebrate diversity (180 species recorded during the survey period); and is located in a broad matrix of habitats forming one of the largest remaining near-contiguous patches of vegetation in the southern Brigalow Belt (EPA 2008). The current status of weeds and other deleterious environmental processes are low.

Priority areas of management for survey area 2 are shown in **Figure 24.** All areas of remnant and regrowth vegetation contain 'core habitat known' or 'core habitat possible' for both EPBC Act and NC Act listed taxa. However, the management areas depicted recognises that remnant vegetation has greater intrinsic value over regrowth vegetation. Further, remnant vegetation may support higher densities of EVNT than regrowth habitat, and as such, remnant vegetation should be retained as the priority. This detailed mapping is only possible due to the level of investigation undertaken on survey area 2, and may not be applicable to other survey areas[2].

Activities within this property will require careful consideration of these environmental values, and should aim to restrict development to areas of cleared land, or areas of shrubby regrowth (**Figure 11**) if practical. While indirect impacts may be mitigated through strategies outlined in the EIS, the loss of remnant or advanced regrowth vegetation will require offsets compliant with the Biodiversity Offset Policy for a number of taxa. To ensure a 'no net loss', offset areas should aim to provide ecologically similar habitats, which in the case of area-dependant fauna (e.g., south-eastern long-eared bat, *Nyctophilus corbeni*), could be problematic. To appropriately offset habitat loss on survey area 2, offset should be sort within, or immediately adjacent (i.e., directly connected to), the aggregated vegetation of Barakula State Forest.

Advanced regrowth habitat is absent of weeds and likely to trend toward remnant status. In their current condition, these areas are likely or known to be inhabited by a number of EVNT taxa. Regrowth vegetation on survey area 2 is currently not mapped as 'advanced regrowth', and is not protected under legislation. As such, this vegetation provides an excellent opportunity for offset allocation.

Water discharge into Bottletree creek is expected during operation. Increased growth of riparian and/or aquatic vegetation, favouring some native and/or exotic species could lead to some geomorphic changes including trapping of sediment, reduced channel capacity and channel migration. Bank erosion may also facilitate tree fall through bank collapse creating a niche for exotic species invasion. Generally, fauna is relatively tolerant of modified ephemeral flows, but may be susceptible to significant variation from background water quality. Permanent flow within the creek will modify existing ecological processes, possibly resulting in the incursion of non-endemic species. Permanent flows may also not be beneficial to some existing inhabitants (e.g., frog species which are typically associated with ephemeral waterbodies in the Brigalow Belt).

[2] Survey areas 7, 8, 9 and F have not been subjected to detailed field investiations, and as such, priority mapping must follow criteria based on interpretation of EVNT mapping. Management priority areas on these properties are based on a different set of criteria.

Upstream weed infestation can be exacerbated by increase water flows spreading weed propagules and infestations downstream. Increased flow within Bottletree Creek has the potential to spread weeds and therefore strict weed control and monitoring may be required.

Discharge regimes should be developed once the location of a discharge point is known. These should consider the protection of geomorphic values to preserve the natural rates of sedimation and erosion. Water quality should be similar to the natural variations of the receiving environment.Whilst outside the scope of this assessment, careful consideration must also be given to the location and construction of any infrastructure leading to survey area 2 (e.g., roads, pipelines etc). These have the potential to fragment existing habitats and populations, which may be detrimental to area sensitive taxa (e.g., the south-eastern long-eared bat (*Nyctophilus corbeni*).

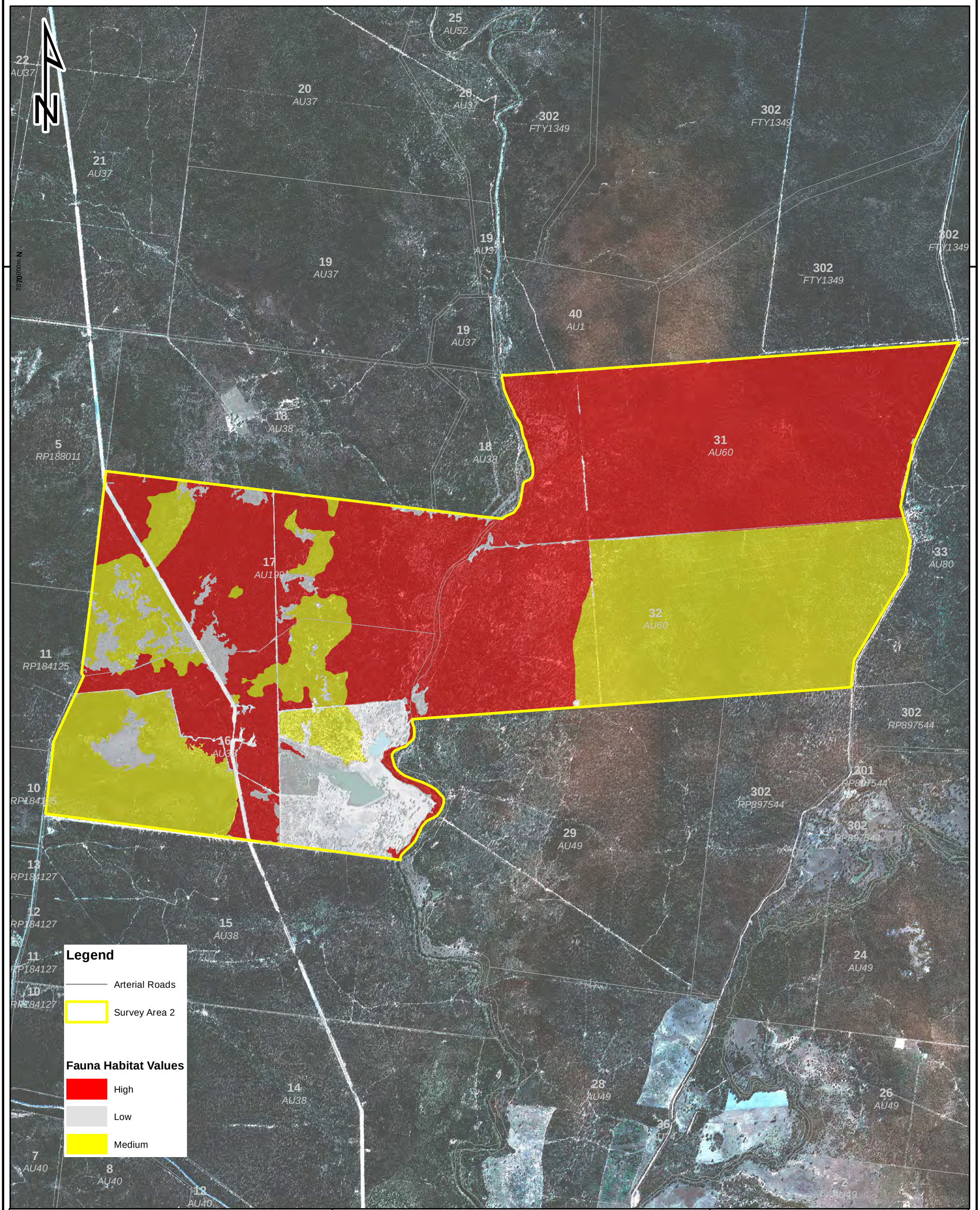
6.4.2 Management of Habitats in Survey Area 9

Confirmation of bulloak jewel attendant ant in habitat on survey area 9 is a noteworthy discovery. It significantly increases the likelihood that this extremely restricted and rare butterfly, known from only two extant populations (Curtis et al. 2012), could occur.

The life-cycle of the butterfly is complex, and requires not only retention of old-growth bulloak (*Allocasuarina luehmannii*) with hollows, but also populations of their attendant ant. The ant, which seems to be associated with abundant fallen debris, may be susceptible to a number of threats including:

- Minor changes in ground strata composition and in particular weed invasion.
- Reduced fallen debris resulting from fire.
- Grazing activities, which can destroy ground structure and trample fallen debris.
- Changes to ant community composition, which can be caused by a variety of (often subtle) impact pathways including increased/decreased flooding, increased light penetration, increased wind, reduced seeding, and changes to the ground stratum.

Accordingly, even small and minor impacts such as roadways or gas acquisition lines could inadvertently either result in the loss of individual ‘nest’ trees (i.e., trees with hollows), or affect ant communities. Further, these indirect impacts (weed infestation, light penetration, etc) resulting from clearing may affect a much broader area. The bulloak jewel (*Hypochrysops piceatus)* is therefore considered to be highly sensitive to anthropogenic disturbance.



NOTES:

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

Figure 24. Priority fauna conservation areas on survey area 2

Client

Coffey Environments

0 900 1,800 2,700 3,600

Meters

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:33,297	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	12/06/2013	A4

An existing pilot well has been located within the bulloak (*Allocasuarina luehmannii*) patch on survey area 9, and has facilitated the spread of exotic pasture grass into the vegetation. The continued spread of weed in this area threatens to alter the ground strata to the detriment of attendant ant colonies. Further survey work, which may require several surveys under suitable conditions, should occur in order to verify the presence of the butterfly. If identified, remedial actions should be undertaken to ensure the habitat is protected.

Rough collared frogs (*Cyclorana verrucosa*) were commonly located in open flooded non-remnant grasslands on survey area 9 and these areas are also likely to be inhabited by grey snake (*Hemiaspis damelii*). Avoidance of all possible non-remnant habitat for these species is not feasible, however development plans should aim to avoid remnant wetlands (e.g., RE 11.3.27). Offsets would be required if remnant wetland habitats are lost.

Non-remnant patches of large belah are present or scattered across the northern portion of survey area 9. Careful inspection for feeding remains of the glossy black-cockatoo (*Calyptorhynchus lathami*) was not possible due to flooding, but should occur in disturbance areas to determine presence. Detailed field investigation using standard trapping methods has not been undertaken on survey area 9, and detailed mapping of priority management areas is thus difficult. General habitat value mapping has been undertaken based on the following criteria represented in **Figure 25.**

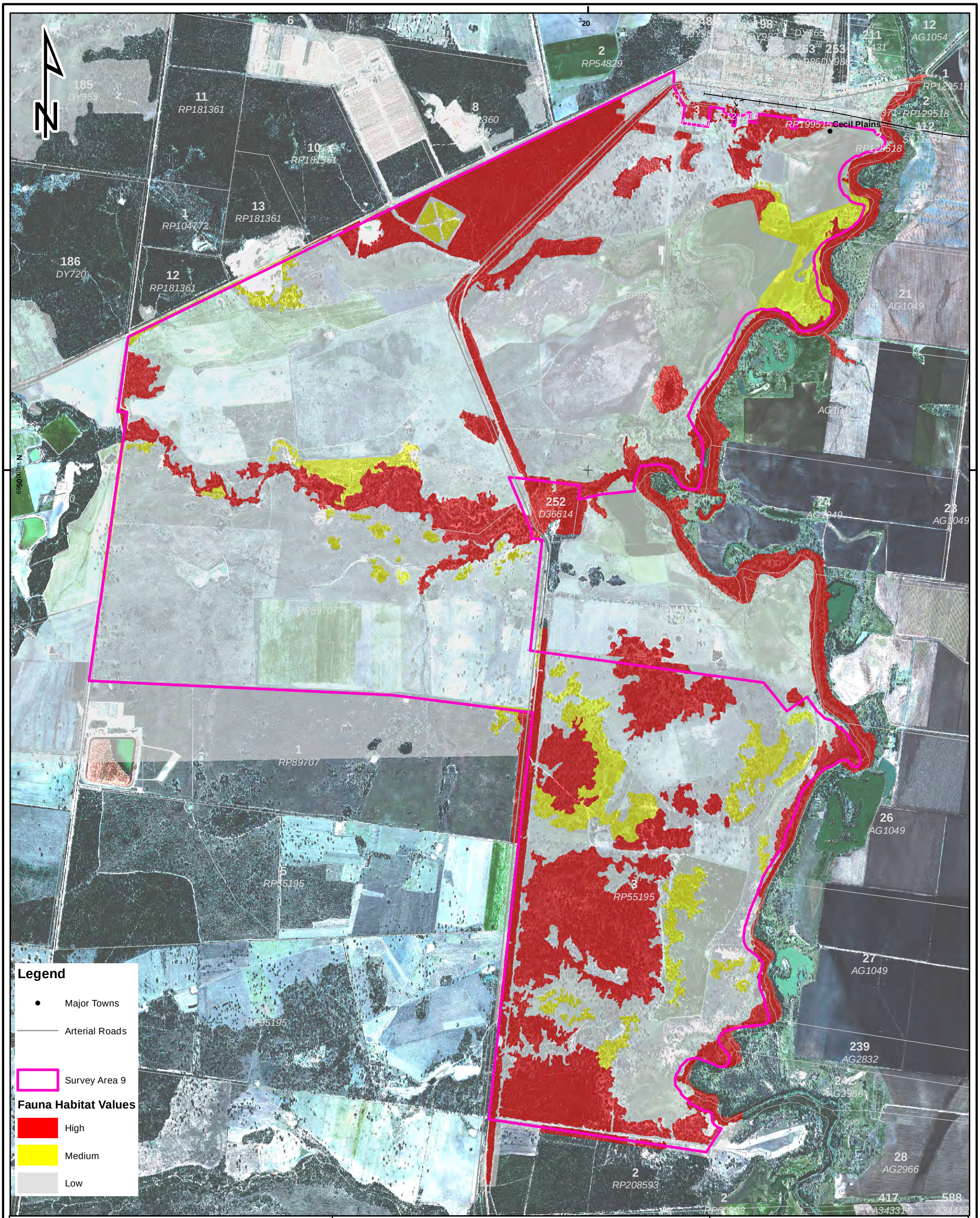
1. Intact (remnant) habitats mapped as 'core habitat known' or 'core habitat possible' for EPBC or NC Act listed species are mapped as 'high value' habitats.
2. Disturbed regrowth habitats mapped as as 'core habitat known' or 'core habitat possible' for listed species which are mapped as 'moderate value'.
3. Other habitat such as cleared agricultural and cultivated land is mapped as 'low value'.

Placement of infrastructure in areas of 'high' or 'moderate' value may necessitate a need for biodiversity offsets or further detailed investigation should be undertaken to evaluate the presence/absence of potentially occuring species. Based on current field investigations, opportunities for habitat offset within survey area 9 seem limited and it should be noted that known habitat for one species, rough collared frog (*Cyclorana verrucosa)* is already known to occur.

Water discharge into the Condamine River is expected during operation. Discharge regimes should be developed once the location of a discharge point is known. These should consider the protection of geomorphic values to preserve the natural rates of sedimation and erosion. Water quality should be similar to the natural variations of the receiving environment.

6.4.3Management of Habitats in Survey Area 8

The number of potential EVNT taxa, and excellent condition of vegetation within remnant habitats of survey area 8, suggest that the area is likely to contain significant habitat. Although there has been some existing disturbance with the placement of a wellhead in the local area, it is recommended that an avoidance policy be implemented on all remaining remnant habitats and



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

Figure 25. Priority fauna conservation areas on survey area 9

Client
Coffey Environments

0 700 1,400 2,100 2,800
Meters

Scale	Drawn By	Checked	File Path	Date	
1:30,142	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

areas of derived grassland. If unavoidable, detailed work (including trapping) should be undertaken to appropriately evaluate potential impacts, and determine if offsets are required.

Detailed field surveys on survey area 8 have not been undertaken as part of this works. However, habitat assessment based on EVNT habitat mapping criteria defined in **Section 6.4.2** has been undertaken indicating that large areas of remnant habitat, mapped as 'high' value may be suitable for several threatened species **(Figure 26**) and clearing of these areas is likely to necessitate a requirement for habitat offsets.

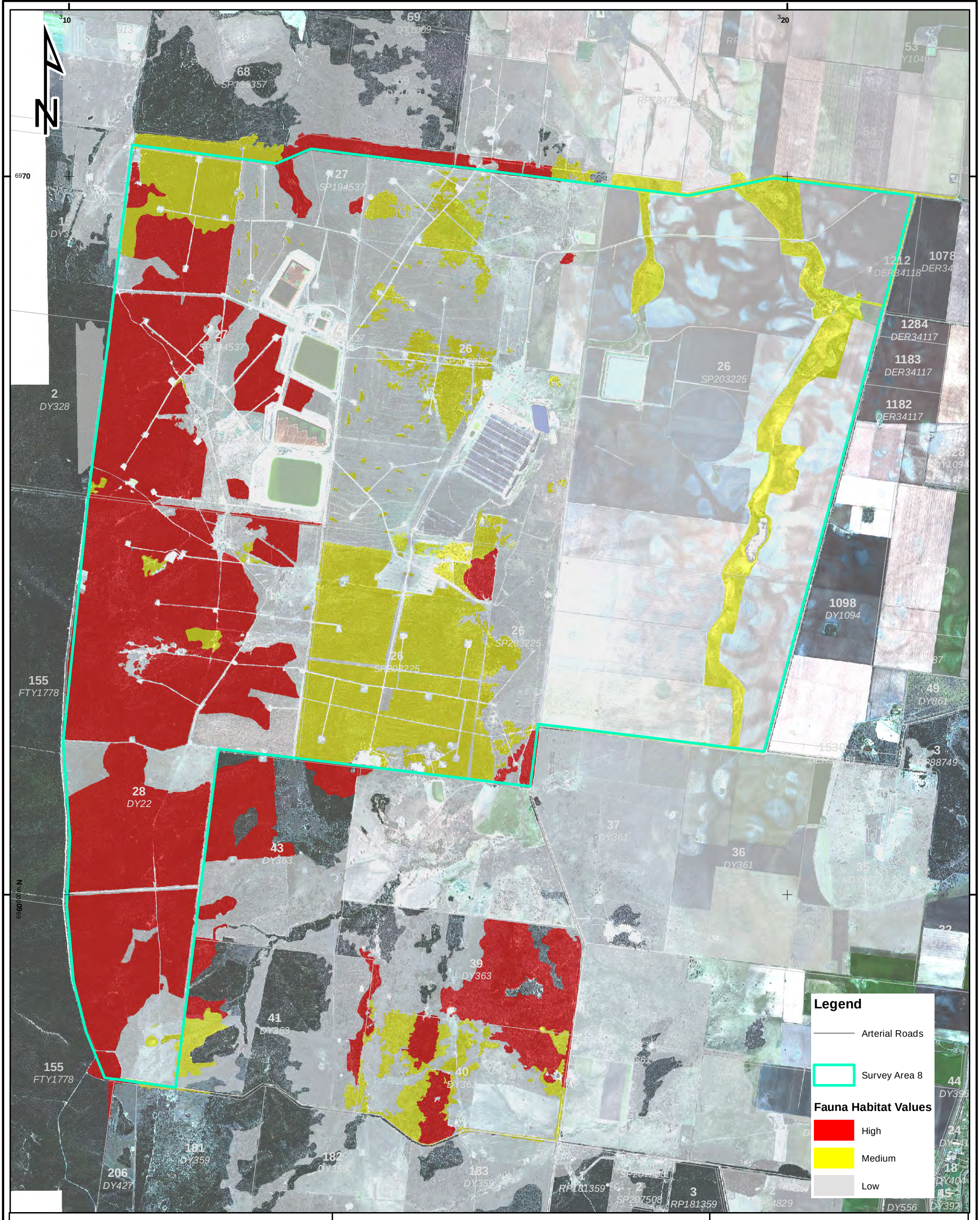
No Back on Track species were recorded on survey area 8, however there is the potential for glossy black-cockatoo (*Calyptorhynchus lathami*) and a number of other species to occur. Should clearing of vegetation with woolly oak (*Allocasuarina inophloia*) be required, surveys should be undertaken for this species. Consideration could also be given to improving existing operations within survey area 8. It was noted during the survey that gathering lines remain relatively open and bare and movement of ground dwelling fauna over these lines could be improved if the area is seeded with native grasses and herbs.

6.4.4 Management of Habitats in Survey Area 7

Habitats within survey area 7 could support a number of EVNT taxa, although areas of high value for EVNT are generally restricted to larger patches of vegetation in the west. In particular patches of RE 11.5.1a, 11.5.20 and 11.10.1d (i.e. woodland habitats) are nearly contiguous with the adjacent state forest (separated by a dirt road) and have habitat characteristics in common with areas inhabited by golden-tailed gecko (*Strophurus taenicauda*), brigalow scaly-foot (*Paradelma orientalis*) and little pied bat (*Chalinolobus picatus*). These species have a high likelihood of occurring. Amongst a number of other species, Dunmall's snake (*Furina dunmalli*) and south-eastern long-eared bat (*Nyctophilus corbeni*) may possibly occur, although these species are less abundant in the landscape and therefore less likely.

Habitats in the east, while more isolated, may also support populations of threatened species. In particular, low-lying areas on dark clays where water pools are likely to be inhabited by rough collared frog (*Cyclorana verrucosa*) and grey snake (*Hemiaspis damelii*). Both these species, and particularly rough collared frog (*Cyclorana verrucosa*), do not require large areas of remnant vegetation. Impact on these species may be unavoidable if populations are present.Areas of tilled land east of Willkie Creek will have little or no value to priority vertebrate taxa.

Detailed field surveys on survey area 7 have not been undertaken as part of this works. However, habitat assessment based on EVNT habitat mapping criteria defined in **Section 6.4.2** has been undertaken indicating that areas of remnant habitat, mapped as 'high' value may be suitable for several threatened species **(Figure 27**). Clearing of these areas is likely to necessitate a requirement for habitat offsets. Future infrastructure should be placed to avoid these areas as a priority, or detailed investigations should be undertaken to provide sufficient data for developing appropriate mitigation. No Back on Track species were recorded on survey area 7 although up to four species could potentially occur.



NOTES:

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

DIGITAL CADASTRAL DATA BASE
© The State of Queensland (Department of Natural Resources) [2012]

Figure 26. Priority fauna conservation areas on survey area 8

Client
Coffey Environments

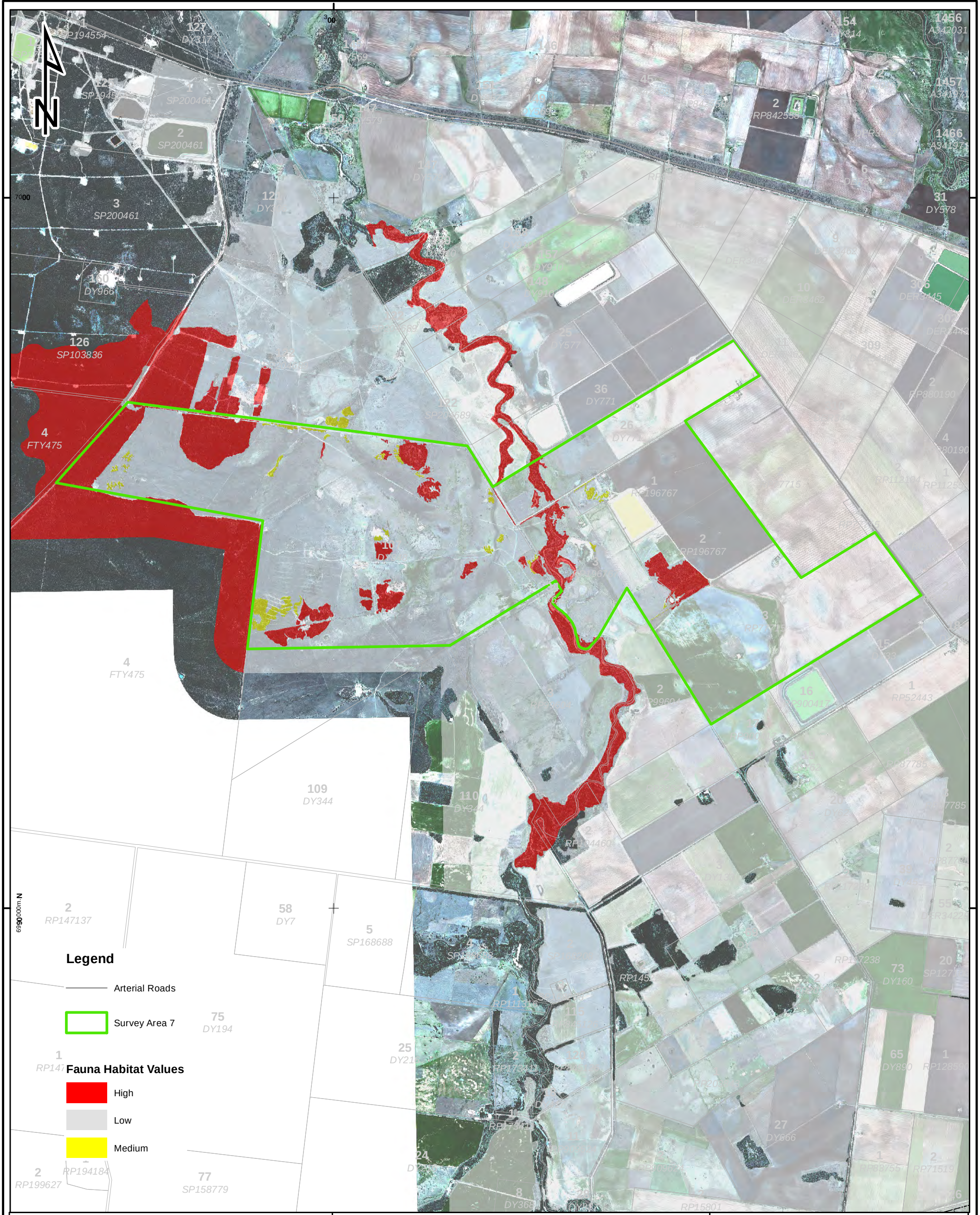
3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:48,855	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	2/05/2013	A4

6.4.5 Management of Habitats in Survey Area F

Habitat assessment suggests the potential for EVNT taxa on survey area F is lower than the preceding four survey areas. However, more recent work has demonstrated the presence of at least one EBPC Act listed species (south-eastern long-eared bat, *Nyctophilus corbeni*). Management of this area should be guided by the results of current detailed work. **Figure 28** provides spatial representation of the value of habitats for EVNT species in survey area F based criteria detailed in **Section 6.4.2**.



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

DIGITAL CADASTRAL DATA BASE
© The State of Queensland (Department of Natural Resources) [2012]

Figure 27. Priority fauna conservation areas on survey area 7

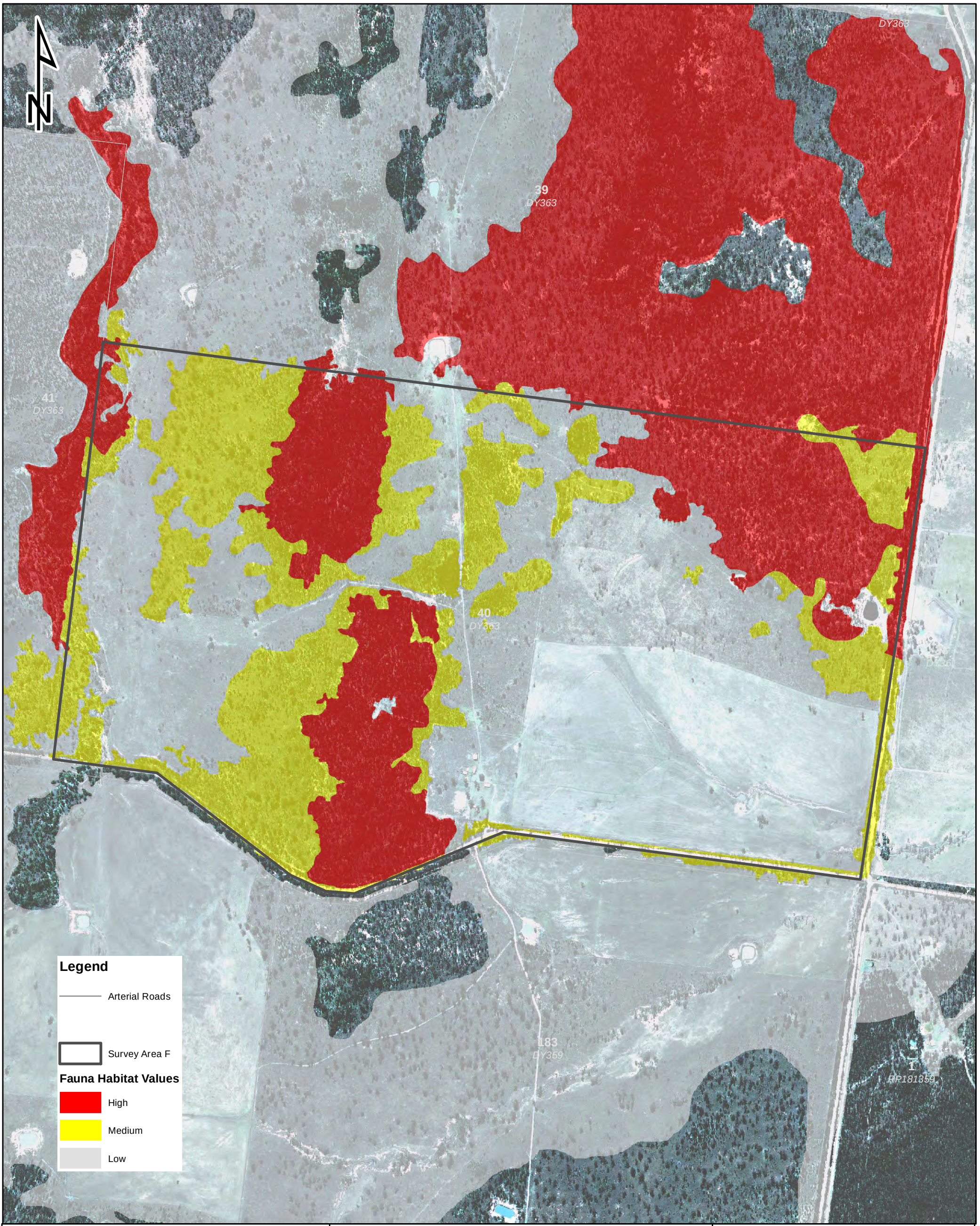
Client
Coffey Environments

0 900 1,800 2,700 3,600
Meters

Scale 1:49,388 | **Drawn By** DG | **Checked** DS | **File Path** C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd | **Date** 12/06/2013 | A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au



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

Source; ESE, Queensland Wetland Database

Figure 28. Priority fauna conservation areas on survey area F

Client
Coffey Environments

0 300 600 900 1,200
Meters

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:12,276	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3D_Surat_Properties_A3P.mxd	6/05/2013	A4

6.5 Updates to Sensitivity Assessments and Likelihood of Occurrence.

The significance assessment is a relatively new concept and is aimed at understanding and improving knowledge on environmental values. Following a review on the EIS by EHP, further refinement of the sensitivity criteria has occurred through desktop assessment and peer review (**Appendix A**). The revised criteria has been applied to all species assessed in the EIS and additional species identified from the SREIS desktop database search along with a review of the likelihood of occurrence. Rationale for sensitivity assessments applied to EPBC Act listed ecological communities, flora species and fauna species are described within individual profiles (See Appendix B, C and D).

Table 41 provides updated information for those values of major conservation significance that have changed from EIS to SREIS studies. In total, the assessment of two ecological communities has been updated from 'possibly occurring' to 'known to occur' within the project development area. The sensitivity of nine plant species and five fauna species has been revised. Due to refinement of desktop assessments, species profiles have been developed for three plant species that were excluded from the EIS assessment, with an additional profile developed for *Cymbonotus maidenii,* a species not recognised within database searches in the EIS assessment. A single fauna species, the spotted tail quoll (*Dasyurus maculatus maculatus)* assessed during the EIS assessment as possibly occurring has been excluded from the SREIS on the basis of further desktop review. The current status of this species in the Brigalow Belt is uncertain, with the last record of this species in 1990 (Keto et al. 2004). As the Granite Belt and the Border Ranges are the only regions in Queensland where this subspecies is still recorded regularly (Burnett and Meyer-Gleaves 2012), it is likely to be locally extinct from the project development area. Additionally, the Bendidee State Forest and National Park have also been excluded from the SREIS survey area due to relinquishment of sub-blocks. As such, impacts to these reserves are no longer considered relevant to the project.

Table 42. Updates to values of conservation significance in SREIS.

Values of Major Conservation Significance	**Status**	**Occurrence within Project Development Area from EIS**	**Sensitivity of Ecological Value from EIS**	**Revised Assessment in SREIS***
Weeping Myall Woodlands	EPBC Act - Endangered	Possibly occurring.	High	**Known to occur;** confirmed to occur within survey area 7. (refer **Appendix B**)
Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (including representative patches of RE11.3.3)	EPBC Act - Endangered	Likely to occur.	Moderate	Sensitivity assessed as **High** (refer **Appendix B**) **Known to occur;** confirmed to occur within survey area 7.
Digitaria porrecta (finger panic grass)	EPBC Act –Endangered; NC Act -Near Threatened BoT – Not Listed	Known to occur	Moderate	Sensitivity assessed as **High.** (refer **Appendix C**)
Acacia curranii (curly bark wattle)	EPBC Act- Vulnerable; NC Act- Vulnerable	Known to occur	High	Sensitivity assessed as **Moderate.** (refer **Appendix C**)
Denhamia parviflora (small leaved denhamia)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT - High	Known to occur	High	Sensitivity assessed as **Extremely High.** (refer **Appendix C**)
Philotheca sporadica (Kogan waxflower)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT – Not Listed	Known to occur	High	Sensitivity assessed as **Moderate** (refer **Appendix C**)
Picris evae (hawkweed)	EPBC Act- Vulnerable; NC Act- Vulnerable	Likely to occur	High	Sensitivity assessed as **Moderate** (refer **Appendix C**)

Values of Major Conservation Significance	Status	Occurrence within Project Development Area from EIS	Sensitivity of Ecological Value from EIS	Revised Assessment in SREIS*
	BoT - High			
Xerothamnella herbacea	EPBC Act- Endangered; NC Act- Endangered BoT – Not Listed	Known to occur	Extremely High	Sensitivity assessed as **High** (refer **Appendix C**)
Acacia handonis (Handon's wattle)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT – Not Listed	Possibly occurring	High	Sensitivity assessed as **Moderate** (refer **Appendix C**)
Acacia wardellii (Wardell's wattle)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT – Not Listed	Possibly occurring	High	Sensitivity assessed as **Moderate** (refer **Appendix C**)
Cadelia pentastylis (ooline)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT – Critical	Possibly occurring	High	Sensitivity assessed as **Extremely High** (refer **Appendix C**)
Rhaponticum australe (Austral cornflower)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT - High	Possibly occurring	High	Sensitivity assessed as **Moderate** (refer **Appendix C**)
Eucalyptus virens	EPBC Act- Vulnerable; NC Act – Vulnerable BoT – Not Listed	Unlikely to Occur	Not Assessed	Assessed as **Possibly** occuring; Sensitivity assessed as **High** (refer **Appendix C**)
Eucalyptus argophloia (Queensland white gum)	EPBC Act- Vulnerable; NC Act – Vulnerable BoT – Critical	Unlikely to Occur	Not Assessed	Assessed as **Possibly** occurring; Sensitivity assessed as **Moderate** (refer **Appendix C**)

Values of Major Conservation Significance	Status	Occurrence within Project Development Area from EIS	Sensitivity of Ecological Value from EIS	Revised Assessment in SREIS*
Acacia lauta (Tara wattle)	EPBC Act- Vulnerable; NC Act – Vulnerable BoT – Not Listed	Unlikely to Occur	Not Assessed	Assessed as **Possibly** occurring; Sensitivity assessed as **Moderate** (refer **Appendix C**)
Cymbonotus maidenii	EBPC Act – Not Listed NC Act – Endangered BoT - Medium	Not Assessed	Not Assessed	Assessed as **Known to Occur**; Sensitivity assessed as **Moderate.**
Dasyurus m. maculatus (spotted tail quoll)	EPBC Act- Vulnerable; NC Act –Endangered BoT – High	Possibly Occurring	Moderate	Species considered unlikely to occur in project development area and not considered further is SREIS. Justification for removal previously provided in **Table 9**.
*Tympanocryptis cf. tetraporophora (*grassland earless dragon)	EPBC Act –Endangered; NC Act –Endangered BoT - High	Known to occur	High	Sensitivity assessed as **Extremely High** (refer **Appendix D**)
Egernia rugosa (yakka skink)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT - Medium	Possibly Occurring	Moderate	Sensitivity assessed as **High** (refer **Appendix D**)
Anthochaera phrygia (regent honeyeater)	EPBC Act- Endangered; NC Act- Endangered BoT - Medium	Known to occur	Moderate	Sensitivity assessed as **High** (refer **Appendix D**)
Geophaps scripta scripta (squatter pigeon)	EPBC Act- Vulnerable; NC Act- Vulnerable BoT - Medium	Known to occur	Moderate	Sensitivity assessed as **High** (refer **Appendix D**)

Values of Major Conservation Significance	Status	Occurrence within Project Development Area from EIS	Sensitivity of Ecological Value from EIS	Revised Assessment in SREIS*
Category A ESAs: Wondul Range National Park (ATP689), Bendidee National Park (ATP689), Lake Broadwater Conservation Park (PL260).	NA	Known to occur (see figure 3)	Extremely High	Bendidee National Park lies within a relinquished sub-block and is of no further relevance to the project.
Category C ESAs: Barakula State Forest, Whetstone State Forest, Western Creek State Forest, Gurulmundi State Forest, Dunmore State Forest, and Kumbarilla State Forest, Lake Broadwater Resources Reserve***, Bulli State Forest, Bulli State Forest**, Bendidee State Forest See relevant indivual assessments for REs with Biodiversity Status of 'Of Concern'.	NA	Known to occur (see Figure 3)	Moderate to High (See Protected Estate) Excludes 'Of Concern' REs	Bendidee State Forest lies within a relinquished sub-block and is of no further relevance to the project.

* Occurrence within the project development stands as assessed in the EIS if a revised assessment is not presented.

** Incorporated into the assessment of neighbouring Whetstone State Forest in EIS.

*** Lake Broadwater Resources Reserve is attributed 'Moderate Sensitivity' as per state forest reserves in the region. Not referenced within EIS as protected estate.

6.6 Updates to Cumulative Impact Assessment

The EIS assessment identified a number of threatened ecological communities, EPBC Act listed flora and fauna species that may potentially be subject to high levels of cumulative impact arising from interactions between the Arrow Surat Gas Project and those projects of other proponents. **Table 42** identifies the three ecological communities, nine flora species and seven fauna species potentially subject to high level cumulative impact and provides an assessment of the degree to which project activities within survey areas 2, 9, 7, 8 and F will contribute to the broader cumulative impacts on the species. The assessment draws from the ecological community and species profiles provided in **Appendices B, C** and **D**.

Table 43. Ecological communities and species with potential for high level of cumulative impact and implications of proposed Arrow activities.

EPBC Act Listed Entity	EPBC Status	Cumulative Impact Assessment from EIS	Potential for Cumulative Impact From Project Activities Within Survey Areas 2, 9, 7, 8 and F
Threatened Ecological Communities			
Brigalow (dominant and co-dominant) ecological community.	Endangered	High	**Moderate**. There is potential for impact to 9.5 ha of this ecological community across all survey areas assessed in SREIS which will reinforce cumulative impacts across interacting projects.
Natural grasslands on basalt and fine textured alluvial plains of northern New South Wales and southern Queensland ecological community.	Critically Endangered	Extremely High	**Low.** The natural grasslands ecological community will not be impacted with development of proposed survey areas. Hence no contribution to the cumulative impact incurred to this ecological community will occur.
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions ecological community.	Endangered	High	**Low.** The semi-evergreen vine thickets ecological community will not be impacted with development of proposed survey areas. Hence no contribution to the cumulative impact incurred to this ecological community is expected.
Flora Species			
Curly-bark wattle (*Acacia currani*)	Vulnerable	Extremely High	**Low.** Habitat for curly-bark wattle will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this species through Arrow activities is expected.
Wardell's wattle (*Acacia wardellii*)	Vulnerable	Extremely High	**Low.** Habitat for Wardell's wattle will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this

EPBC Act Listed Entity	EPBC Status	Cumulative Impact Assessment from EIS	Potential for Cumulative Impact From Project Activities Within Survey Areas 2, 9, 7, 8 and F
			species through Arrow activities is expected.
Ooline *(Cadellia pentastylis)*	Vulnerable	High	**Low.** Habitat for ooline will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this species from Arrow activities is expected.
Gurulmundi fringe myrtle (*Calytrix gurulmundensis)*	Vulnerable	Extremely High	**Low.** Habitat for Gurulmundi fringe myrtle will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this species from Arrow activities is expected.
Belson's panic (*Homopholis belsonii)*	Vulnerable	High	**Low to Moderate.** Whilst the species was not recorded in during field assessment of survey areas, potential habitat exists in survey area 9 with 20.1 ha of potential habitat occuring. If pre-clearance survey does not locate this species, Arrow contribution to cumulative impacts will be not be significant.
Microcarpea agonis	Endangered	High	**Low**. Habitat for *Microcarpea agonis* will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this species through Arrow related development is expected.
Kogan waxflower (*Philotheca sporadica)*	Vulnerable	Extremely High	**Low to Moderate.** Whilst the species was not recorded during field assessment of survey areas, potential habitat exists in survey area 8 with 936.1 ha of potential habitat occuring. If pre-clearance survey does not locate this species, Arrow contribution to cumulative impacts will be low.
Prostanthera sp. (Dunmore D. M. Gordon)	Vulnerable	Extremely High	**Low.** Habitat for Prostanthera sp. (Dunmore D. M Gordon) will not be impacted with development of proposed survey areas and hence no contribution to the cumulative impact incurred to this species is expected.
Xerothamnella herbacea	Endangered	High	**Low to Moderate.** Whilst the species was not recorded during field assessment of survey areas, it potentially exists in survey area 9 and 7 with 6.3 ha of potential habitat occuring. If pre-clearance survey does not locate this species, Arrow contribution to cumulative impacts will be low.
Fauna Species			
Collared delma (*Delma torquata)*	Vulnerable	Extremely High	**Low.** The species in not considered likely to be present within habitats contained within survey areas 2, 7, 8, 9 and F and hence potential for Arrow to contribute to cumulative impacts will be low.
Brigalow scaly-foot (*Paradelma orientalis)*	Vulnerable	High	**Moderate.** Habitat for the species will potentially be impacted during development of survey area 2 with 444.4 ha of known habitat occuring on the property . This will contribute to cumulative impact to the species although the impacts incurred to this species through actions of other proponents are not clear.
Five-clawed worm-skink (*Anomalopus mackayi*)	Vulnerable	High	**Low.** The species in not considered likely to be present within habitats contained within survey areas 2, 7, 8, 9 and F and hence potential for Arrow activities to contribute to cumulative impacts will be low.
Darling Downs earless dragon	Endangered	High	**Low.** The species in not considered likely to be present within habitats contained within survey areas 2, 7, 8, 9 and

EPBC Act Listed Entity	EPBC Status	Cumulative Impact Assessment from EIS	Potential for Cumulative Impact From Project Activities Within Survey Areas 2, 9, 7, 8 and F
(*Tympanocryptis cf. tetraporophora*			F and hence potential to contribute to cumulative impacts will be low.
Dunmall's snake	Vulnerable	High	**Low.** The species potentially occurs on survey areas 2, 7 and 8 although was not found during survey. There is potential for Arrow works to contribute to cumulative impacts to this species although with appropriate pre-clearance survey, cumulative impacts will be low.
Australian painted snipe (*Rostratula australis)*	Vulnerable	High	**Low.** The species in not considered likely to be present within habitats contained within survey areas 2, 7, 8, 9 and F and hence potential for Arrow activities to contribute to cumulative impacts will be low.
Regent honeyeater (*Anthochaera phrygia)*	Endangered	High	**Low.** The species in not considered likely to be present within habitats contained within survey areas 2, 7, 8, 9 and F and hence potential for Arrow activities to contribute to cumulative impacts will be low.

6.7 Additional Flora Species Profiles

A single NC Act species, *Cymbonotus maidenii* that was not identified within the EIS is included within the SREIS assessment. The species was listed as endangered under schedules of the NC Act in 2009. This listing was not however up to date in the Herbrecs dataset acquired at the start of the EIS survey in August 2009. Hence, the updated assessment of the species was not captured. Additional EPBC Act listed species not assessed within the EIS, being Tara wattle, (*Acacia lauta),* Wardell's wattle (*Acacia wardellii), Eucalyptus virens* and Queensland white gum (*Eucalyptus argophloia)* are dealt with individually within **Appendix C**. Impact assessment procedure follows methods detailed in **Appendix F.**

Cymbonotus maidenii

Family: Asteraceae

Status: NC Act – Endangered; **EPBC Act** - Not Listed; **BoT** - Medium

Recovery Plan: No recovery plan has been prepared for *Cymbonotus maidenii*

Description (based on Holland and Funk, 2006): *Cymbonotus maidenii* is a small herb with erect lance shaped leaves standing 10-40cm tall. Individual leaves are 10-40cm long and 3-9cm wide, toothed, and divided into triangular lobes which nearly reach the mid-vien. The upper leaf surface is dark green and sparsely hairy. The underside of the leaf is light green or greenish-grey, with sparse to moderately dense cottony hairs. Single yellow flowers grow on stems of 2-30cm tall fine hairs apparent along the length of the stem.

Ecology: Other than being a perennial, very little is known about this species although, though as a daisy it is probably fairly short-lived (e.g. living < 5 years). The species is known to flower throughout

the year but most prominently in spring, possibly in response to rainfall. The seeds are likely to be wind dispersed, which should assist colonisation. It has the ability to survive along disturbed roadsides in in other highly disturbed habitats.

Habitat: The species is associated with a range of remnant and non-remnant habits with records occurring on disturbed roadside drains, native and derived grasslands. It is typically associated with heavy brown to grey cracking clay soils (Holland & Funk 2006). Habitats favoured by the species are RE11.3.21 from which it is known to occur. The woodland RE11.3.2 and derived native grassland also present potential habitat for the species. It can however occur in a range of highly disturbed locations and hence its occurrence may not be readily predicted.

Distribution: The species occurs in scattered populations throughout central areas of NSW and in southern inland districts as far west as Mitchell (Holland and Funk, 2006).

Likelihood of occurrence and extent of habitat in the project development area: A total of five Herbrecs (EHP 2013) specimens are recorded in the study area, mostly in the area between Cecil Plains and Millmerran including roadside collections to the south of Dalby on the Dalby - Cecil Plains Road where it occurs within native grassland (RE11.3.21). The species is also found in disturbed roadside locations, occuring specifically on areas of heavy clay soil. Many of these areas are likely to have been occupied by poplar box woodlands (RE11.3.2).

Threats: The species is threatened by roadside clearing and herbicide drift. It may also be threatened by invasion of exotic species of which lippia (*Phyla canescens)* and green panic (*Megathyrsus maximus var. pubiglumis)* pose the most immediate threat.

Significance of project related impacts (Unmitigated): The sensitivity of *Cymbonotus maidenii* is considered ***Moderate*** based on its known ability to survive in disturbed paddocks and along roadsides. If flowers throughout the year and is likely to colonise adjacent areas. However, following mechanical disturbance (e.g. of roadside) invasion of exotic pasture grasses and weeds has the potential to degrade habitat and limit the re-colonisation of disturbed areas. Any remnant and derived grassland and poplar box woodlands on alluvium present potential habitat and populations contained within may be susceptible to disturbance. The species occurs regionally with populations occurring through central NSW and inland southern Queensland. Hence, in consideration of its broader regional occurrence, the potential magnitude of impact is considered ***Moderate.*** Unmitigated activities in the vicinity of local populations and possible habitats are therefore likely to have an impact of ***Moderate* (13).**

Impact Mitigation: Generic mitigation measures detailed in Arrow Commitments (**Appendix A**) are sufficient to mitigate impacts to this species.

Summary residual impact assessment: Impacts of ***Moderate (13)*** significance will potentially occur in the absence of mitigation. Areas mapped as 'core habitat possible', warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding areas of known and potential core habitat will mitigate against impacts and residual impacts will be ***Low (4)*.**

Grassland and grassy woodland habitats support a number of other EVNT flora species and are particularly vulnerable to mechanical disturbance. Implementation of commitments that describe the establishment and maintenance of buffers where legislated, limiting the width of disturbance corridors, rehabilitation of disturbance areas using seeding of native grass seed of local provenance, and management of exotic grass and herb invasion will be largely effective to a degree that impact significance is ***Low* (8)**.

Residual Significance Assessment				
Avoidance*			Others#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Low	Low (8)

* No clearing of vegetation within areas of core habitat known or core habitat possible.
# Clearing of core habitat known and possible is unavoidable.

Conclusions: As detailed in **Section 6**, *Cymbonotus maidenii* has potential to occur within survey area 9 within derived grasslands mapped as 'general habitat'. It was not recorded during field surveys undertaken on these survey areas although there remains potential for the species to occur within suitable habitat. Should the species be located on these survey areas during pre-clearance survey, generic mitigation measures should mostly alleviate impacts and the resulting impact significance would be low. There is limited potential for cumulative impacts to this species to be enhanced through the proposed development actions.

Rule(s) for Habitat Mapping:

1. Confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as "Core Habitat Known" (clearance calculations not to include non-remnant habitats).
2. RE polygons (including mature regrowth vegetation) with confirmed records (<500m precision) should be treated as "core habitat known".
3. The species is most likely to occur between Dalby (-27.15) and Millmerran (-27.9) . The following REs occuring between these latitudes should be classed as 'core habitat possible'.
   - 11.3.21
   - 11.3.24
4. RE 11.3.2 and associated derived grasslands occuring between Dalby (-27.15) and Millmerran (-27.9) should be treated as "general habitat".
5. All other remnant vegetation and cleared agricultural land in the project development area should be treated as "absence suspected".

7.0 Conclusions

The SREIS study was undertaken to provide specific detailed impact assessment of project development activities on terrestrial ecological values within areas identified for development (survey areas). The study is intended to provide greater clarity in regard to specific aspects of the EIS assessment where required or requested due to updates to the project description and/ or as requested through submissions to the EIS. Both field survey and desktop review were used to further assess the impact on terrestrial ecological values. Through this process, it was possible to validate assessment made in the EIS study and confirm any specific aspects of site mitigation not captured in current mitigation commitments (as identified in **Appendix A**).

Buffer distances presented in the EIS were considered in ecological assessments undertaken for the SREIS. Whilst adequate setbacks may protect ecological values in specific cases (e.g. pristine examples of highly sensitive habitats), this protection may not apply in all cases. The application of buffers to highly degraded habitats (e.g. brigalow degraded with buffel grass and other weeds) may result infrastructure being placed in good condition remnant vegetation rather than more appropriately within degraded habitats contained within a designated buffer. Hence, application of buffers in an appropriate manner should be considered on a case by case basis. Where it is considered impractical to maintain buffers around sensitive habitats, alternative management controls should be considered to manage impacts which are cognisant of the sensitivity of the ecological asset to be avoided. Where necessary, buffers will be applied to protect significant environmental values, particularly where indirect impacts (e.g., edge effects, displacement) are likely. The need for buffers and buffer distances will be determined by legislative requirements at the time or management measures set out in species-specific management plans

Concluding information relevant to this study, pertaining in particular to individual survey areas is provided in the following sections.

7.1 Survey areas 2, 7, 8, 9 and F

Considering suvey areas as a whole, impact to EPBC Act listed ecological communities, REs as regulated under the EP Act and EPBC Act and NC Act listed flora and fauna species are expected although impacts will vary between survey areas. This assessment assumes the proposed development footprints involve the total clearing of vegetation contained within survey areas (which is not realistic). In reality, information obtained during field survey will form the basis for detailed property scale planning, ultimately aimed at minimising impact to sensitive ecological values. This is consistent with the framework approach as identified in **Section 1.2**.

7.1.1 Survey Area 2

Listed Ecological Communities and Sensitive Regional Ecosystems

No EPBC Act listed ecological communities are present within the property. The loss of the following sensitive REs (category C ESAs) with of concern biodiversity status is expected, assuming total clearance of the survey area:

- RE11.3.4 (56.1 ha)
- RE11.3.25 (31.3 ha)

In total, based on detailed mapping assessment, 1376 ha of remnant vegetation comprising 87 ha with 'of concern' biodiversity status and 1289 ha with biodiversity status of 'no concern at present'.

Listed Flora Species

No listed flora species were recorded during the survey although a number of EPBC Act listed species (curly bark wattle, Hando's wattle, Wardell's wattle, Cobar greenhood orchid, lobed bluegrass) and NC Act listed species (sandstone prickle bush and plunkett mallee) may be present. Pre-clearance surveys are required to determine wether any further mitigation and habitat offset strategies are to be required. Preclearance surveys form a commitment made within the EIS.

Fauna Species and Habitat

Based on the unrealistic assumption that all vegetation within survey areas will be cleared, habitat loss will occur for the following listed species:

- South-eastern long eared bat (*Nyctophilus corbeni* - Vulnerable EPBC Act) with 701.6 ha of known habitat (core habitat known) and 662.8 ha of possible habitat (core habitat possible) mapped on the property.
- Brigalow scaly-foot (*Paradelma orientalis* -Vulnerable EPBC Act and NC Act) with 443.4 ha of known habitat and 806.4 ha of possible habitat mapped on the property.
- Glossy black-cockatoo (*Calyptorhynchus lathami* – Vulnerable NC Act) with 109.67 ha of known habitat and 1022.61 ha of general habitat mapped on the property.
- Black-chinned honeyeater (*Melithreptus gularis* – Near Threatened NC Act) with 772.1 ha of known habitat and 645.1 ha of potential habitat mapped on the property.
- Little pied bat (*Chalinolobus picatus* – Near Threatened NC Act) with 887.8 ha of known habitat and 524.3 ha of potential habitat mapped on the property.
- Golden-tailed gecko (*Strophurus taenicauda* - Near Threatened NC Act) with 1356.7 ha of known habitat and 768.1 ha of potential habitat mapped on the property.

Impacts other than habitat loss on these species will need to be managed in accordance with commitments set out in the EIS and **Appendix A**, Loss of habitat for these species will require a

habitat offset plan to be developed under state and federal offset polices (SEWPaC 2011 and DERM 2011b) as detailed in **Section 7.1.5.**

7.1.2 Survey Area 9

Listed Ecological Communities and Sensitive Regional Ecosystems

The following listed ecological communities are present on the survey area 9 and are subject to impact:

- 5.4 ha of the Brigalow Ecological Community (as RE11.4.3).
- 14.5 ha of RE11.3.17 with 'endangered' biodiversity status.
- 121.9 ha of 'of concern' REs which includes RE11.3.2, 11.3.4, 11.3.27 and 11.3.25.

Impact may however be avoided or minimised through site specific planning prior to construction. In total 636 ha of remnant vegetation will be cleared during development of the survey area, assuming total clearance of vegetation.

Listed Flora Species

No listed flora species were recorded during the survey although a number of EPBC Act listed species being Belson's panic (*Homopholis belsonii)*, *Xerothamnella herbacea,* Austral toadflax (*Thesium australe),* finger panic grass *(Digitaria porrecta)*, Cobar greenhood orchid *(Pterostylis cobarensis,* lobed bluegrass (*Bothriochloa biloba*) and NC Act listed species which include *Solanum stenopterum, Cymbonotus maidenii* and Blake's spikerush (*Eleocharis blakeana*) may be present. Pre-clearance surveys are required to determine whether any further mitigation and habitat offset strategies are to be required.

Fauna Species and Habitat

Impacts are predicted to be incurred upon:

- Rough collared frog (*Cyclorana verrucosa* – Near Threatened NC Act) with 277.9 ha of known habitat mapped on the property. .

A number of additional listed fauna species including brigalow scaly-foot (*Paradelma orientalis)*, bulloak jewel *(Hypochrysops piceatus),* grey snake *(Hemiaspis damelii)*, glossy black-cockatoo (*Calyoptorhynchus lathami)* and black-chinned honeyeater (*Melithreptus gularis)* may be present within habitats with pre-clearance surveys required to verify habitat assessments.

7.1.3 Survey Area 8

Listed Ecological Communities and Sensitive Regional Ecosystems

The following listed ecological communities and sensitive REs are identified as occuring within survey area 8:

- 2.1 ha of the Brigalow Ecological Community represented as advanced brigalow regrowth (> 15 yrs old). This represents a low quality occurrence of the brigalow ecological community.
- 16.4 ha of the 'of concern' RE 11.3.4.

Assuming total clearance of vegetation and based on detailed mapping assessment undertaken in the SREIS, 2015 ha of remnant vegetation (including 1998.6 ha of vegetation listed as 'no concern at present') on the property will be cleared. In reality however, extensive clearing of remnant vegetation may be avoided through site specific planning.

Flora Species

No listed flora species were recorded during the survey although a number of EPBC Act listed species including Kogan waxflower (*Philotheca sporadica)*, Tara wattle (*Acacia lauta)*, Cobar greenhood orchid (*Pterostylis cobarensis)*, lobed bluegrass (*Bothriochloa biloba)*, finger panic grass(*Digitaria porrecta*) and NC Act listed species including *Calotis glabrescens* and plunket mallee *(Eucalyptus curtisii*) may be present. Pre-clearance surveys are required to determine whether any further mitigation and habitat offset strategies are required for impact to listed flora species.

Fauna Species and Habitat

Golden-tailed gecko *(Strophurus taenicauda)* has been confirmed as occuring on survey area 8 with 326.5 ha of 'core habitat known' recognised in revised habitat mapping databases.

A number of additional listed fauna species including brigalow scaly-foot (*Paradelma orientalis)*, pale imperial hairstreak (*Hypochrysops piceatus)*, grey snake (*Hemiaspis damelii)*, rough collared frog (*Cyclorana verrucosa)*, five clawed worm skink (*Anomalopus mackayi),* glossy black-cockatoo (*Calytptorhynchus lathami)* and black-chinned honeyeater (*Melithreptus gularis)* may be present within habitats. Pre-clearance surveys required to determine the extent of known habitat and requirements for habitat offset.

7.1.4 Survey Area 7

Listed Ecological Communities and Sensitive Regional Ecosystems

The following listed ecological communities are present on survey area 7 and subject to potential impact:

- Coolibah Black-Box Woodland Ecological Community (endangered) with 11.5 ha identified as occurring.

- Weeping Myall Woodlands Ecological Community (endangered) with 0.8 ha identified on the property.
- A small patch of the Brigalow Ecological Community (endangered) with 0.9 ha occuring as a disturbed regrowth habitat.

In addition 199 ha of remnant vegetation present on the property is subject to clearance assuming all vegetation on the survey area will be cleared. This includes 15.2 ha of RE11.3.3 (of concern biodiversity status) 11.5 ha of which is included in the Coolibah –Black Box Woodland Ecological Community, 54.4 ha of RE11.3.4 (of concern biodiversity status), 5.5 ha of RE11.3.25 (of concern biodiversity status) and 4.1 ha of RE11.3.27 (of concern biodiversity status).

Flora Species

No listed flora species were recorded during the survey although a number of EPBC Act listed species such as lobed bluegrass (*Bothriochloa biloba)*, finger panic grass (*Digitaria porrecta)*, Tara wattle (*Acacia lauta*), *Xerothamnella herbacea,* Kogan waxflower (*Philotheca sporadica)*, and NC Act listed species *Cyperus clarus, Fimbristylis vagans* and Blake's spikerush (*Eleocharis blakeana*) may be present. Pre-clearance surveys are required to determine whetherany further mitigation and habitat offset strategies are to be required.

Fauna Species and Habitat

A number of additional listed fauna species including brigalow scaly-foot (*Paradelma orientalis*), golden-tailed gecko (*Strophurus taenicauda*), rough collared frog (*Cyclorana verrucosa)*, and little pied bat *(Chalinolobus picatus)* may be present within habitats occuring on the survey area. Pre-clearance surveys required to determine the extent of known habitat and requirements for habitat offset.

7.1.5 Survey Area F

The following listed ecological communities are present on the survey area F site and are subject to impact:

- A small patch of the Brigalow Ecological Community (1.1 ha) mapped as RE11.4.3 occuring as a discrete remnant patch.

In addition, 99 ha of remnant vegetation is contained within the survey area, excluding RE11.4.3, all of which is listed as having a 'no concern at present' biodiversity status.

Flora Species

No listed flora species were recorded during the survey although a number of EPBC Act listed species Belson's panic (*Homopholis belsonii)*, lobed bluegrass (*Bothriochloa biloba*), *Xerothamnella*

herbacea, Cobar greenhood orchid *(Pterostylis cobarensis)* and Kogan waxflower (*Philotheca sporadica*) and the NC Act listed species Blake's spikerush (*Eleocharis blakeana*) may be present. Pre-clearance surveys are required to determine whetherany further mitigation and habitat offset strategies are to be required.

Fauna Species

No listed fauna species were confirmed to occur on the property although it is considered to provide potential habitat for rough collared frog (*Cyclorana verrucosa)*, golden-tailed gecko *(Strophurus taenicauda)*, brigalow scaly-foot (*Paradelma orientalis)*, square-tailed kite (*Lophoictinia isura)* and little pied bat *(Chalinolobus picatus)*. Further pre-clearance surveys are required to develop mitigation actions, identify occurrences of these species and determine the requirement for habitat offset.

Impacts to Riparian Habitats

Water discharge into both Bottletree Creek (survey area 2) and the Condamine River (survey area 9) is expected during operation. The major potential source of impact will be:

- Increased growth of riparian and/or aquatic vegetation, favouring some native and/or exotic species could lead to some geomorphic changes including trapping of sediment, reduced channel capacity and channel migration. Bank erosion may also facilitate tree fall through bank collapse creating a niche for exotic species invasion.

Discharge regimes should be developed once the location of a discharge point is known. These should consider the protection of geomorphic values to preserve the natural rates of sedimation and erosion. Water quality should be similar to the natural variations of the receiving environment.

7.1.6 Requirement for Habitat/ Biodiversity Offset

Where significant residual impacts to EPBC Act listed ecological communities, and habitat for EPBC Act listed flora and fauna species remain after mitigation, habitat offsets will be required to be developed under the Environment Protection and Biodiversity Conservation Act 1999 - Environmental Offsets Policy (SEWPAC 2012).

Habitat offsets for REs, including those determined as sensitive (of concern biodiversity status) will be governed by their habitat value to NC Act listed fauna and flora species as detailed in the Queensland Biodiversity Offset Policy (DERM 2011b) or any subsequent policy. As required under the current policy, habitat offsets will need to meet a pre-determined measure of ecological equivalence linked directly to the structure, floristic composition and condition of those habitats that have been impacted.

7.1.7 Validation of EIS Assessments

Assessment undertaken at a property (survey area) scale indicate the following trends which can be applied in general to all future detailed surveys undertaken with the Arrow Surat Gas Project Area (as detailed in **Section 6.1**):

1. Failure to account for fine scale variation in vegetation through refinement of certified RE mapping (EHP 2012a and 2012b) may result in impacts to sensitive REs or EPBC Act listed ecological communities that are not identified in existing mapping databases. Fine scale vegetation mapping should be undertaken prior to development to ensure sensitive areas are adequately identified and accounted for.
2. Whilst comprehensive survey for sensitive flora species may result in downgrade in the recognised value of habitat in some circumstance, it is much more difficult to do so for fauna species where animal mobility and varying seasonal conditions means that species can be much less reliably detected. Hence whilst 'core habitat possible' has been downgraded to 'general habitat' for some flora species in survey area 2, it has not been possible to do so for fauna species. Hence it will be desirable to avoid potential habitat for fauna species, whether the fauna species was confirmed in survey or not.
3. Revised vegetation mapping has greatly increased resolution to the mapping of floristic and faunal habitats, enabling site specific planning to be undertaken on an informed and detailed basis.

The results and implications are largely consistent with the desired objectives of the 'framework approach', being "once the site is ground truthed, and where further constraints are discovered, the site will re-enter the planning phase and the site adjusted to attempt to avoid the initial constraint (Section 1.2)". For both survey area 2 and survey area 9, detailed ground survey has resulted in a greatly refined understanding of the constraints on the site, allowing detailed planning to reduce impacts to sensitive habitats.

8.0 References

3D Environmental (2013). Revised vegetation and habitat mapping database at 1:10 000 and 1:40 000 scale. Prepared for Coffey Environments.

Accad, A; Neldner, V.J; Wilson, B. A; and Niehus, R.E. (2012) *Remnant Vegetation in Queensland. Analysis of remnant vegetation 1997-2009, including regional ecosystem information.* (Queensland Department of Science, Information Technology, Innovation and the Arts: Brisbane).

Arrow (2012). Arrow Surat Gas Project EIS. Available online at:

http://www.arrowenergy.com.au/community/project-assessment-eis/surat-gas-project-eis

Australia's Virtual Herbarium (2013). Available at:
http://avh.chah.org.au.

Australia's Virtual Herbarium (2013h).
http://avh.ala.org.au/occurrences/search?taxa=Eriocaulon+carsonii#mapView

Australia's Virtual Herbarium (2013i).
http://avh.ala.org.au/occurrences/search?taxa=Eucalyptus+pachycalyx+subsp.+waajensis#mapView

Australia's Virtual Herbarium (2013j).

http://avh.ala.org.au/occurrences/search?taxa=Lepidium+peregrimum#mapView

Australia's Virtual Herbarium (2013k).

http://avh.ala.org.au/occurrences/search?taxa=Macrozamia+conferta#mapView

Burnett, S. and Meyer-Gleaves, S. (2012). 'Spotted-tailed Quoll (southern subspecies),' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 344-345.

Czechura G. V., Hobson R. G., Steward D. A (2011). Distribution, status and habitat of the Red Goshawk *Erythrotriorchis radiatus* in Queensland. *Corella* 35: 3- 10

Dennis, A. J. (2012). 'Large-eared Pied Bat' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 374-375.

Department of Agriculture Forestry and Fisheries (Qld Department of) (DAFF). Weeds, pest animals and ants. Available at:

http://www.daff.qld.gov.au/26_8259.htm

Department of Environment and Heritage Protection (Queensland Department of) (EHP) (2013). HERBRECS data Extract January, 2013.

Department of Environment and Heritage Protection (EHP) (2012a). Regional Ecosystem Digital Data, Version 7.0. *Queensland Herbarium*, Brisbane.

Department of Environment and Heritage Protection (EHP) (2012b). EP Act Mature Regrowth Digital Data. *Queensland Herbarium*, Brisbane.

Department of Environment and Heritage Protection (EHP) (2012c). Regional Ecosystem Description Database Data. *Queensland Herbarium*, Brisbane.

Department of Environment and Heritage Protection (EHP) (2012d). Back on Track Species Prioritisation Framework. Available at: http://www.ehp.qld.gov.au/wildlife/prioritisation-framework/back_on_track_species_prioritisation_framework

Department of Environment and Heritage Protection (2012e). Queensland Wetland Mapping and Classification for Queensland. Version 1.3 – February 2009. *Department of Environment and Resource Management,* Queensland.

Department of Environment and Resource Management (DERM) (2011a). Policy for Vegetation Management Offsets- Version 3. *Queensland Government*.

Department of Environment and Resource Management (DERM) (2011b). Queensland Biodiversity Offsets Policy (Version 1). *Queensland Government*.

Department of Environment and Resource Management (DERM) (2011c). Ecological Equivalence Methodology Guideline, Policy for Vegetation Management Offsets, Queensland Biodiversity Offsets Policy. *Queensland Government*.

Department of Environment, Water, Heritage and Arts (DEWHA) (2008). Matters of National Environmental Significance: Significant impact guidelines 1.1. *Australian Government.* Canberra.

Department of Sustainability, Environment, Water, Population and Communities (2013a). EPBC Act Protected Matters Report. Online at http://www.environment.gov.au/cgi-bin/erin/ert/ert_dispatch.pl?loc_type=coordinate&search=Search&report=epbc. Accessed 13 February 2013.

DSEWPaC (2013b). *Botaurus poiciloptilus* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 19 Mar 2013 14:34:28 +1100.

Department of Sustainability, Environment, Water, Population and Communities (2012). EPBC Act 1999 Environmental Offsets Policy. *Australian Government*, Canberra.

Environmental Protection Agency (2008a). Biodiversity Planning Assessment–Brigalow Belt. Version 1.3. *Environmental Protection Agency*, Brisbane.

EPA (2008b). BPA BRB South Fauna Expert Panel Report – V 1.3, June 2008. *Environmental Protection Agency*, Brisbane.

Eyre, T.J., Ferguson, D.J., Hourigan, C.L., Smith, G.C., Mathieson, M.T., Kelly, A.L., Venz, M.F., Hogan, L.D. (2012). Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland. *Department of Science, Information Technology, Innovation and the Arts, Queensland Government*, Brisbane.

Eyre, T.J., Kelly, A.L. and Neldner, V.J. (2011). Methodology for the Establishment and survey of Reference Sites for Biocondition*n*, Version 2. *Department of Environment and Resource Management.* Queensland

Fielder, D. (2012). 'Western Sawshelled Turtle,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 203-204.

Garnett, S. T., Szabo, J. K. and Dutson, G. (2011). The action plan for Australian birds 2010. *CSIRO Publishing*, Collingwood.

Gordos, M. (2012). 'Fitzroy River Turtle,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 205-206.

Holland A. E, and Funk V. A (2006). A revision of Cymbonotus (Compositae:Arctotideae, Arctotidinae). *Telopea* (3) 266-275

Higgins, P. J., Peter, J. M. and Cowling, S. J eds. (2006). Handbook of Australian, New Zealand and Antarctic birds. Vol. 7. Boatbill to starlings. Part B: Dunnock to starlings. *Oxford University Press*, South Melbourne.

Hines, H. (2012a). 'Border Thick-tailed Gecko,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 213-214.

Hines, H. (2012b). 'Giant Barred Frog,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 172-173.

Hurley, V. G. (2012). 'Major Mitchell's Cockatoo,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 284-285.

Keto, A., Kennedy, S., Kwan, A. and Scott, K. (2004). (Draft) Conservation values and integrity of the Western Hardwoods Area: Brigalow Belt and New England Tableland Bioregions Southern Queensland. *Australian Rainforest Conservation Society*.

Lindenmayer, D. and Burgman (2005). Practical Conservation Ecology. *CSIRO Publishing*, Canberra.

Lindenmayer, D. B. and Fischer, J. (2006). “Habitat Fragmentation and Landscape Change. An Ecological and Conservation Synthesis. *CSIRO Publishing*, Canberra.

Melzer, A. (2012). ‘Dunmall’s Snake,’ in Queensland’s threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 243-244.

Neldner, V. J., Wilson, B. A., Thompson, E. J. and Dilleward, H. A. (2012). Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 3.1. Updated September 2005. Queensland Herbarium, *Environmental Protection Agency*, Brisbane.

Neldner,V. J, Kirkwood A, B. and Collyer B.S (2004). Optimum time for sampling floristic diversity in tropical eucalypt woodlands of northern Queensland. *Rangelands Journal No.26* (2) 190 – 203.

Norton, M. (2012). ‘Long-nosed Potoroo (south-east mainland subspecies),’ in Queensland’s threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 292-293.

Parker, D. G. and Webster, R. (2012). ‘Superb Parrot,’ in Queensland’s threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 292-293.

Payne, R. B. (2010). ‘Family Estrildidae (Waxbills),’ in Handbook of the birds of the world. Vol. 15. Weavers to New World warblers, eds. J. del Hoyo, A. Elliott and D.A. Christie, *Lynx Edicions,* Barcelona. pp. 234-377.

Queensland Water Commission (QWC). 2012. Underground Water Impact Report for the Surat Cumulative Management Area. Brisbane, Queensland.

Threatened Species Scientific Committee (2008o). Approved Conservation Advice for *Acacia lauta* [Online]. *Department of the Environment, Water, Heritage and the Arts*. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/4165 -conservation-advice.pdf.

Threatened Species Scientific Committee (2008ab). Approved Conservation Advice for *Tylophora linearis* [Online]. *Department of the Environment, Water, Heritage and the Arts*. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs.

Threatened Species Scientific Committee (2008ac). *Commonwealth Listing Advice on Weeping Myall Woodlands*. [Online]. *Department of the Environment, Water, Heritage and the Arts*.

9.0 Appendices

Appendix A. Elaboration on Assessment Method and Process

A1. Significant Habitat, Flora and Fauna Species Assessments

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

A2. Habitat Mapping

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

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

'Essential habitat' for NC Act listed species as regulated under the VM Act has been considered within the EIS assessment. As essential habitat may be drawn from a number of data sources, both verified and non-verified, is not regularly updated and does not account for all previously recorded occurences of a species, it is considered secondary to the classification of 'core habitat known' in this study in which habitat mapping has been undertaken for management and planning purposes rather than having direct legislative significance. Essential habitat as recognized by EHP, both in remant and high value regrowth datasets will however generally be captured within those areas mapped as 'core habitat known' for a particular species.

Index of Confidence

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

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

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

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

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

A3. Impact Mitigation

The measures of mitigation and management (otherwise referred to as 'commitments') follow a tiered approach and can be generically applied across the majority of taxa and habitats. These commitments are presented in EIS Chapter 17, Terrestrial Ecology, Section 17.6. A list of commitments made within

the EIS, as relevant to terrestrial ecology, is provided within **Table A1**. A full list of commitments, including those that remain unchanged from the EIS and details on those that have changed, are included in SREIS, Part C, Attachment 4, Commitments Update. Where new commitments are provided for the management of all species have been identified in **Table A1**. Where new commitments are required which are specific to the taxa, they have been identified in the species profiles (**Appendix C** and **Appendix D**) and are provided below in **Table A2** and **Table A3.** Broadly, mitigations can be attributed to the various groupings listed below although in practice, these groupings may overlap considerably.

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

Table A1. Arrow mitigation commitments from the Surat EIS as relevant to terrestrial ecology.

Commitment Number	Commitment	Relevant Phase
Manage edge effects and invasive species		
C015	Clear areas progressively and implement rehabilitation as soon as practicable following construction and decommissioning activities.	• Construction • Operations • Decommissioning
C099	Wash down vehicles and equipment that have potentially been in contact with weeds before entering new work sites.	• Planning and Design • Construction Operations • Decommissioning
C157	Implement a 100-m buffer zone from the high bank of all watercourses to ensure that no development or clearance occurs within these buffers (other than construction of watercourse crossings for roads, pipelines and discharge infrastructure and associated stream monitoring equipment).	• Planning and Design Construction
C176	Use coal seam gas water for dust suppression on roads or for construction and operations activities authorised in the environmental authority in accordance with the water quality parameters described in the environmental authority.	• Construction Operations
C179	Ensure all relevant personnel are made aware of the location and extent of weed infestations in the vicinity of the work area and the risks involved in moving from one site or property to another.	• Planning and Design Construction Operations • Decommissioning
C180	Do not wash down vehicles in watercourses.	• Planning and Design Construction Operations • Decommissioning
C187	Design washdown facilities to ensure that runoff is contained on site and does not transfer weed seeds, spores or infected soils to adjacent areas. Treat or dispose of washdown solids in a registered landfill.	• Planning and Design

Commitment Number	Commitment	Relevant Phase
C188	Develop a declared weed and pest management plan in accordance with the Petroleum Industry - Pest Spread Minimisation Advisory Guide (Biosecurity Queensland, 2008). Undertake species-specific management for identified key weed species at risk of spread through project activities (mesquite, parthenium, African lovegrass and lippia). Increase weed control efforts in areas particularly sensitive to invasion. The pest management plan should include, as a minimum, training, management of pest spread, management of pest infestations and monitoring effectiveness of control measures.	• Planning and Design
C193	Identify declared weeds during the preconstruction clearance survey.	• Construction
C221	Design facilities to ensure natural surface water flows are not impounded, e.g., by installing culverts on roads and stormwater diversion ditches around production facilities.	• Planning and Design
C223	Develop fire plans for production facilities.	• Planning and Design • Operations
C227	Manage potential impacts on Category A, B and C ESAs through implementation of buffers as proposed in Table 17.10.	• Construction
C229	Ensure relevant workers, including contract plant and machinery operators, are made aware of the location of significant remnant vegetation and buffers and are guided by qualified personnel when clearing is undertaken.	• Construction
C230	Demarcate appropriate buffers and inform workers and machinery operators of buffer locations when working within the vicinity of national- and state-listed communities and areas identified for potential avoidance.	• Construction
C238	Retain woody debris, logs and rocks for use in rehabilitation. These should be spread over part or all of the corridor or, as a minimum, piled along the edge of the cleared corridor to provide refuge for crossing fauna.	• Construction
C247	Identify areas for rehabilitation.	• Decommissioning
C250	Advise, through procedures and plans, on requirements for rehabilitation in identified areas that are no longer in use.	• Decommissioning
C251	Reinstate self-supporting drainage lines.	• Decommissioning

Commitment Number	Commitment	Relevant Phase
C252	Inspect rehabilitation areas after decommissioning for regrowth similar to the surrounding environment.	• Decommissioning
C253	Select plant species for the purposes of rehabilitation that are specific to the original ecosystem and of local provenance, wherever practicable.	• Decommissioning
C259	Train field personnel to identify key pest species and to maintain constant vigilance for weeds and pest fauna species throughout the project life to ensure early detection and intervention.	• Construction Operations Decommissioning
C261	Install and maintain appropriate sediment and erosion control structures at work sites.	• Construction Operations Decommissioning
C505	Inspect erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures is maintained.	• Inspection and Monitoring
Minimise disturbance		
C020	Minimise the disturbance footprint and vegetation clearing.	• Planning and Design Construction
C191	Design gathering lines and tracks to avoid watercourses, drainage lines and riparian areas (particularly permanent watercourses or perennial aquatic habitat), where practicable.	• Planning and Design
C231	Minimise the width of construction ROW within areas of sensitivity to the greatest extent practicable without compromising the safety of workers.	• Construction
C234	Retain habitat trees, where practicable.	• Construction
C240	Construct production wells, gathering lines and access tracks within cleared areas, where practicable, with the aim of avoiding remnant vegetation and high-value regrowth.	• Construction
C241	Fell trees away from existing stands where practicable. Where trees unavoidably fall into a stand, leave trees in situ to emulate natural tree fall and provide habitat for ground-dwelling species, where practicable.	• Construction
C242	Avoid damaging standing trees not identified for removal. Limit the scraping of standing tree trunks and breaking of limbs by equipment as far as practicable.	• Construction

Commitment Number	Commitment	Relevant Phase
C256	Prohibit disturbance or harassment of wildlife and the unauthorised collection of flora and forest products.	• Construction • Operations • Decommissioning
Avoid Sensitive Areas		
C217	Avoid the following areas: • Wondul Range National Park, Bendidee National Park and Lake Broadwater Conservation Park (Category A ESAs). • Chinchilla Sands Local Fossil Fauna Site. • 'Critically endangered' EPBC Act communities within the project development area (REs 11.3.21, 11.3.24, 11.8.2a) including three natural grassland road reserves (Dalby Kogan, Dalby St George and Dalby Cecil Plains).	• Planning and Design
C218	Aim to avoid: • Additional national- and state-listed communities: Brigalow (REs 11.3.1, 11.4.3, 11.4.10, 11.9.5, 11.9.6), Semi-evergreen vine thickets (REs 11.9.4a, 11.8.3), Weeping Myall Woodlands, and Coolibah-Blackbox Woodlands (RE 11.3.3). • Category B ESAs. • Category C ESAs, including Gurulmundi State Forest, Bendidee State Forest, Binkey State Forest and Barakula State Forest. • Wyaga-Kindon Ooline populations. • Stock routes and state or bioregional wildlife corridors. • Essential and core habitat (supporting listed wildlife species). • State forests and resources reserves. • State-listed 'of concern' regional ecosystems.	• Planning and Design

Commitment Number	Commitment	Relevant Phase
C220	Conduct preconstruction clearance surveys to identify any additional areas that may need to be avoided.	• Planning and Design
C228	Ensure boundaries are clearly marked for site-specific sensitive areas that require avoidance.	• Construction
C232	Conduct preconstruction clearance surveys and include as a minimum: • Vegetation mapping at a scale suitable for site-specific planning. • Identification of core habitats and listed species. • Identification of site-specific sensitive areas that require avoidance or buffer areas.	• Construction
Manage mortality and entrapment		
C035	Apply appropriate international, Australian and industry standards and codes of practice for the handling of hazardous materials (such as chemicals, fuels and lubricants).	• Planning and Design • Construction • Operations • Decommissioning
C038	Carry out corrective actions immediately upon the identification of any contamination of soil or groundwater that has occurred as a result of project activities.	• Planning and Design • Construction • Operations • Decommissioning
C048	Apply appropriate international, Australian and industry standards and codes of practice for the design and installation of infrastructure associated with the storage of hazardous materials (such as chemicals, fuels and lubricants).	• Planning and Design • Construction • Operations

Commitment Number	Commitment	Relevant Phase
		• Decommissioning
C212	Inspect food scrap bins and exclusion fences to ensure they are properly operated and maintained.	• Inspection and Monitoring
C258	Dispose of food scraps in large skips or bins that prevent animal access. Empty these storage devices regularly in a manner that does not involve disposal to onsite trenches or waste dumps.	• Construction • Operations • Decommissioning
C214	Design dams to have an egress (escape point) for wildlife.	• Construction
C233	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.	• Construction
C235	Assess trees prior to felling for potential nesting hollows. If identified, fell trees in the presence of a qualified fauna spotter and roll them so that the hollows are facing upwards, allowing fauna to escape.	• Construction
C236	Identify key koala trees (*Eucalyptus tereticornis* and *Eucalyptus populnea*), and visually inspect prior to clearing to ensure that they are free of koalas. If koalas are located, the tree should be retained until the animals have moved on, typically overnight.	• Construction
C243	Erect fauna-exclusion fences around project dams.	• Construction
C260	Implement speed limits on project-controlled roads to reduce the potential for vehicle collisions with wildlife.	• Construction • Operations • Decommissioning
C473	During rehabilitation works, care will be taken when moving stockpiled logs and vegetation to avoid fauna mortality.	• Decommissioning

Commitment Number	Commitment	Relevant Phase
C500	Inspect and manage open trenches in accordance with the following: • Inspect trenches for the presence of fauna daily (preferably in the morning), as well as immediately prior to closing a trench. • Have appropriately trained personnel remove any fauna from a trench to minimise stress to the animal and to avoid personal injury. • Record details of trapped fauna for inclusion in the DERM Wildnet database.	• Construction • • Operation
Manage impacts to threatened species		
C224	Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals.	• Planning and Design
C225	Avoid construction activities in waterbodies frequented by migratory species.	• Planning and Design
C239	Translocate or propagate significant species where it is deemed necessary for use during rehabilitation or in offsets in accordance with relevant legislation.	• Construction
C249	Where not possible to avoid Bendidee State Forest (which provides habitat for the 'endangered' bull oak jewel butterfly), conduct activities in predisturbed areas following the development and implementation of a bull oak jewel butterfly management plan with regard to the existing recovery plan (Lundie-Jenkins & Payne, 2000).	• Planning and Design
Secure habitat offsets		
C219	Where avoidance is not possible, implement an offset strategy approved by a relevant government agency and comply with reporting conditions of an offset plan.	• Planning and Design
C244	Consider the preconstruction clearance survey baseline characterisation when rehabilitating project sites.	• Decommissioning
C245	Implement site planning, preparation and management requirements in accordance with a developed and approved decommissioning and rehabilitation plan.	• Decommissioning
C246	Decommission the pipeline corridors in a manner that minimises potential impacts on the environment.	• Decommissioning

Commitment Number	Commitment	Relevant Phase
Implement monitoring programs		
C303	Develop monitoring programs that are site specific and based on the identified risk to the conservation or maintenance of a viable population.	• Inspection and Monitoring
C478	Carry out routine monitoring of rehabilitation success.	• Inspection and Monitoring
Other measures		
C254	Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques.	• Construction • Operations • Decommissioning
C255	Minimise light spill from project activities to reduce disturbance to nocturnal fauna.	• Construction • Operations • Decommissioning

Table A2. Additional recommended mitigation measures.

Commitment Number	Commitment	Relevant Phase
Manage edge effects and invasive species		
C223 Updated	Develop fire plans for production facilities. Where fire susceptible EVNT species are identified in areas adjacent to facilities, wells and pipeline infrastructure, minimise the fragmentation of populations and adjacent habitat to allow natural fire movement.	• Planning and Design • Operations
-	Retain clusters of EVNT plants within the disturbance footprint, where practicable, as a future source of seed for rehabilitation or natural post disturbance regeneration.	• Construction

Table A3. Additional recommended mitigation measures SREIS relevant to fauna and flora species.

Commitment Number	Commitment	Relevant Phase
Machin's macrozamia (*Macrozamia machinii*)		
Ensure that the location of any newly identified populations of this species are not made public due to the sensitivity of the species to plant collection, Identification of this species will be reported to relevant authorities.		• Planning and Design • Operations
Microcarpaea agonis		
Develop a site specific plan to minimise changes to wetland habitat hydrology, including water quality, in areas of ground truthed populations.		• Planning and Design • Operations
Erect permanent exclusion fences around ground truthed populations.		• Planning and Design • Operations

A4. Sensitivity, Impact Magnitude and Impact Significance Assessment

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

Sensitivity

A sensitivity ranking for ecological communities is provided in **Table A4**, flora species in **Table A4** and fauna species in **Table A6.**

Table A4. Ecological community sensitivity ratings.

Sensitivity Ranking	Descriptor
Not Sensitive)	The ecological community is not adversely affected by short-term or long-term disturbance as it is resilient to changes in habitat structure or condition. This includes: • An ecological community where floristic structure is relatively simple and edaphic conditions favour re-establishment of native groundcovers following disturbance (An example might be a habitat formed by a species with repeatedly demonstrated rapid and abundant post-disturbance recruitment providing strong population resilience and rapid recovery). • An ecological community that exists in a highly degraded state prior to disturbance.
Low	The ecological community has a high resilience to disturbance, or the habitat of the species is already highly disturbed due to historic activities. An ecological community is resilient to change and able to quickly recover after disturbance because it demonstrates the following features: • An ecological community comprises species that are able to regenerate rapidly through coppicing and the species seeds abundantly; • An ecological community occupies soil or landform types that do not favour extensive invasion of exotic species following disturbance; • An ecological communities structure and general floristic composition are generally restored to near natural condition in a short to moderate time frame (15 to 20 years); • The ecological community is amenable to rehabilitation and seed stock of the dominant constituent species are generally readily available.
Moderate	The ecological community is capable of regeneration following disturbance although original habitat structure and general floristic composition may take many years to recover and require some intervention to ensure natural ecological process is restored. The habitat may have several of the following features: • The floristic composition of the ecological community comprises a suite of species, the majority of which are capable of post disturbance regeneration via coppicing although seeding events may be irregular and local seed bank short lived. • The ecological community is relatively resilient to the impact of edge effects including dust generation, weed invasion although soil conditions will tend to favour displacement of native ground covers and shrubs with exotic species in the absence of intervention. • The ecological community is capable of persisting and regenerating on roadsides

Sensitivity Ranking	Descriptor
	following disturbance although original floristic composition may never be restored in the absence of intervention;
High	The ecological community has a relatively low resilience to disturbance and impacts may lead to a long-term loss of habitat integrity causing permanent decline in habitat extent and condition. The habitat typically has several of the following features: • The ecological community is dominated by perennial species with limited or irregular germination although some regeneration via coppicing may occur; • The ecological community a relatively diverse floristic composition in the shrub and ground cover layers with a high proportion of species incapable of persisting following disturbance; • The ecological community is highly susceptible to edge effects and may suffer severely from edge effects such as dust and weed invasion, often manifest in habitat dieback. • For the ecological community, associated soil conditions favour expansion of exotic weeds over native ground covers; • For the ecological community, intensive intervention is required to re-establish natural vegetative structure and composition.
Extreme high	The ecological community has extremely low resilience to disturbance and impacts are likely to lead to permanent structural and floristic change and long term decrease in habitat occupancy. The ecological community has several of the following features; • The ecological community is dominated by perennial species which lack the capacity for vegetative regeneration via coppicing. • Within the ecological community, aggressive exotic coloniser species typically take residence and ultimately displace native species in areas of disturbance. • The habitat depends on highly specific edaphic conditions which are readily destroyed following disturbance (e.g. soil compaction) and difficult to restore. • The habitat is highly susceptible to grazing pressure which may interfere with the habitats ability to recolonise. • The habitat condition continues to decline years after impact due to an inability to tolerate disturbance and aggressive displacement by exotic species. • The amenability of the habitat to rehabilitation is poor or unknown and constituent species not readily available. • The habitat may become extinct (at the local scale) due to inability to recover from disturbance.

Table A5. Flora species sensitivity ratings – the sensitivity of a local populations (i.e. those growing within 25 km buffer of the project development area) to disturbance *

Sensitivity Ranking	Descriptor
Not Sensitive	Short-term or long-term disturbances are not likely to adversely affect the local populations of this species, or the population may benefit from the disturbance regimes (e.g. aggressive coloniser species that benefit from disturbance) and is resilient to changes in habitat structure or condition. For example, an annual or ephemeral species which repeatedly demonstrated rapid and abundant post-disturbance recruitment providing strong population resilience and expansion following disturbance. The species exists in a highly disturbed impacted habitat already.
Low	The local populations of this species have a high resilience to disturbance, or the habitat of

Sensitivity Ranking	Descriptor
	the species is already of a low degree of intactness and condition due to previous disturbances. A disturbance may cause short-term impacts but is unlikely to cause local extinction, with no long-term impact expected on abundance, extent or integrity of the local population. The population is resilient to change and able to quickly recover after disturbance because the species has several of the following features: • Is an annual or biennial herb with previously documented abundant post-disturbance recruitment. • Is a perennial known to survive disturbances through vegetative persistence via coppicing, and also produces abundant seed germination. • Has a long-lived local seed reserve (e.g. a hard-seeded legume), and/or its seed disperses long distances via wind, water or animals (e.g. daisies). • Seedlings are known to mature to produce seed within two years of germination.
Moderate	The local populations of this species have a moderate resilience to disturbance. Short-term impacts (over one - two generations) may lead to a loss of abundance or extent, but are unlikely to cause extinction of the local population. The species can recolonise and only minor long-term impacts are expected on the abundance, extent and integrity of the local population because the species has several of the following features: • Is an annual or biennial herb which is expected to have abundant post-disturbance recruitment, based on characteristics of the species or closely related species. • Has a long-lived local seed reserve (e.g. a hard-seeded legume), and/or its seed disperses long distances via wind, water or animals (e.g. daisies). • Is a perennial capable of vegetative persistence following disturbance via coppicing and scattered seedlings. • A perennial incapable of vegetative persistence following disturbance via coppicing, but will likely recruit abundant post-disturbance seedlings, with those seedlings expected to require less than six years to mature. • Known to persist in moderately disturbed areas, such as roadsides.
High	The local populations of this species have a fairly low resilience to disturbance. Impacts may lead to a long-term decrease in its abundance and/or extent, or may affect the long-term integrity of the local population causing it to decline permanently or become locally extinct. The species regenerates or recolonises with difficulty after disturbance because the species has several of the following features: • Is a perennial with limited or irregular germination. • The population may remain at a declined density for years after the disturbance until seed germination occurs sporadically in later years. • Seedlings take six to ten years to mature to produce seed. • Has capacity for some vegetation regeneration via coppicing. • Has a local seed reserve likely to persist for several years, or seed disperses long distances via wind, water or animal. • Seed reserves are short lived, with most seeds likely to be dead or eaten within months of seed drop. • Is known to be negatively impacted by normal grazing pressures, or particularly susceptible to feral animals damage. • Is known to be particularly impacted by invasion of common local weeds that are likely to invade disturbed sites.
Extreme	The local populations of this species have very low resilience to disturbance. Impacts are likely to lead to the long-term decline or extinction of a local population. Natural recruitment

Sensitivity Ranking	Descriptor
sensitivity	or colonization would not replace or restore the population within several generations because the species has several of the following features: • Is a perennial with only very occasional, erratic germination and lacks the capacity for vegetative regeneration via coppicing. • Seedlings take more than ten years to mature to produce seed. • If capable of vegetative regeneration via coppicing, then the coppice shoots take decades to mature to produce seed. • Seed production is irregular, and seed reserves are ephemeral, with no seeds likely to survive many weeks of seed drop. • Juvenile plants (e.g. saplings) are particularly sensitive to disturbance. • It's population density is known to be significantly reduced by invasion of common local weeds that are likely to invade disturbed sites. • Requires surrounding habitat to be in good condition for its population persistence (e.g. intact scrub without weed invasion). • The population continues to decline years after the disturbance due to the inability to survive in a disturbed ecosystem. The habitat containing the local population currently has a high degree of intactness and may represent benchmark condition in reference to examples of the habitat across its broader range. Therefore the local population is only known from undisturbed, high quality habitat that is sensitive to disturbance. A single disturbance is likely to have ongoing negative effects on this species, so that any post-disturbance survivors or new recruits are unable to tolerate the disturbed ecosystem.

* Based on a broad range of population concepts developed by Keith 1996 and Whelan et al. (2012) in Bradstock et al, 2012.

Table A6. Fauna species sensitivity assessment.

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

Sensitivity Ranking	Description
	reduction in extent, but are unlikely (<30%) to cause extinction of the local population. • The species may decline during construction activities, but declines during operation and maintenance, and decommissioning activities are not expected. • A species can recolonise and only minor long-term impacts are expected on the abundance, extent and integrity of the local population following rehabilitation of suitable habitat.
High	The species has the following attributes: • Local populations of this species have low resilience to disturbance. Impacts may lead to the long-term decline of a local population. • The species is likely to decline during construction activities, but declines during operation and maintenance, and decommissioning activities is less likely. The local population may (>30% likelihood) become extinct. • Natural recruitment or re-colonisation is unlikely to replace or restore the population following rehabilitation.
Extremely High	The species has several of the following attributes: • Local populations of this species have very low resilience to disturbance. Impacts are likely to lead to the long-term decline of a local population and these declines are likely to continue during operation and maintenance, and decommissioning. • Natural recruitment or colonisation would not replace or restore the population. The local population is likely (>80% likelihood) to become extinct. • Populations have declined historically. • Small, restricted ranges or discrete isolated populations. • Sedentary and highly susceptible to fragmentation. • Specialised habitat requirements which may include being restricted to habitats that are discrete, highly fragmented and susceptible to degradation.

Magnitude of Impact

The magnitude of an impact on an environmental value is an assessment of the geographical extent, duration and severity of the impact. Applying these attributes enables the magnitude of an impact to be ranked as major, high, moderate, low or negligible as shown in Table 4.

Table A7. Impact magnitude ranking definitions.

Magnitude Ranking	Description
Negligible	The impact of disturbance does not extend beyond the project footprint. The impact will be difficult to detect when the activity or source of impact ceases. The impact occurs in areas mapped as 'absence suspected' for the species and only affects a local population.
Low	The impact of disturbance does not extend beyond the project footprint. The impact will be detectable although recovery will occur in the short term (months) without the risk of long term impacts to the affected individuals or population. The impact occurs in areas mapped as 'general habitat' for the species and only affects a local population.
Moderate	The impact of disturbance may extend beyond the project footprint and affects a local or regional population. The impact is short term and can be managed by implementation of environmental controls. The impact occurs in areas mapped as 'general habitat' and 'core habitat possible' for the species and only affects a regional population.
High	The impact of disturbance extends beyond the project footprint affecting local ecosystem function in the surrounding area and a bioregional population or species. Impacts are medium to long term. Environmental controls and management actions specific to the species are required over a long period of time to mitigate impacts. The impact affects

Magnitude Ranking	Description
	areas mapped as ‘core habitat possible’ and ‘core habitat known’ and affects local and regional populations.
Major	The impact of disturbance extends beyond the project footprint and local ecosystems affecting population or geographically dispersed population at a bioregional, national or world scale. Environmental controls and management actions have limited potential to reduce impacts or have not been proven for the species. The impact affects areas mapped as ‘core habitat possible’ and ‘core habitat known’ and involves local, regional and potentially national populations.

Impact Significance Assessment

The significance of an ecological impact is derived from the risk matrix as provided in **Table A8.** This has been determined from the sensitivity of an ecological value and the magnitude of the impact it experiences. Descriptors for the impact significance ranking are given in **Table A9.** In some cases, the level of residual impact has remained at the same level as the unmitigated impact, after the implementation of mitigation measures is considered. The implementation of environmental controls outlined in **Appendix A3** will reduce the overall magnitude of impact on each species or community. The reduction in the magnitude of impact may be insufficient to lower the broad level of magnitude (ie low, moderate, high, very high) although within these categories the magnitude of impact may have in fact reduced.

Table A8. Matrix for the assessment of the significance of an ecological impact.

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

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

Table A9. Impact significance ranking definitions

Significance Ranking	Descriptor
Negligible	An impact occurs to an ecological value that is of limited importance on a local or regional basis. The impact is largely reversible with degradation controlled by a range of standard mitigation and management measures that have been proven to be extremely effective.
Low Significance	An ecological value is of local importance only and impacts will be of a transient nature that will not affect the long term viability of a local population. A range of mitigation and management measures are known to ameliorate or reverse the process of degradation.
Moderate Significance	Although resilient to change, further degradation of an ecological value will occur due to the impact scale, or the activity has potential to increase the susceptibility of the ecological value to further change. Although important in the local ecological context, the value is widespread outside the area of impact and a range of management measures are known to facilitate recovery or replacement of the ecological value.
High Significance	A high magnitude impact occurs when proposed activities exacerbate or accelerate the degradation of a unique or rare ecological value. Whilst management actions are known to ameliorate impacts, a full recovery of the value to pre-impact condition is a long term process (decades) which will require rigorous active management. In these cases, avoidance is the preferred primary mitigation measure.
Major	An impact occurs that causes major, long term and widespread harm to a habitat or ecological value that is irreplaceable because of its uniqueness or restricted occurrence. The impact is largely irreversible and no mitigation measures have been proven to ameliorate the impact, and avoidance is considered the only effective mitigation

A5. Specific Recommendations for Ecological Survey Effort

Robust survey methodologies have been developed under Commonwealth guidelines for reptiles (SEWPaC 2011), birds (DEWHA 2010b) and bats (2010a) although no such guidelines are available for survey of flora species, nor ecological communities. Nelder et al (2012) provide methods for the survey and mapping of REs in Queensland and these have some application for the survey of EPBC Act listed ecological communities. The threshold criteria for REs and EPBC Act listed communities varies considerably and as such, Nelder et al (2012) can only be applied as a general method guide. Neldner (et al) is not intended as a guideline for the survey of threatened flora species, although application of such methods may result in threatened flora species being found. The most robust survey guideline for threatened flora species has been prepared by the New South Wales DEH (2012a) (Threatened Species – Field Survey Methods) although it has no formal endorsement from either Queensland or Commonwealth regulators.

A range of survey method policies and documents were reviewed to determine their adequacy for identifying species in the context of the predominantly linear and spatially distributed project infrastructure. Recommendations on revised methods are presented within species profiles in **Appendices B** and **C**. Implementation of the recommendations, which consider the isolation of communities; extent to which species can be detected in various habitats and the risk of disturbance and adverse impacts, will ensure compliance with relevant aspects of the survey guidelines.

Recommendations for survey effort presented in **Appendices B** and **C** will be reviewed for incorporation into pre-clearance survey procedures to be developed by Arrow. These survey procedures will be based on standard survey methodology and refined to target listed species based on the risk of disturbance at individual sites.

A6. MNES Assessment Criteria and Definitions

Significant Impact Criteria

The Matters of National Environmental Significance – Significant Impact Guidelines (DEWHA, 2008) provide a basis for the assessment of impact significance to species and ecological communities that are threatened at a national level. The guideline provides a list of 'significant impact criteria' for listed species and ecological communities that 'critically endangered', 'endangered' or 'vulnerable'. An additional category of 'extinct in the wild' is also discussed although this category is not relevant to any species known from within the project development area. A significant impact on a critically endangered or endangered species is defined as one that will:

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

A significant impact on a vulnerable species is defined as one that will:

- lead to a long-term decrease in the size of an important population of a species.
- reduce the area of occupancy of an important population.
- fragment an existing important population into two or more populations.
- adversely affect habitat critical to the survival of a species.
- disrupt the breeding cycle of an important population.
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- result in invasive species that are harmful to a vulnerable species becoming established in thevulnerable species' habitat.
- introduce disease that may cause the species to decline.
- interfere substantially with the recovery of the species.

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

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

Important Populations

An 'important population' is defined by DEWHA (2008) as a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

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

APPENDIX B. MNES Assessments- Threatened Ecological Communities

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

EPBC Act Status: Endangered

VM Act Status: Endangered

Biodiversity Status*:* Endangered

Sensitivity: High

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

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

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

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

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

Other relevant habitats:

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

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

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

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

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

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

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

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

Plate 30. Tall brigalow woodland on the alluvial plain of Wilkie Creek (Site AS138). This occurrence is represented as RE11.3.17 in DERM (2009b).

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

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

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

The community is degraded throughout much of its range with sub-canopy layers often dominated by *Opuntia spp.* and *Harissia martini.* Canopy dieback, although a natural feature of the brigalow community, is severe in some locations. Excessive light penetration through a dramatically reduced

canopy cover has further promoted the invasion of exotic species into the ground cover and shrub layers.

Plate 1. Well developed woodland of *Acacia harpophylla* and *Casuarina cristata* in the Chinchilla Sporting Shooters Club (Site AS 170).

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

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

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

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

Within revised RE mapping completed at 1: 40 000 scale, the ecological community was defined to include brigalow regrowth with > 60% canopy cover, >0.5 ha in size, a width of >10 m for linear

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

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

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

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

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

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

Occurrence in the project development area and extent of habitat: The Brigalow TEC is known to occur in the project development area. The extent of the Brigalow TEC in the project development area is provided in **Table A10** with distribution shown in **Figure A1.** The Brigalow TEC was recorded

within survey area 9 and survey area F. Small, highly disturbed fragments also occur within survey area 7 with 0.8 ha of advanced regrowth (regrowth >15yrs old) being recorded and 2.1 ha of advanced regrowth recorded in survey area 8. The Brigalow TEC is not identified in survey area 8.). Details within specific survey areas is provided below.

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

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

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

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

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

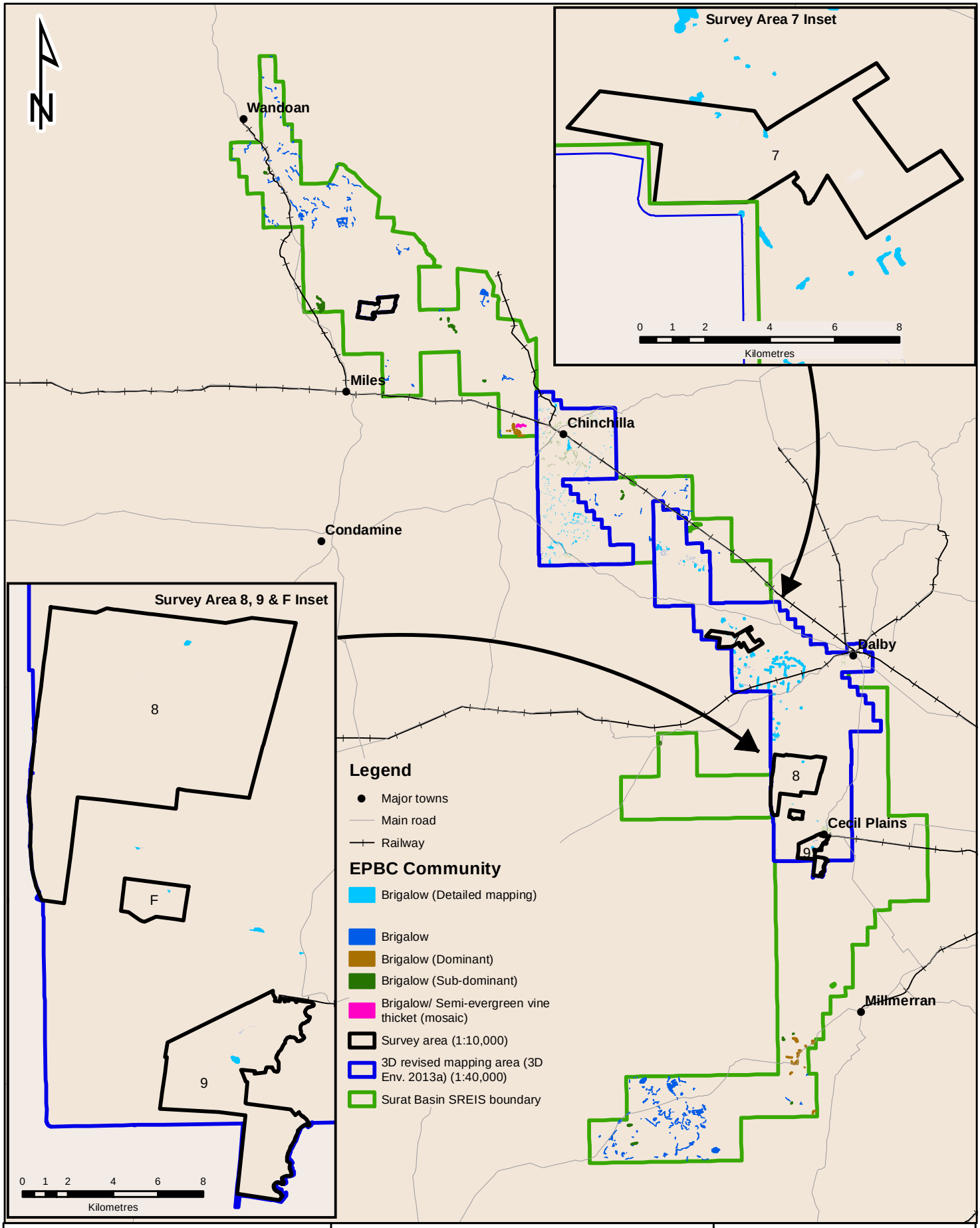
2 Based on 1: 40 000 scale RE mapping undertaken for the EIS within PL areas by 3D Environmental, 2103. Level of Confidence = ***Moderate***

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

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

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

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



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

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

Figure A1. Distribution of Brigalow ecological community

Client Arrow

0 15 30 45 60
Kilometres

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

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_Append_A4P.mxd

Rule(s) for Ecological Community Mapping:

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

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

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

An estimated 804 264 ha of this ecosystem occurs nationally (TSSC2001a) with 586 049 ha of this ecosystem present in the bio-region including 50394 ha occurring within Queensland National Park Reserves based on data provided by Accad *et al*. (2012). This does not include areas mapped as mature regrowth (EHP 2012b) as release of the mature regrowth data postdates these assessments. Based on analysis of government RE and mature regrowth Mapping (EHP 2012a and EHP 2012b) 4450 ha of remnant brigalow and 2534 ha of regrowth brigalow are present in the project development area with a combined total of 6984 ha. Individually, the small disturbed fragments that are common across the landscape present poor type examples, although some much better preserved examples are present in the project development area, typically within historic stock routes. As the Brigalow TEC consists largely as fragmented remnants within the project development area representing

0.86% of the national extent, the impact magnitude in terms of direct habitat loss is considered to be ***Moderate*** and the unmitigated impact significance is considered to be ***Moderate (17).***

Proposed management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to this ecological community.

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

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

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

Evaluation under MNES referral guidelines

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

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

Criteria	Evaluation
Criteria 1: Reduce the extent of an ecological community	Within survey areas 7, 8, 9 and F, 9.5 ha of the Brigalow TEC will be cleared for project development activities. Total anticipated clearing represents <0.001% of the national extent of the ecological community. No impact will be incurred within survey areas 2 as it was not found to be present. In accordance with Criteria 1, a significant impact is expected due to reduction in extent of the Brigalow TEC.
Criteria 2: Fragment or increase fragmentation of an ecological community	Where the Brigalow TEC occurs in survey areas 7, 8, 9 and F, these habitats represent remnants that have been previously subject to landscape fragmentation and represent poor examples of the community. If direct clearing of these fragmented remnants occurs, it will not lead to further degradation and fragmentation of

Criteria	Evaluation
	the Brigalow TEC in the adjacent landscape or broader project development area. Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present. In accordance with **Criteria 2**, no significant impact is expected.
Criteria 3: Adversely affect habitat critical to the survival of an ecological community.	The occurrences subject to clearance are small isolated remnants that are heavily degraded. These habitats are not considered critical to the survival of the ecological community. Development of survey areas 2 will not result in impact to the Brigalow TEC as it was not found to be present. In accordance with **Criteria 3**, no significant impact is expected.
Criteria 4: Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	It is assumed that all brigalow habitats within survey areas 7, 8, 9 and F will be cleared during development. If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (Appendix A Table A1) will be sufficient to prevent modification or destruction of abiotic factors critical to the survival of the ecological community. Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present. In accordance with **Criteria 4**, no significant impact is expected.
Criteria 5: Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	It is assumed that all brigalow habitats within survey areas 7, 8, 9, and F will be cleared during development. If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (within Appendix A, Table A1) will be sufficient to prevent loss of a functionally important species. Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present. In accordance with **Criteria 5**, no significant impact is expected.
Criteria 6: Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established; or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	It is assumed that all brigalow habitats within survey areas 7, 8, 9 and F will be cleared during development. If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (within Appendix A, Table A1) will be sufficient to prevent the loss in quality or integrity of an occurrence of an ecological community. It should be noted that these habitats exist in a degraded condition. Development of survey area 2 will not result in impact to the Brigalow TEC as it was not found to be present. In accordance with **Criteria 6**, no significant impact is

Criteria	Evaluation
	expected.
Criteria 7: Interfere with the recovery of an ecological community.	The ecological community is not in state of recovery within survey areas 7, 8, 9 and F and are being degraded by ongoing processes of attrition through weed invasion and canopy senescence. Development of survey areas 2 will not result in impact to the Brigalow TEC as it was not found to be present In accordance with **Criteria 7**, no significant impact is expected.

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

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

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

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

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

EPBC Act Status: Critically Endangered

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

VM Act Status: Endangered

Biodiversity Status: Endangered

Sensitivity: Extremely high

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

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

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

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

Overview of the Natural Grassland TEC

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

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

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

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

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

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

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

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

It should also be noted that two minor areas of RE 11.3.24 (*Themeda avenacea* grassland on alluvial plains. Basalt derived soils.) are indicated to the northeast of Cecil Plains. In this location, the ecosystem is represented in association with grassland ecosystem 11.3.21. Access restrictions to private property prevented confirmation although it is considered unlikely however that small areas of basalt derived alluvial soil could be differentiated from within a broader alluvial landform. Hence this ecosystem has been merged with the broader RE11.3.21 ecosystem for the purpose of impact assessment.

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

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

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

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

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

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

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

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

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

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

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

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

Project-related impact significance (unmitigated): Whilst mechanical disturbance is implicated as a means of effecting the spread of exotic plants, Fensham (1998) indicates that relatively few exotic species have the capacity to displace native species without mechanical disturbance, with the

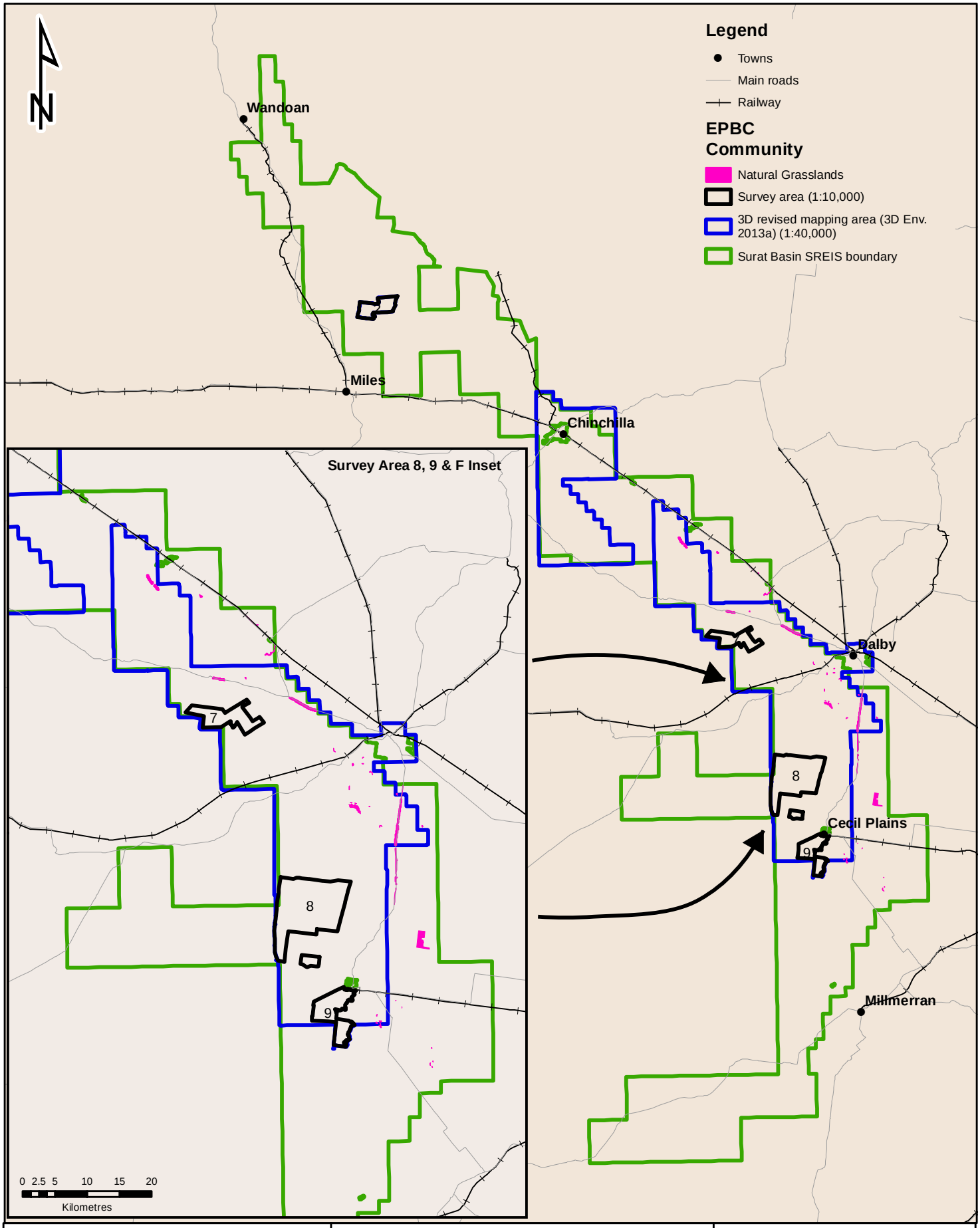
exception of lippia (*Phyla canescens)* a weed which is a pervasive groundcover in many habitats within the project development area. Due to the susceptibility of the habitat to edge effects and invasive species, plus the highly specific edaphic controls, the Natural Grassland TEC is attributed as having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

Proposed management / mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impact to this ecological community.

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

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

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



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

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

Figure A2. Distribution of natural grasslands ecological community

Client Arrow

0 15 30 45 60
Kilometres

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:1,084,632	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A2_A4P.mxd	5/05/2013	A4

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A2_A4P.mxd

Rule(s) for Ecological Community Mapping:

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

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

Evaluation under MNES referral guidelines

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

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

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

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

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

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

EPBC Act Status: Endangered

VM Act Status: Endangered

Biodiversity Status: Endangered

Sensitivity: High

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

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

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

Overview of the Semi-evergreen Vine Thicket TEC

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

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

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

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

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

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

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

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

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

Table A44. Extent of the Semi-evergreen Vine Thicket TEC within the project development area and associated areas of assessment.

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

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

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

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

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

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

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

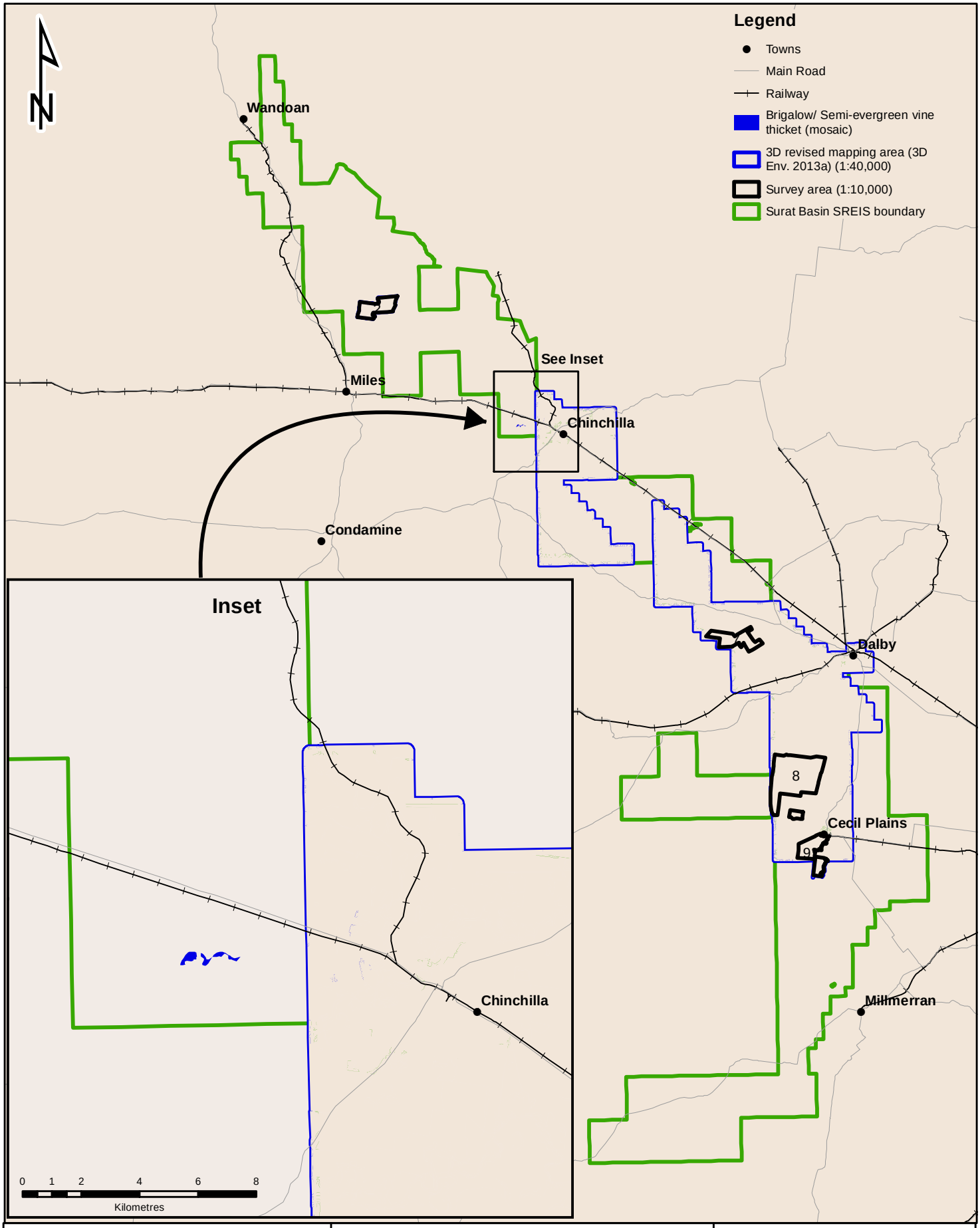
Proposed management / mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impact to this ecological community.

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

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

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

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



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

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

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

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,084,632	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A3_A4P.mxd	5/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A3_A4P.mxd

Rule(s) for Ecological Community Mapping:

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

Evaluation under MNES referral guidelines

Table A45. Significance of impact to the Semi-evergreen Vine Thicket TEC under MNES referral guidelines.

Criteria	Evaluation
Criteria 1: Reduce the extent of an ecological community	The Semi-evergreen Vine Thicket TEC does not occur within survey areas 2, 7, 8, 9 or F and no reduction in the extent of this ecological community will result from project development activities in these locations. In accordance with **Criteria 1**, no significant impact is expected.
Criteria 2: Fragment or increase fragmentation of an ecological community	Will not fragment or increase fragmentation of the ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 2**, no significant impact is expected.
Criteria 3: Adversely affect habitat critical to the survival of an ecological community.	Will not adversely affect habitat critical to the survival of the ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 3**, no significant impact is expected.
Criteria 4: Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	Will not modify or destroy abiotic (non-living) factors necessary for an ecological communities survival based on information provided in **Criteria 1.** In accordance with **Criteria 4**, no significant impact is expected.
Criteria 5: Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 5**, no significant impact is expected.
Criteria 6: Cause a substantial reduction in the quality or integrity of an occurrence of an ecological	Will not cause a substantial change in the species composition of an occurrence of an ecological

Criteria	Evaluation
community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established; or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	community based on information provided in **Criteria 1.** Extensive measures to control the introduction and spread of exotic species within Arrow tenements are proposed (commitments C099, C179, C188, C183). In accordance with **Criteria 6**, no significant impact is expected.
Criteria 7: Interfere with the recovery of an ecological community.	Will not interfere with the recovery of an ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 7**, no significant impact is expected.

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

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

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

Weeping Myall Woodlands

EPBC Status: Endangered

VMA Status: Not Represented

Biodiversity Status: Not Represented

Sensitivity: High

No of survey sites: 1 Secondary (GB82).

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

Regional Ecosystems: Not represented

Overview of the Weeping Myall Woodlands TEC

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

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

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

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

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

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

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

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

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

development area meaning that any occurrences are highly significant, representing the eastern limits of the ecological communities distribution.

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

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

Significance of project-related impacts: Current indications are that the community is capable of regeneration following removal of disturbance regimes (DEWHA, 2009c) although information relating to the success of rehabilitation efforts from past examples is lacking. The groundcover, dominated by graminoids and herbs is highly sensitive to disturbance and was observed to be subject to infestation by lippia in patches. The habitat sensitivity is therefore considered to be ***High.*** A total of 31 000 ha of the community is estimated to occur in Queensland (DEWHA, 2009). This is however based on

available RE mapping (EHP 2012a) which is poorly constrained due to the prevalence of heterogeneous polygons and coarse spatial accuracy (± 100 m) which does not provide a sound basis for accurately assessing the extent of the Weeping Myall TEC within the project development area. Given that the project development area occurs at the eastern limit of the ecological communities distribution, the potential magnitude of impact is considered to be ***Moderate (17)*.**

Proposed management / mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impact to this ecological community.

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

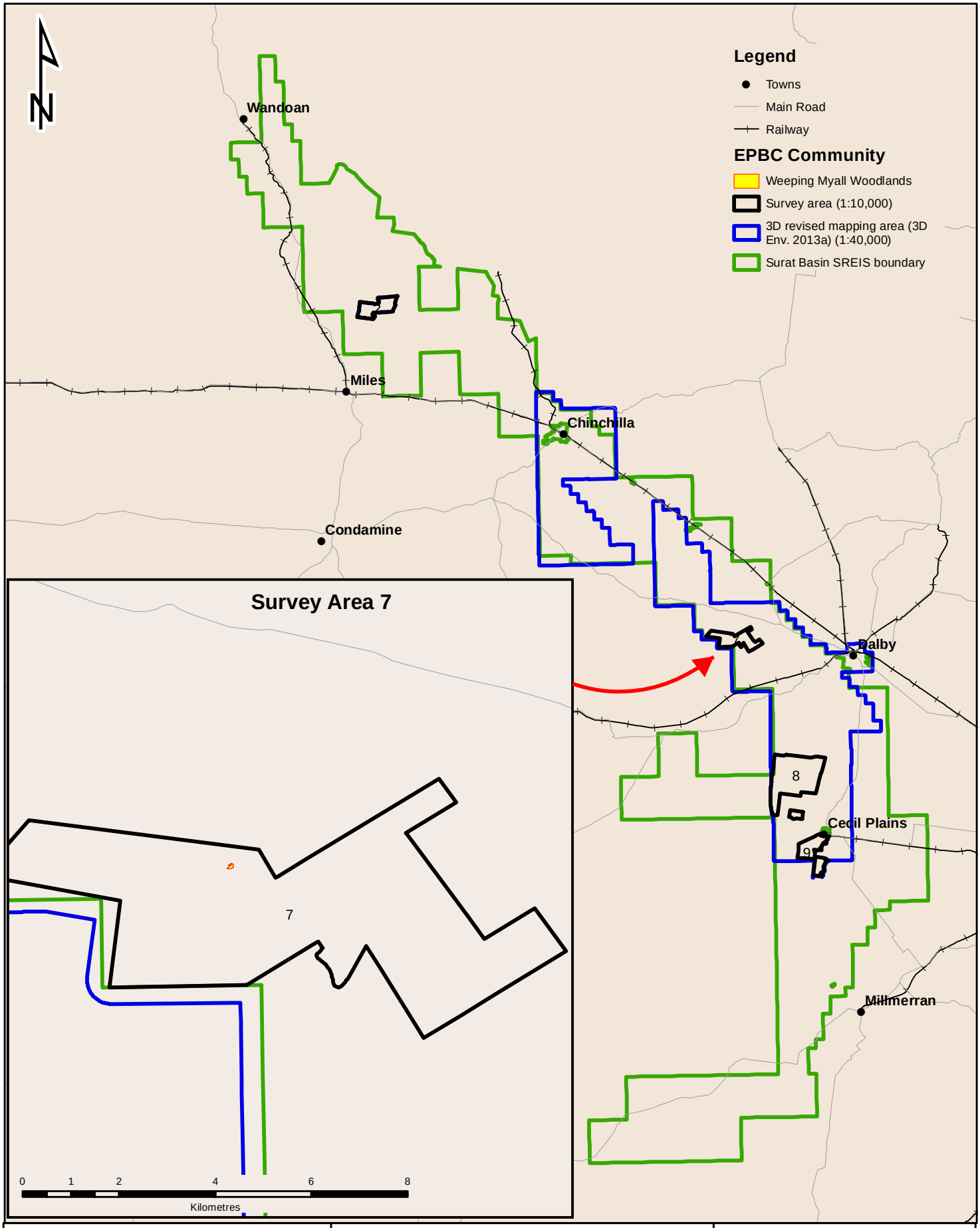
Without any mitigation, impact significance will be ***Moderate* (17)*.*** Avoidance with strict protocols to manage edge effects through appropriate application of buffers will completely mitigate impacts potentially incurred through Arrow activities and there will be no residual impact. The application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

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

*Includes appropriate application of management buffers

Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts



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

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

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

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,084,632	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A4_A4P.mxd	5/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A4_A4P.mxd

Rule(s) for Ecological Community Mapping:

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

Evaluation under MNES referral Guidelines

Table A46. Significance of impact to the Weeping Myall Woodland TEC under MNES referral guidelines.

Criteria	Evaluation
Criteria 1: Reduce the extent of an ecological community	Within survey area 7, 0.85 ha of the Weeping Myall Woodland Ecological Community will be cleared for project development activities. This assessment assumes that all vegetation associated with survey area 7 will be cleared. Development of survey areas 2, 7, 8, 9 and F will not result in impact to the the ecological community. No impact will be incurred within survey areas 2 as it was not found to be present. In accordance with Criteria 1, a significant impact is expected due to reduction in extent of the Weeping Myall Woodlands TEC.
Criteria 2: Fragment or increase fragmentation of an ecological community	Clearing associated with development activities on survey area will increase fragmentation of an ecological community based on detail provided in **Criteria 1**. In accordance with **Criteria 2**, a significant impact is expected.
Criteria 3: Adversely affect habitat critical to the survival of an ecological community.	The occurrences subject to clearance are small isolated remnants that occur in a heavily fragmented landscape. The habitat associated with survey area 7 should not be considered critical to the survival of the ecological community. In accordance with **Criteria 3**, impact to the Weeping Myall TEC in survey area 7 will not adversely affect habitat critical to the survival of an ecological community. It should be noted however that the ecological community in survey area 7 occurs at the eastern limits of distribution and provides a good type example of the habitat in relatively good condition.
Criteria 4: Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	It is assumed that the entirety of Weeping Myall Woodland TEC within survey area 7 will be cleared during development. If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (within Table A1) will be sufficient to prevent

Criteria	Evaluation
	modification or destruction of abiotic factors critical to the survival of the ecological community and no impact in accordance with **Criteria 4** is expected.
Criteria 5: Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	Clearing associated with development activities on survey area 7 will destroy the occurrence of Weeping Myall TEC and cause substantial change in species composition in accordance with **Criteria 5**. If the Weeping Myall Woodland TEC within survey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (within Table A1) will be sufficient to prevent loss of a functionally important species.
Criteria 6: Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established; or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	Clearing associated with development activities on survey area 7 will destroy the occurrence of Weeping Myall TEC and cause substantial reduction in the quality and integrity of an occurrence of and ecological community in accordance with **Criteria 6**. If the Weeping Myall Woodland TEC within survey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (within Table A1) will be sufficient to mitigate impacts described in association with **Criteria 6.**
Criteria 7: Interfere with the recovery of an ecological community.	The ecological community is not in state of recovery within survey area 7. Hence project development activities with survey area 7 will not have an impact in accordance with **Criteria 7**.

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

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

Rule(s) for survey effort required in accordance with survey guidelines: Guidelines for survey of vegetation in Queensland, prepared by Nelder et al, are sufficient to identify this ecological community during field surveys. Conditions thresholds for classification of this TEC contained within DEWHA (2009) should be referenced during survey to ascertain ecological community size and condition thresholds.

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

EPBC Status: Critically Endangered

VM Act Status: Least Concern

Biodiversity Status: No Concern at Present

Sensitivity: High

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

Regional Ecosystems: 11.8.2a

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

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

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

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

A relatively extensive occurrence of RE 11.8.2a (*Eucalyptus tereticornis* + *Eucalyptus melliodora* woodland) are represented in the certified RE mapping (EHP, 2012a) on steep basalt landforms in the Captains Mountain area to the south of Millmerran. The ecological community forms a primary component of this RE (TSSC, 2006a). These sites could not be accessed during the field survey to allow habitat confirmation, although the occurrence of white box (*Eucalyptus melliodora)* in roadside regrowth vegetation suggests that the RE is likely to be accurately represented. However, the nature of the shrub layer requires consideration and only those remnants with a significant cover of native tussock grasses and a patchy shrub layer are consistent with classification of the ecological community. Remnant patches with consistently dense shrub layers are excluded from the classification. In the absence of detailed field survey, it should be assumed that areas of mapped RE11.8.2a provide representation for the White Box – Yellow Box Blakely's Red Gum Grassy Woodland Ecological Community. The community should therefore be considered likely to occur in basalt landscapes to the southern portion of the project development area.

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

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

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

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

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

Table A47. White Box-Yellow Box-Blakely's Red Gum Grassy Woodland TEC within the project development area and associated areas of assessment.

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

* Based on regional ecosystem mapping of EHP (2012a ad 2012b). Level of confidence = ***Low***
** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate***
*** Extent of habitat in the detailed mapping area as per RE mapping provided by EHP (2012a and 2012b) for purposes of comparison. Level of confidence = ***Low***
**** Calculations based on detailed 1: 10 000 scale RE mapping undertaken for supplementary assessment purposes. Level of confidence = ***High***.
***** Not Considered in the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC.

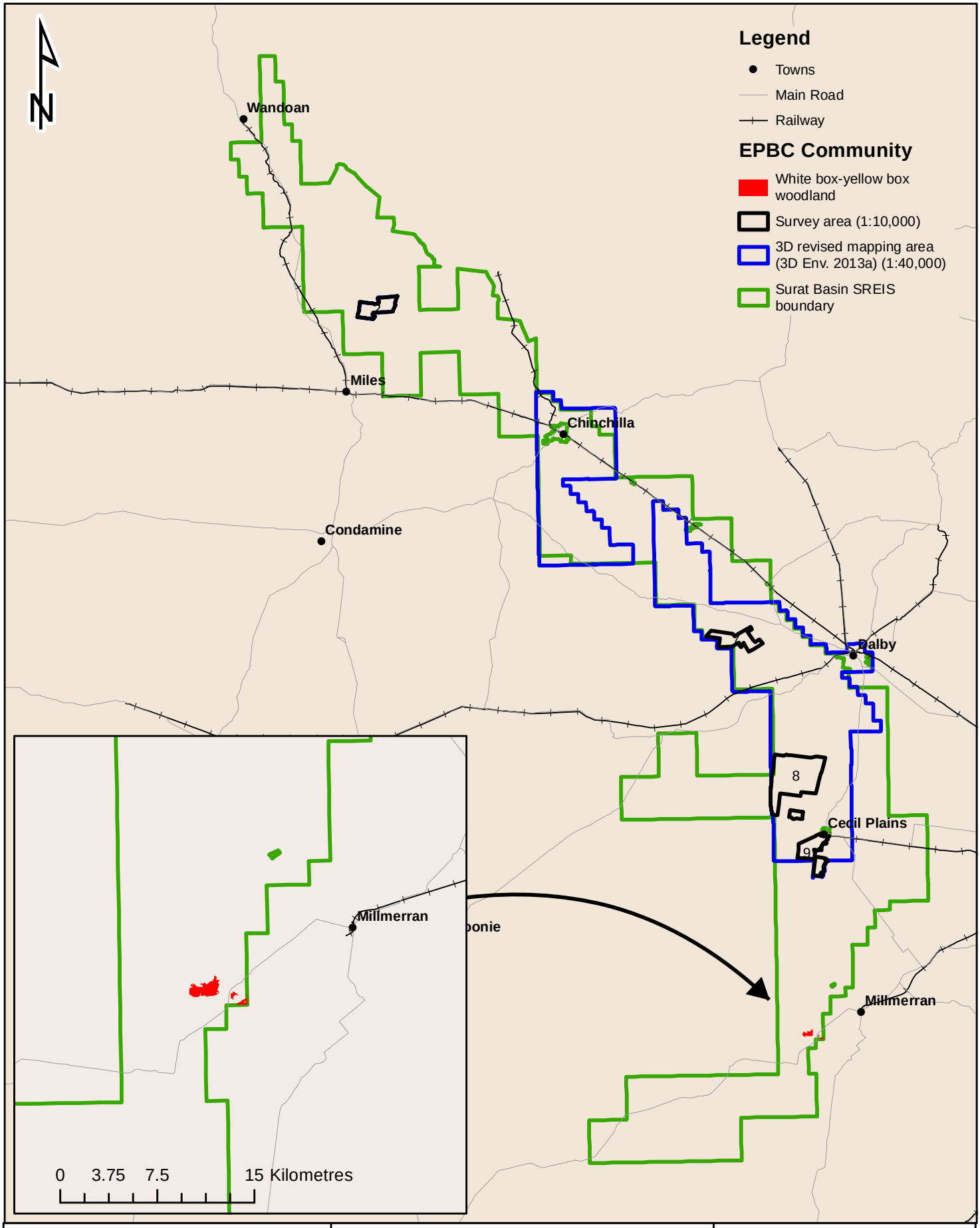
Significance of project-related impacts: Given the fragile nature of the ground cover which comprises a number of perennial grass species which are susceptible to degredation, coupled with the fact that the community is at the northern limit of its ecological range, the sensitivity of this habitat is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

Proposed management / mitigation measures: Commitments made by Arrow documented within **Table 1** are considered sufficient to mitigate impact to this ecological community.

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

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

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



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

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

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

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,084,632	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A5_A4P.mxd	5/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A5_A4P.mxd

Rule(s) for Habitat Mapping:

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

Evaluation under MNES referral guidelines

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

Criteria	Evaluation
Criteria 1: Reduce the extent of an ecological community	The White Box – Yellow Box, Blakely's Red Gum Grassy Woodland does not occur within any survey area. No reduction in the extent of this ecological community will result from project development activities in these locations. In accordance with **Criteria 1**, no significant impact is expected.
Criteria 2: Fragment or increase fragmentation of an ecological community	Will not fragment or increase fragmentation of the ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 2**, no significant impact is expected.
Criteria 3: Adversely affect habitat critical to the survival of an ecological community.	Will not adversely affect habitat critical to the survival of the ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 3**, no significant impact is expected.
Criteria 4: Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	Will not modify or destroy abiotic (non-living) factors necessary for an ecological communities survival based on information provided in **Criteria 1.** In accordance with **Criteria 4**, no significant impact is expected.
Criteria 5: Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 5**, no significant impact is expected.
Criteria 6: Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established; or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	Will not cause a substantial change in the species composition of an occurrence of an ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 6**, no significant impact is expected.
Criteria 7: Interfere with the recovery of an ecological community.	Will not interfere with the recovery of an ecological community based on information provided in **Criteria 1.** In accordance with **Criteria 7**, no significant impact is expected.

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

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

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

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

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

EPBC Status: Endangered

VM Act Status: Of Concern

Biodiversity Status: Of Concern

Sensitivity: High

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

Relevant REs: 11.3.3

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

Overview of the Coolibah – Black Box Woodlands TEC

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

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

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

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

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

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

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

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

Table A48. Extent of the Coolibah – Black Box woodlands TEC within the project development area and associated areas of assessment.

	RE11.3.3*	**Mature Regrowth (RE11.3.3)***	**Total (ha)**
Project development area*	259	225	484
3D Detailed Mapping Area**	11.7	0	11.7
3D Detailed Mapping Area based on EHP (2012a and 2012b)***	127	163	290
Project development area****	144	62	206

	RE11.3.3*	Mature Regrowth (RE11.3.3)*	Total (ha)
Survey area 7*****	11.7	0	11.7
Survey areas 28, 9 and F *****	0	0	0

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

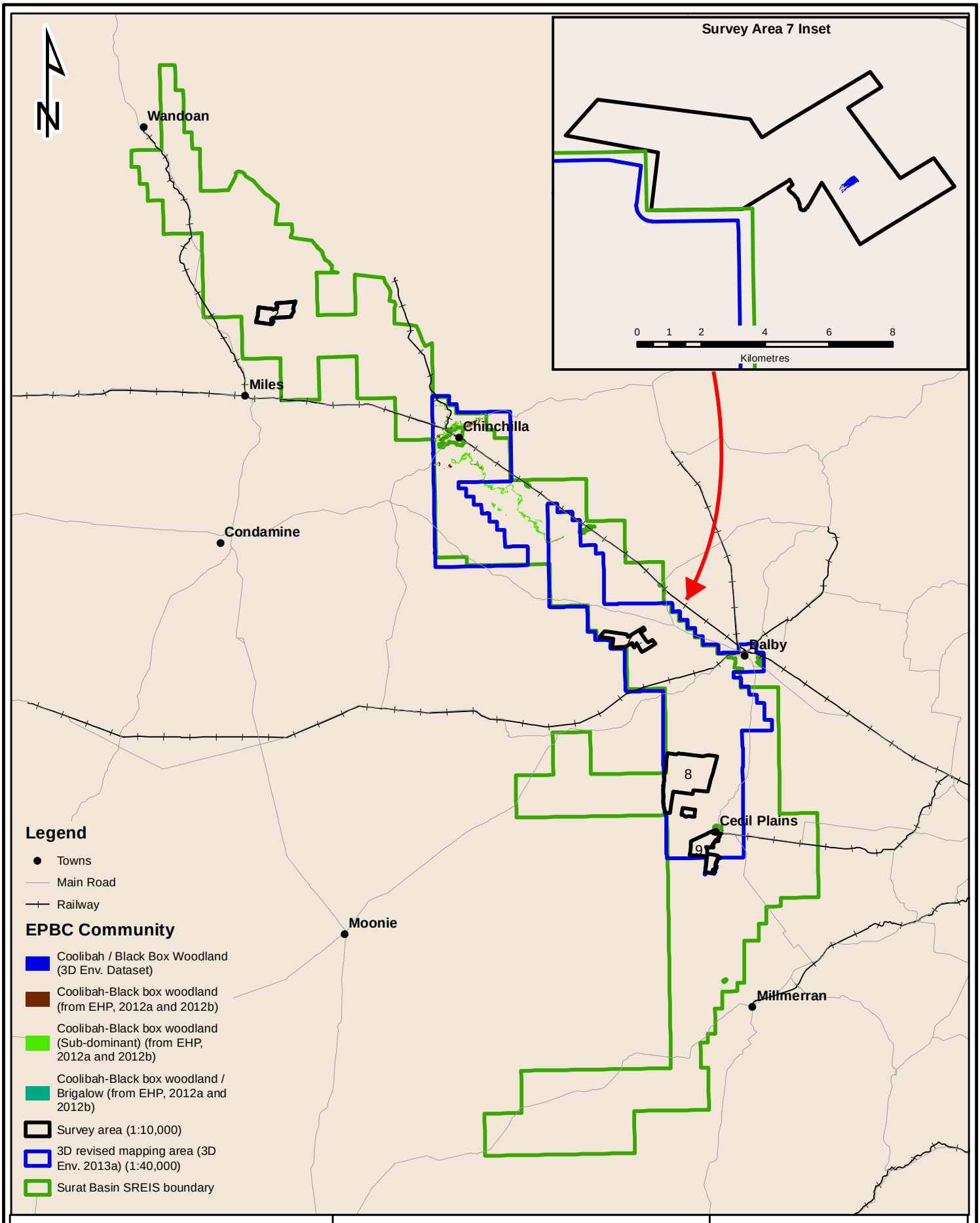
** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental. Level of Confidence = ***Moderate*** (excludes patch sizes < 5ha).

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

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

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

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



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

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

Figure A6. Distribution of coolibah-black box ecological community.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,084,632	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A6_A4P.mxd	5/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_Append_A6_A4P.mxd

Rule(s) for Ecological Community Mapping:

1. EHP RE mapping database (EHP 2012a); The Coolibah – Black Box Woodlands TEC is applied to RE11.3.3, and 11.3.3c. Where these REs contribute <50% to the total area of a heterogeous polygon, they are mapped as 'Coolibah – Black Box sub-dominant'. Where these REs (or a combination of these REs) contribute >50% but less than 100% to the total area of a polygon, they are mapped as 'Coolibah – Black Box dominant'.
2. EHP mature regrowth dataset (EHP 2012b): The Coolibah – Black Box Woodland TEC is applied to the mature regrowth dataset (EHP 2012b) as per EHP 2012a.
3. 3D Environmental database (3D Environmental 2013); The The Coolibah – Black Box Woodland TEC is applied to RE11.3.3 where it occurs in patch sizes > 5 ha. Refer to TSSC (2011b) for mapping and floristic thresholds.
4. The 3D Environmental database (3D Environmental 2013) takes precedence for mapping purposes although this is subject to further refinement following detailed field survey.

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

Significance of project-related impacts : The habitat is highly sensitive to altered hydrological regimes which may modify and cause irreversible changes in ground cover composition and integrity. Hence the sensitivity to disturbance of this ecological community is considered ***High***. The Brigalow Belt South bioregion hosts 181 173 (13%) of the ecological community out of a total of 1 321 103 ha at a national level (TSSC, 2011a). Approximately 386 ha of the community is inferred to be present in the project development area (based on EHP 2012a), 0.14% of the total bioregional representation. The magnitude of potential unmitigated impact to this habitat is considered ***Moderate*** with the significance of unmitigated impact considered to be ***Moderate (17).***

Proposed management / mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impact to this ecological community.

Summary residual impact assessment: Without any mitigation, impacts of moderate significance will possibly happen and impact significance will be ***Moderate (17).*** Total habitat avoidance will completely mitigate against impact and residual impact will not be incurred Alternative management measures and well managed rehabilitation in disturbed areas will mostly mitigate impacts. The residual impacts in this case will be of ***Low (4)***.

Residual Significance Assessment				
Avoidance			**Others**	
Sensitivity Ranking	**Magnitude Ranking**	**Significance Ranking**	**Magnitude Ranking**	**Significance Ranking**
High	NA	NA	Extremely Low	Low (4)

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

Evaluation under MNES referral Guidelines

Table A20. Significance of impact to the Coolibah - Black Box Woodlands TEC under MNES referral guidelines.

Criteria	Evaluation
Criteria 1: Reduce the extent of an ecological community	Within survey area 7, 11.7 ha of the Coolibah / Black Box Woodlands TE will be cleared for project development activities. This assessment assumes that all vegetation associated with survey area 7 will be cleared. In accordance with **Criteria 1**, a significant impact is expected. Development of survey areas 7, 8, 9, 2 and F will not result in impact to the the ecological community.
Criteria 2: Fragment or increase fragmentation of an ecological community	Clearing associated with development activities onsurvey area 7 will increase fragmentation of an ecological community based on detail provided in **Criteria 1**. In accordance with **Criteria 2**, a significant impact is expected.
Criteria 3: Adversely affect habitat critical to the survival of an ecological community.	The occurrences subject to clearance are small isolated remnants that occur in a heavily fragmented landscape. The habitat associated within survey area 7 should not be considered critical to the survival of the ecological community. In accordance with **Criteria 3**, no significant impact is expected through this mechanism.
Criteria 4: Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	It is assumed that the all Coolibah - Black Box Woodlands within survey area 7 will be cleared during development. If these habitats can be avoided through modification of the impact footprint, commitments made by Arrow (within Table A1) will be sufficient to prevent modification or destruction of abiotic factors critical to the survival of the ecological community. In accordance with **Criteria 4**, no significant impact is

Criteria	Evaluation
	expected through this mechanism.
Criteria 5: Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	If the Coolibah - Black Box Woodlands Ecological Community withinsurvey area 7 can be avoided through modification of the impact footprint, commitments made by Arrow (within Table A1) will be sufficient to prevent loss of a functionally important species. In accordance with **Criteria 5**, no significant impact is expected through this mechanism.
Criteria 6: Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • Assisting invasive species, that are harmful to the listed ecological community, to become established; or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	As per information provided within Criteria 4 and Criteria 5. In accordance with **Criteria 6**, no significant impact is expected through this mechanism.
Criteria 7: Interfere with the recovery of an ecological community.	The ecological community is not in state of recovery within survey area 7. In accordance with **Criteria 7**, no significant impact is expected through this mechanism.

Conclusions: For the Coolibah – Black Box Woodlands TEC the potential impacts are known with 11.7 ha cleared on survey area 7 assuming the entirety of the survey areas are cleared of vegetation. This impact is significant under MNES referral guidelines, Criteria 1 and Criteria 2. These impacts are hoawever predictable and can be reversed by appropriate application of biodiversity offsets according to EPBC Act Environmental Offsets Policy (SEWPaC, 2012). Project related activities will contribute to the cumulative impact incurred to this community across the range of interacting projects considered within the EIS.

There is potential for the Coolibah – Black Box Woodlands TEC to be impacted within the project development area although more likely close to Chinchilla. Survey works to identify areas of this TEC should be undertaken prior to project development activities and habitat avoided wheren indicated. Assuming pre-clearance surveys are undertaken and habitat is avoid, impacts will not be significant under MNES guidelines.

Rule(s) for survey effort required in accordance with survey guidelines: Guidelines for survey of vegetation in Queensland, prepared by Nelder et al, will be sufficient to identify this ecological community during field survey. Thresholds for classification of this TEC contained within TSSC (2011b) should be referenced during survey.

APPENDIX C. MNES Assessments - Significant Flora Species

Shrubs and Trees

Curly-bark wattle (*Acacia curranii*)

Family: Mimosaceae

Status: EPBC Act: Vulnerable; **NC Act**: Vulnerable; **BoT**: Not Listed

Sensitivity: Moderate

Recovery plan: A recovery plan has been prepared by the Australian Nature Conservancy (Pickard 1995a) although this document could not be sourced.

Overview of curly-bark wattle

Description (based on Pedley 1978 & 1987; Maslin 2001): An erect or spreading multi-stemmed shrub, up to 3 m tall, with distinctive red curling (minni-ritchi) bark. Phyllodes (i.e. leaves) are up to 18 cm long, needle-like in shape, though slightly flattened with longitudinal striations. Flowers are clustered into small yellow spikes, < 1.5 cm long. Pods are narrow, up to 3 mm wide.

Plate 9. Curly-bark wattle (*Acacia curranii).* Photograph M. Fagg, Australian National Botanical Gardens

Ecology: The typical life span of curly-bark wattle is unknown, but it is probably similar to many other shrubby *Acacia* species in being a moderately long-lived shrub of 10 to 30 years. It has been recorded flowering during August and September, with pods maturing several months later (Pedley 1987). As a hard-seeded legume, the soil-stored seed reserves of *A. curranii* are likely to be long lived (i.e. > 10 years).

The response to fire by curly-bark wattle may vary depending on the intensity and timing of the burn. In New South Wales populations, plants have been observed to survive fire through vegetative regeneration from root suckers (DECC 1995), yet Cohn (1995) considered that post-fire regeneration at different sites was most likely the result of seed germination, with pre-fire plants apparently killed. There is consistency in reports that curly-bark wattle is capable of post-fire germination, which can be quite dense (Cohn 1995; DECC 1995). Abundant post-fire seed germination probably explains the high stem density of some curly-bark wattle populations. The age at which curly-bark wattle seedlings mature to begin producing seed is an unknown but critical issue influencing appropriate fire intervals. Seedlings of the closely related fire-killed *Acacia tenuissima* begin seed production when 4 years old (Williams *et al*. 2006).

The abundant regeneration via seedlings after fire suggests *Acacia curranii* will also germinate seedlings following mechanical disturbance of the topsoil, although repeated soil disturbance would kill the seedlings that germinate after any initial disturbance. The impact of stock grazing is unknown, but damage from grazing by feral goats has been observed (Cohn 1995).

Habitat: Plants are known to occur in shrubby heaths, dry sclerophyll forests and semi-arid woodlands where they can occur as widely scattered thickets in very species-rich heathy scrub with emergent eucalypts (Pickard 1995c, Threatened Species Scientific Committee 2008). Curly-bark wattle grows on sandy clay soils that are poorly drained on weathered sandstone (Pedley 1987; Pickard 1995c). The Queensland population at Gurlumundi has been reported as growing in dense "groves" (Pedley 1987). Queensland collections of curly-bark wattle, recorded in Herbrecs (EHP 2013), mostly occur within areas mapped by the Queensland Herbarium as Regional Ecosystem 11.7.5; shrubland with *Calytrix* spp., *Hakea* spp., *Kunzea* spp., *Micromyrtus* spp., *Acacia* spp., *Melaleuca* spp. and a spinifex grass layer, on natural scalds on deeply weathered sedimentary rocks.

Herbrecs collections (EHP 2013) indicate that a population of curly-bark wattle has been collected on the north-west boundary of the project development area occuring within the mapped regional ecosystem 11.7.6, which is Lemon scented gum (*Corymbia citriodora*) or ironbark (*Eucalyptus crebra*) woodland on lateritic duricrust. An additional curly-bark wattle plant has also been collected in an adjacent area mapped as a mixture of regional ecosystems 11.7.7, 11.7.4 and 11.5.1. These ecosystems are various eucalypt woodlands (e.g. *Eucalyptus fibrosa* subsp. *nubile, Corymbia citriodora, Eucalyptus decorticans* or *Eucalyptus crebra*) woodland on lateritic duricrust or Cainozoic sand plains. The consistent factor in these ecosystems is their association with lateritic duricrust or sand plains.

Distribution: The species has a disjunct distribution in NSW and Queensland, with populations separated by several hundred kilometres. The NSW populations occur in the south west plains of

western NSW, in the Lake Cargelligo area and on the Gunderbooka Range near Bourke (Pickard 1995c, Orchard & Wilson 2001a). The only Queensland population occurs in and adjacent to the Gurulmundi State Forest area of the Darling Downs, approximately 65 km north-west of Chinchilla (Pedley 1987; Maslin 2001). The Gurulmundi population, which is adjacent to the project development area and restricted to an area of less than 20 km diameter (EHP 2013), represents a highly disjunct northern limit of distribution. It is considered that the three main populations are too broadly separated to facilitate gene flow between populations.

Likelihood of occurrence in the project development area and extent of habitat: The species is is shown to occur from existing Herbrecs collections on the north-west boundary of the project development area, approximately 65 km north of Chinchilla, and further west towards and within Gurulmundi State Forest. These records are all attributed with 'low' precision (±16 km) and hence the occurrence of curly-bark wattle should only be considered 'possible' within the project development area. The Gurulmundi area is reported to support two populations with approximately 200 individuals (Pickard 1995c). The species was not detected during field surveys within the project development area, not being recorded in any of the sites proposed for development (i.e. survey area 2, 7, 8, 9 and F). The Gurulmundi population including the collection within the project development area is associated with a broad east-west trending bioregional wildlife corridor that spans the northern portion of the study area. This wildlife corridor encompasses both Barakula and Gurulmundi State Forests.

Figure A7 indicates the location of Herbrecs collections of the species (EHP 2013) as well as providing representation of the distribution of habitat (including 'core habitat known' and 'core habitat possible) within the project development area. The extent of habitat within specific areas of the project development area is summarised within **Table A21.**

Threats: The main threats to the local populations of curly-bark wattle are:

- Grazing, browsing and trampling of adult and seedling plants by feral goats and rabbits (and to less an extent by stock, and macropods). This may be facilitated installation of well ponds which artificially increases watering points for feral animals.
- Clearing of vegetation, including for road widening, gravel extraction and mining;
- Habitat erosion and associated sedimentation of habitat.
- Inappropriate fire regimes, including too frequent fires that do not allow seedlings to mature to produce seed; or fires that are too intense and extensive, which do not leave any mature plants unburnt and limit vegetative survival from root suckers. Alternatively, a long absence of fire, required to promote seedling establishment, for such a period that the soil seed reserves begin to senesce (Lithgow 1997, DECC 2005a, Threatened Species Scientific Committee 2008a). Fires may also be ignited accidentally during construction and operation.

Table A21. Extent of habitat for curly-bark wattle within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
Project development area*	0	74666	0
3D Detailed Mapping Area**	0	0	1479
3D Detailed Mapping Area based on EHP (2012)***	0	1315	0
Survey area 2****	0	0	1249
Survey area 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Of the threats listed above, removal of the shrubs through mechanical clearing, damage from feral animals, especially goats and rabbits, and inappropriate fire regimes are likely to be the most significant for the Gurulmundi population. Damage to curly-bark wattle populations from grazing by goats has been recorded by several observers of NSW populations (Cohn 1995; Martin 2011). For example, in 2011, a group of naturalists were unable to find a NSW population of curly bark wattle on Mt Gundabooka, which in 2005 had been reported to have 150 mature plants across two small areas (Martin 2011). It was also suggested that damage from goats or changed fire regimes may be the cause of this localised decline. Fire regimes that are too frequent will not allow sufficient post-fire seedlings to mature to seed production, and very infrequent fires may lead to the absence of seedlings to replace plants that senesce after a decade or more.

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, influencing the success of pollen and seed dispersal.
- Changed fire regimes, such as complete fire exclusion, or repeated, frequent unplanned fires that occur before seedlings can begin producing seed. Changes to fire regimes may be

associated with landscape fragmentation that may occur during development of linear infrastructure and gathering lines.

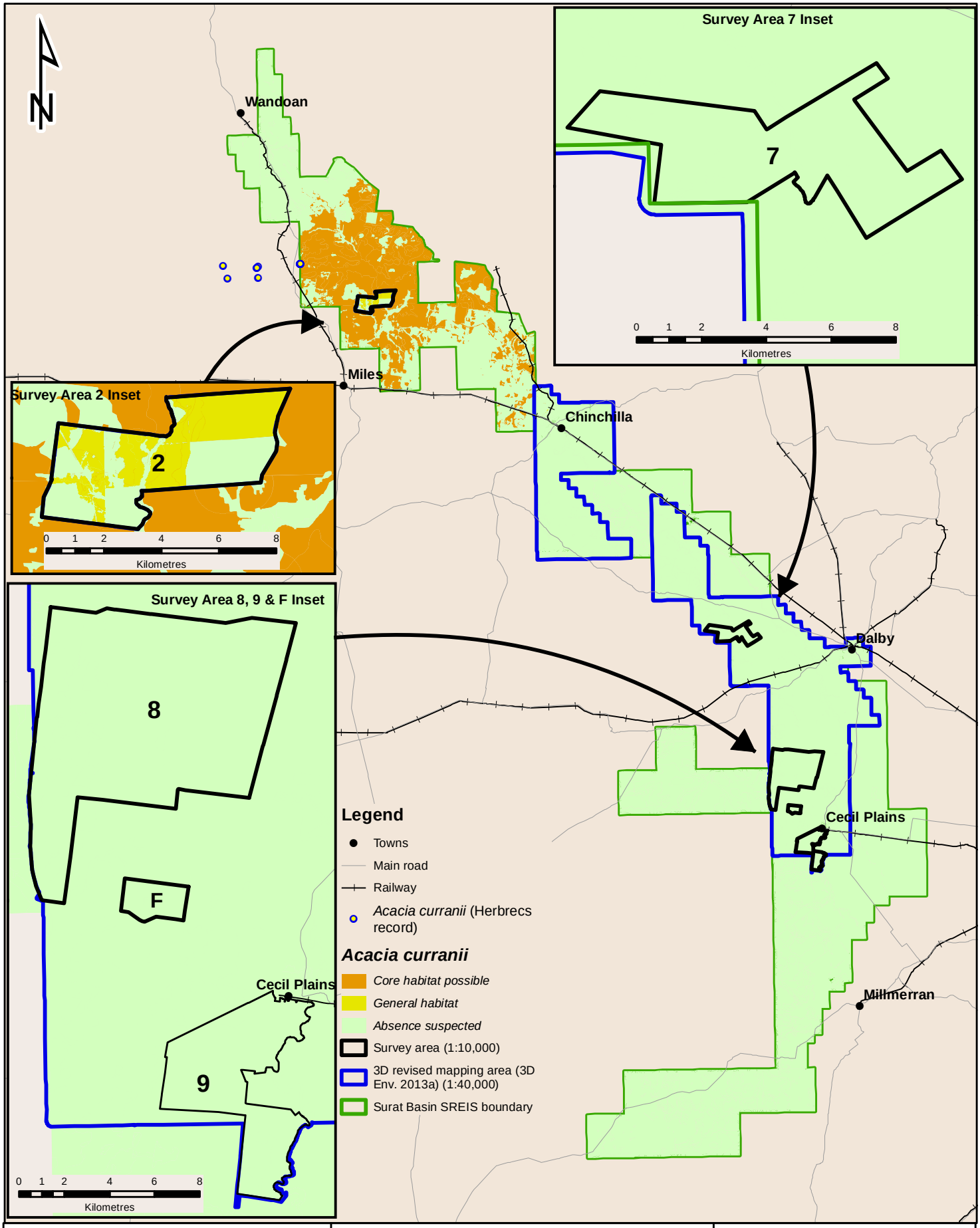
Significance of project related impacts (unmitigated): The sensitivity of curly-bark wattle disturbance is considered ***Moderate.*** This is based on the fact that curly-bark wattle is a perennial plant with the ability to generate abundantly from seed following a disturbance such as fire, with some capacity for survival through vegetative suckering; and due to the likelihood of a long lived soil seed reserves.

The potential magnitude of unmitigated impact to curly-bark wattle is considered ***High.*** This is because, based on attribution of the government generated RE and mature regrowth mapping databases (EHP 2013a and 2013b), approximately 20% of the local population occurs within the project development area, and an estimated 12% of the project development area contains possible habitat ('core habitat possible').

The only known core habitat for curly-bark wattle in Queensland occurs within a 20 km area, with part of this local population occurring on the north-western boundary of the project development area. Core habitat also occurs outside of project development area in Gurulmundi SF, which is known to be contained within non-Arrow controlled petroleum leases. It has a low abundance both locally and regionally. Core habitat within state forest areas and adjoining land is subject to disturbance by logging. Without mitigation measures, project impacts to restricted areas of core habitat are expected to occur over the life of the project causing decline in local populations although never extinction. It is possible, though not certain, that natural recruitment following disturbance will be able to replace or restore the population density within several generations. It is unlikely to affect the long-term integrity of the entire species which is also known in NSW from two populations.

Specific management / mitigation for curly-bark wattle populations: Management of this species is covered in Arrow committments made within **Table A1.** Infrastructure design and site selection that seeks to avoid core habitat known of curly bark wattle will be prioritised. In addition, the following mitigations should be applied specifically to curly-bark wattle:

- Ensure habitat adjacent to curly-bark wattle retains sufficient connectivity to allow natural movement of fire throughout the landscape. Consider prescribed fire management for the species where habitat connectivity is interrupted (recommended additional context to fire management contained within the commitment C223).
- Where possible, retain some undisturbed clusters of plants within the disturbance footprint as a future source of seed for rehabilitation or natural post disturbance regeneration.



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A7. Curly bark wattle *(Acacia curranii)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for Habitat Mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. RE polygons with confirmed records (≤ 500 m precision) should be treated as “core habitat known”:
3. The following regional ecosystems occurring to the north of Chinchilla (-27.75) should be classed as “core habitat possible”:
    - RE 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 (‘low’confidence is applied to EHP 2012a with ‘high’ confidence applied to 3D Environmental dataset (3D Environmental 2013).
    - Where these REs have been subject to intensive survey and the species was not found, they can be downgraded to ‘general habitat’.
4. The EHP mature regrowth dataset (EHP 2013) is not included in the attribution as the species is known only from intact habitats.
5. All other remnant and non-remnant vegetation, including cleared grazing land within the project development area should be treated as “absence suspected” (‘high’ confidence is applied).

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Summary residual impact assessment: Unmitigated project related activities may result in a residual impact of ***Moderate*** **(18**) significance to curly-bark wattle populations within the project development area. Where avoidance of habitat or populations is not possible, the identified impact management measures of minimising disturbance, and rehabilitation are considered to be mostly effective. Curly-bark wattle is known to germinate abundant seedlings and is likely to be successfully rehabilitated, with a new population maturing within several years. These may mitigate impacts to a large degree, to the extent that minor loss in a local population occurs. If infrastructure avoids core habitat, no impact to the ecological community is expected. If not avoided, but other mitigation measures are implemented, impacts of ***Moderate (13)*** significance may be expected in consideration to the expected success of rehabilitation, particularly if some undisturbed plant clusters can be retained within disturbance footprint.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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

Evaluation under MNES referral guidelines

Table A22. Evaluation of impact significance for curly bark wattle under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge a single record of the species occurs within the project development area with further records occurring within the Gurulmundi State Forest 10 km west of the project development area boundary. The record within the project development area should be considered a component of the Gurulmundi population which forms the only population of the species known from Queensland. Curly bark wattle populations are highly disjunct and all should be considered 'important populations'. The proposed facility site survey area 2 contains general habitat for the species and although extensive site survey not locate a population of curly-bark wattle, there remains potential for the species to exist. Pre-construction surveys will be required to totally discount its occurrence. No other property considered for development in the near future contains potential habitat for the species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive field survey failed to locate this species within potentially suitable habitats. It is not possible however to totally discount occurrence of the species within these properties and pre-clearance survey will be required once final project footprints have been identified. Based on current knowledge an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact to the species is not expected.

Criteria	Evaluation
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not adversely affect habitat critical to survival of the species based on detail provided in **Criteria 1**. In accordance with **Criteria 4**, a significant impact to the species is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact to the species is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Whilst broadscale clearing of propertlysurvey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of propertysurvey area 2 will not introduce landscape scale processes that have potential to modify, destroy, remove or isolate or decrease habitat leading to decline of the species. Development within other subject properties will not impact wildlife corridors. In accordance with **Criteria 6**, a significant impact to the species is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not result in establishment of an invasive species based on detail provided in Criteria 5. Commitments presented in the EIS should be used to control the introduction and spread of exotic species within tenements areas proposed. In accordance with **Criteria 7**, a significant impact to the species is not expected.
Criteria 8: introduce a disease	Diseases which impact acacia species are not known to occur. In accordance with **Criteria 8**, a significant impact to the species is not expected.
Criteria 9: interfere with the recovery of the species	The species currently exists within an intact population in vicinity of the project development area. From current knowledge, this population is stable and not in the process of recovery from prior disturbance. In accordance with **Criteria 9**, a significant impact to the species is not expected.

Conclusions: For curly-bark wattle (*Acacia curranii)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There

is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

Rule(s) for survey effort required in accordance with survey guidelines: Curly-bark wattle is a perennial shrub species that, due largely to the nature of its distinctive bark, should be readily identified throughout all seasons. Hence no specific survey timing is required to effectively detect the species.

Hando's Wattle *(Acacia handonis)*

Family: Mimosaceae

Status: EPBC Act: Vulnerable; **NC Act**: Vulnerable **BoT:** Not Listed

Sensitivity: Moderate

Recovery plan: A formal recovery plan has not been prepared although Halford (1995b) has prepared advice in regard to species management.

Overview of Hando's wattle

Description (based on Pedley 1981; Maslin 2001; Hando 2007): Hando's wattle is a small shrub of 1 to 2 m in height. It is resinous, with ribbed branchlets. The phyllodes (i.e. leaves) are spirally arranged, less than 2 cm long and 5 mm wide, and with a small recurved mucro point at the apex. Flowers are grouped together into bright yellow globular heads, with a single head arising from a phyllode axil. Pods are up to 4 cm long and 4 mm wide, which are thickened along the edges of the suture and have a coating resembling sawdust.

Plate 10. Hando's wattle (*Acacia handonis).* Photograph M. Fagg, Australian National Botanical Gardens.

Ecology: The life span of Hando's wattle plants in the wild is unknown, but they live for about 10 years in cultivation (Hando 2007). Plants have been collected in flower in July, August and September, and with pods in August, September and November (EHP 2013). As a hard-seeded legume, the soil-stored seed reserves of Hando's wattle are likely to be long lived (i.e. > 10 years).

The response to fire by Hando's wattle has not been well studied. However, it is suggested that it regenerates well from seed following burning (DNR 2000). Hando (2007) reported the value of treating seeds with boiling to promote germination – a treatment typically used to mimic the heat of a fire. (Halford 1995b) observed a few plants re-sprouting from the base of the stems after a fire, suggesting Hando's wattle is mainly fire killed, regenerating via seedlings, but that a minor number can survive where the fire is a low intensity fire.

Acacia species with fire-promoted germination often have quite dense clumping of plants and this has been observed by botanists while collecting samples of Hando's wattle (e.g. with clumps of several hundred plants noted in a 2003 collection (AVH 2013a). Halford (1995b) recorded plant density varied across the known population, from one to 16 plants every 100 m^2, estimating that approximately 60% of the population were juveniles, < 10 cm tall. Twelve years later, Hando (2007) reported that the population had declined. Barakula State Forest is capable of fuelling intense fires, the most recent of which occurred in November 2012 (ABC 2012). Fires burnt through most of the known population area in Barukula State Forest in 1990 and 1991, though the fires were patchy enough so that some plants were not burnt (Halford 1995b).

The information from various reports reveal a population dominated by juveniles in 1995, four or five years after fires, and a decline in plant density by 2007. This reflects a typical boom and bust cycle of a short-lived, fire-promoted wattle. The age at which Hando's wattle seedlings begin producing seed is a critical unknown issue that is an important to determine to assist the management of the species.

Habitat: Hando's wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest (Maslin 2001, Orchard & Wilson 2001). The vegetation it grows within is a shrubby woodland of *Eucalyptus fibrosa* subsp. *nubila*, *Eucalyptus watsoniana* subsp. *watsoniana, Lysicarpus angustifolius,* and *Allocasuarina inophloia* (Halford 1995). The descriptions of the habitat from which it has been collected are consistent with the regional ecosystem mapping for its locations. This is, primarily RE 11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. One collection is also recorded in RE 11.7.6: *Corymbia citriodora* or *Eucalyptus crebra* woodland on lateritic duricrust. Although in the wild, Hando's wattle is restricted to lateritic sandstone ridges, Hando (2007) found that they could be grown successfully in sandy loam soil and required very little watering, which is important information for potential translocation and rehabilitation.

Distribution: Hando's wattle has an extremely restricted occurrence, being known only from the Barakula State Forest, approximately 40 km north of Chinchilla (Maslin 2001). This population of Hando's wattle was considered to occur in three adjacent areas and was estimated in 1994 to contain around 10 080 individuals over approximately 28 ha (Halford 1995b). The extent of population was considered to have broadened within the Barakula State Forest between the initial collections in 1978 and 1997 (Lithgow, 1997). Although Hando (2007) reported that the population had declined in the years prior to 2007, suggesting dry years may have caused some death.

Likelihood of occurrence and extent of habitat in the project development area: This species possibly occurs although has not been recorded in the project development area to date. All currently known populations occur in Barakula State Forest in a cluster approximately 25 km to the east of the project development area boundary. One collection locality is mapped by Herbrecs (EHP 2013) only nine km east of the project development area margins. This outlying sample is the original 1978 collection by Val Hando, which has less precise details (record precision ± 16km) of the collection point than later collections (i.e. was simply recorded as "Barakula SF"). Hando (2007) wrote that the plants collected were to the east of the Auburn Road-Chinchilla road, and all of her subsequent collection localities in 1981 were recorded to the east of the Auburn Road-Chinchilla road, amongst the cluster of all other plant collections, 25 km to the east of the project development area. The population has consistently been considered a single locality encompassing three areas totalling 28 ha to the east of Auburn-Chinchilla Rd (Halford 1995b; Lithgow 1997, DNR 2000).Therefore it is almost certain that the closest known Hando's wattle plants to the project development area are 25 km to the east, well within Barakula State Forest. **Figure A8** indicates the location of Hando's wattle records and distribution of potential habitat whilst **Table A23** provides a summary of the extent of potential species habitat within the project development area.

There is the potential that additional, as yet unknown populations occur within the northern part of the project development area in suitable habitat adjoining Barakula State Forest. Gurulmundi State Forest should also be considered to host possible habitat for *Acacia handonis*. However, the species was not detected during field surveys.

Table A23. Extent of habitat for Hando's wattle within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	74666	0
3D Detailed Mapping Area**	0	0	1479
3D Detailed Mapping Area based on EHP (2012)***	0	1315	0
Survey area 2	0	0	1288
Survey area 7, 8, 9 and F.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: Inappropriate fire regimes, habitat destruction, disturbance from timber harvesting, inappropriate grazing regimes (DNR 2000) are considered the major threats to *Acacia handonis* populations. Halford (1995b) suggested the main threat to Hando's wattle was inappropriate fire regimes. That is, fires that are too frequent, intense fires, or complete fire exclusion.

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, reducing the success of pollen and seed dispersal.
- Changed fire regimes, such as complete fire exclusion that may result from fragmentation, or repeated, frequent unplanned fires that occur before seedlings can begin producing seed.

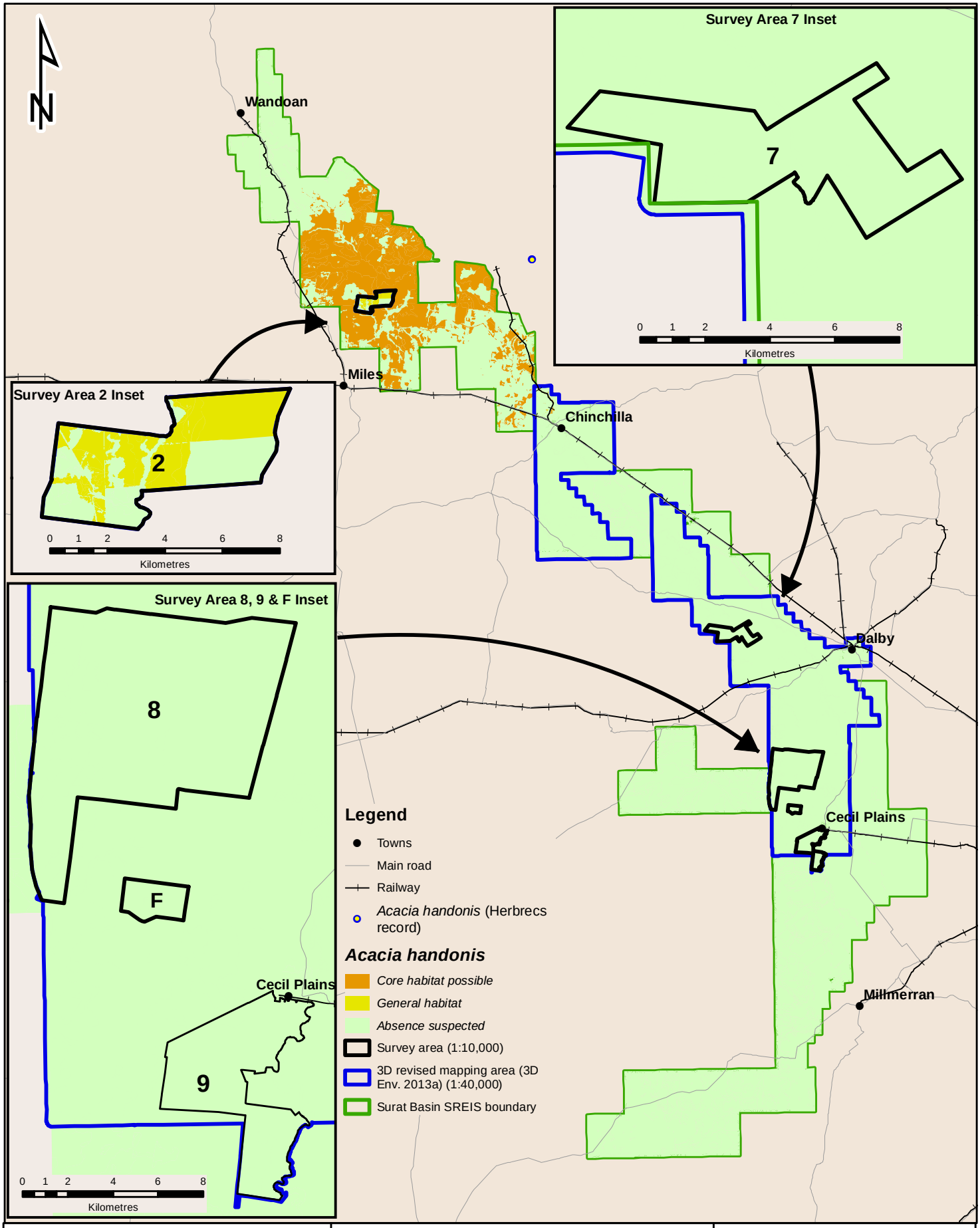
Significance of project related impacts (unmitigated): The sensitivity of populations of Hando's wattle to unmitigated impacts within the project development area is considered ***Moderate.*** This is because it is a perennial species with the ability to generate abundantly from seed following a disturbance such as fire, with some capacity for survival through vegetative suckering observed. Also, Hando's wattle is likely to have a long lived soil seed reserves due to the hard seeds.

The potential magnitude of unmitigated impact is considered ***Moderate.*** This is because no plants are currently known from within the project development area, despite being a well search-for species; and around 10% of the project development area contains known or possible core habitat based on mapping produced by EHP (2012a). The species is reported to propagate readily from seed and is therefore likely be able to be rehabilitated successfully.

Specific management / mitigation measures: Management of individuals of this species is covered in generic recommendations made within **Appendix A, Table A1** and **Table A2**. Infrastructure design and site selection that seeks to avoid core habitat known of Hando's wattle will be prioritised

In addition:

- Ensure habitat adjacent to Hando's wattle retains sufficient connectivity to allow natural movement of fire throughout the landscape. Consider prescribed fire management for the species where habitat connectivity is interrupted (recommended additional context to fire management contained within the commitment C223).



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A8. Hando's wattle *(Acacia handonis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for Habitat Mapping

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. RE polygons with confirmed records (≤ 500 m precision) should be treated as “core habitat known”.
3. The following regional ecosystems occurring to the north of Chinchilla (-27.75) should be classed as “core habitat possible”:
    - RE 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 (‘low’confidence is applied to EHP 2012a with ‘high’ confidence applied to 3D Environmental dataset (3D Environmental 2013).
    - Where these REs have been subject to intensive survey and the species was not found, they can be downgraded to ‘general habitat’.
4. The EHP mature regrowth dataset (EHP 2013) is not included in the attribution as the species is known only from intact habitats.
5. All other remnant and non-remnant vegetation, including cleared grazing land within the project development area should be treated as “absence suspected” (‘high’ confidence is applied).

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Summary residual impact assessment: Where avoidance is not possible, the unmitigated project related impacts to any populations of Hando's wattle that are found within the project development area are considered ***Moderate*** **(17)**. Rehabilitation, from seed collection and propagation, will likely facilitate recovery over several to many years. Hando's wattle regenerates from seedlings after burning. As such, the burning of grass across a disturbed site may provide some rehabilitation, as long as the topsoil containing seed reserves is maintained or stock-piled. If the project disturbance avoids core habitat, impact is not expected.

Where avoidance is not possible, the identified impact management measures of minimising disturbance (including leaving some clusters of undisturbed plants within the footprint), and rehabilitation are considered to be mostly effective, because of Hando's wattle documented success in propagation. These measures may mitigate impact to a large degree, to the extent that a minor loss in a local population occurs. Therefore, if core habitat can't be avoided, but other mitigation measures are implemented, project activities may result in impacts of ***Moderate*** **(13)** significance.

Residual Impact Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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

Evaluation under MNES referral guidelines

Table A24. Evaluation of impact significance for Hando's wattle under MNES Guidelines.

Criteria	**Evaluation**
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge the only known population of Hando's wattle occurs in the Barakula State Forest, approximately 25 km east of the project development area. Three sub-populations exist within this locality and all are considered 'important populations' The proposed facility site survey area 2 contains general habitat for the species although extensive site survey not locate a population of Hando's wattle. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount its occurrence. No other property considered for development in the near future contains potential habitat for the species.

Criteria	Evaluation
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive field survey within survey area 2 failed to locate this species within suitable habitat. It is however not possible to totally discount occurrence of the Hando's wattle within the property and pre-clearance survey will be required once project footprints have been identified. Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** Project related activities within these areas will not the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Whilst broadscale clearing of propertlysurvey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of propertysurvey area 2 will not introduce landscape scale processes that have potential to modify, destroy, remove or isolate or decrease habitat leading to decline of the species. Development within other subject properties will not impact wildlife corridors. In accordance with **Criteria 6**, a significant impact is not expected.

Criteria	Evaluation
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. Extensive measures to control the introduction and spread of exotic species within tenements are proposed (commitment C099, C179, C188, C183). In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact acacia species are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	The species currently exists within an intact population vicinity 25 km east of the project development area. From current knowledge, this population is stable and not in the process of recovery from prior disturbance. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Hando's wattle (*Acacia handonis)* no impact is expected from project development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

Rule(s) for survey effort required in accordance with survey guidelines: Hando's wattle is a perennial shrub species that should be readily identified throughout all seasons. Although no specific survey timing is suggested, surveys completed during the optimal season period (July to November) would add confidence to the assessment.

Wardell's wattle (*Acacia wardellii*)

Family: Mimosaceae

Status: NC Act: Vulnerable; **EPBC Act**: Vulnerable; **BoT:** Not Listed

Sensitivity: Moderate

Recovery plan: A recovery plan has not been prepared for Wardell's wattle.

Overview of Wardell's wattle

Description (based on Maslin 2001): Wardell's wattle is a slender shrub or tree 5 to 7 m high with smooth, silvery-grey or white bark, developing into a rough trunk base on older plants. Branchlets often have a whitish waxy bloom. Phyllodes (i.e. leaves) are 10 to 18 cm long by 1.5 to 3 cm wide, shiny, curved, with two raised main veins that merge together near the phyllode base. The outer phyllode margin often has several gland-tipped teeth. Flowers are clustered into pale yellow globular heads. Seed pods are up to 12 cm long, 6 mm wide and indented between each seed.

Plate 11. Wardell's wattle (*Acacia wardellii).* Photograph Copyright © Boobook

Ecology: Apparently a short-lived wattle, possibly only living 5 years or so and susceptible to borer attack (Eddie 2007; Lester 2008). Its response to fire is unrecorded. However the closely related *Acacia binervata* is fire-killed (Benson & McDougall 1996).

SEWPAC (2013) suggest that "research by Taylor (1989) and House (1995) showed that frequent burning is detrimental for this species". However the research by Taylor (1989) and House (1995) refers to other acacia species in a different section of south-east Queensland, so do not provide any direct evidence of the fire ecology of Wardell's wattle. However, based on closely related acacia species, and the short life span of Wardell's wattle, it remains likely that that it would be a fire-killed species requiring several fire-free years for post-fire seedlings to mature. It is known to have been cultivated in the region and reported to grow in disturbed areas, such as road sides and pipelines (Eddie 2007; L. Pedley's 1984 collection label and Pollock's 2001 collection notes viewed at AVH (2013b)).

Habitat: The species inhabits gravelly soils on shallow weathered sandstone in eucalypt woodland (Pedley, 1978). Herbrecs data (EHP 2013) indicates habitat in Condamine State Forest which includes; woodland of *Eucalyptus decorticans* (RE 11.7.4); RE 11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. It is also likely to grow within RE 11.7.5: Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks

Wardell's wattle has been collected in non-remnant areas including previously cleared land, especially along roadsides and on a hillside with *Acacia jucunda,* a former a brigalow-belah dominant habitat.

Distribution: The species is known from south of Roma, south-west of Chinchilla and the Thomby Range in south-east Queensland (Maslin 2001). On the Thomby Range, the species has been collected near Rocky Glen Homestead, Glenmore in the Silver Springs Gas Field and closer to the project development area, within an area ranging from 15 km east-north-east to 15 km east-south-east of Condamine (TSSC 2008c). Herbrecs records (EHP 2013) indicate habitat 36 km south-west of Chinchilla, approximately 16 km west of the nearest point of the project development area. Populations have been recorded on a gas pipeline easement east of Condamine (QGC Ltd 2009). Qld Herbarium records (EHP 2013) in the Condamine State Forest indicate robust populations of 10 to 20 plants at the collection site.

Likelihood of occurrence and extent of habitat in the project development area: The species possibly occurs within the project development area although has not been previously recorded. It has potential to occur in suitable remnant and regrowth habitat on the western margins of the project development area south of the Condamine-Kogan Rd. It was not recorded during field survey. Herbrecs records of Wardell's wattle in the project development area with extent of potential habitat is shown in **Figure A9**.

Table A25. Extent of habitat for Wardell's wattle within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
Project development area*	0	32226	21768
3D Detailed Mapping Area**	0	1646	6062
3D Detailed Mapping Area based on EHP (2012)***	0	14994	7543
Survey area 2****.	0	0	2076
Survey area 7, 8, 9 and F	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Known Threats: The main identified threats are clearing for agriculture, grazing, infrastructure or mining; and inappropriate fire regimes (SEWPaC 2013).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmenting the local population, reducing the success of pollen and seed dispersal, and
- Changed fire regimes, such as complete fire exclusion, or repetitive unplanned fires that occur before seedlings can begin producing seed.

Significance of project related impacts (Unmitigated): The sensitivity of populations of Wardell's wattle to unmitigated project related impact is considered ***Moderate.*** The basis for this assessment is that it is a perennial species with a demonstrated ability to regenerate abundantly from seed following disturbance and it is likely to be amenable to rehabilitation based on its records within disturbed areas, such as along roadsides. Also, Wardell's wattle is likely to have a long lived soil seed reserves, due to the hard nature of the seeds.

The magnitude of potential of unmitigated impact is also considered ***Moderate.*** This is because no plants are currently known from within the project development area and approximately 10% of the project development area contains known or possible core habitat based on RE mapping provided by EHP (2012a).

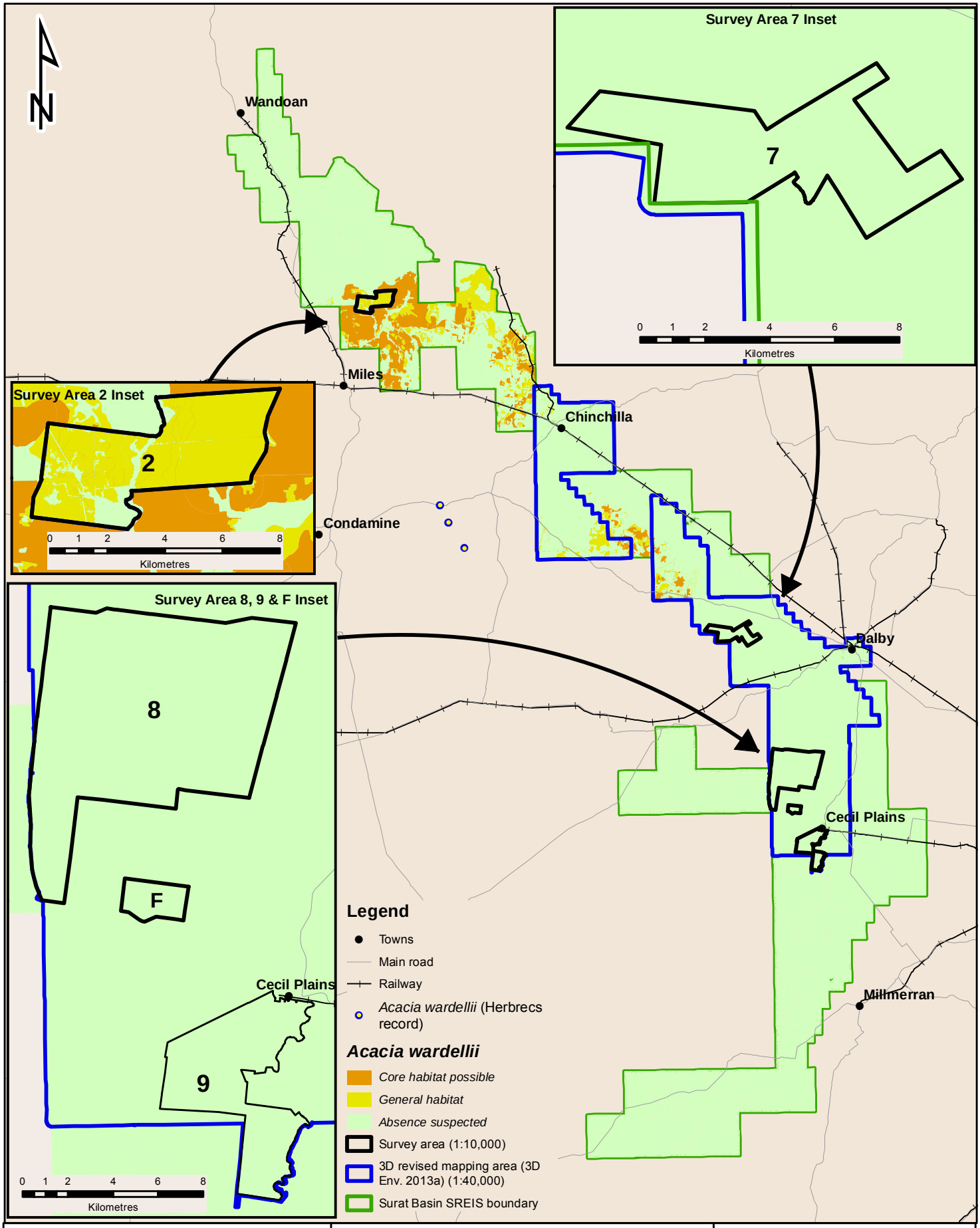
Specific management / mitigation measures: Management of individuals of this species is covered in generic recommendations made within **Appendix A, Table A1** and **Table A2**. Infrastructure design and site selection that seeks to avoid core habitat known of Wardell's wattle will be prioritised.

Summary Residual Impact Assessment: Rehabilitation, from seed collection and propagation, will likely facilitate recovery over several to many years. If the project disturbance avoids core habitat, no impact would be incurred.

Where avoidance is not possible, the identified impact management measures of minimizing disturbance (including leaving some clusters of undisturbed plants within the footprint), and rehabilitation are considered to be mostly effective, because of Wardell's wattle documented ability to grow in disturbed areas. These may mitigate impact to a large degree, to the extent that minor loss in a local population occurs. Therefore, if core habitat can't be avoided, but other mitigation measures are implemented, project related activities may result in impacts of ***Moderate*** **(13)** significance.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A9. Wardell's wattle *(Acacia wardellii)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for Habitat Mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant REs within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. RE polygons with confirmed records (≤ 500 m precision) should be treated as “core habitat known” (Confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by EHP).
3. The following regional ecosystems should be classed as “core habitat possible” within 50 km of previous records:
    - RE11.7.4, RE11.7.7, RE11.7.5, RE11.7.6
4. RE 11.5.1/ 11.5.1a within 50km of prior records should be considered “general habitat” (‘low’ confidence levels apply).
5. Mature regrowth of ‘core habitat possible’ and ‘general habitat’ REs should be classified as ‘general habitat’.
6. All other remnant vegetation in the project development area and non-remnant and cleared agricultural and grazing land outside of the species known distribution outside these areas should be treated as “absence suspected”.

Evaluation under MNES Referral Guidelines

Table A26. Evaluation of impact significance for Wardell's wattle under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, Wardell's wattle occurs in a number of discrete populations near, Roma, south west of Chinchilla and in the Thomby Range area near Surat. The nearest population occurs 36 km south-west of Chinchilla, 16 km south-west of the project development area. Any newly identified population occurring within the project development area should be considered an 'Important Population' as it would represent an extension of the species range. General habitat for the species is indicated in survey area 2 although field survey in these localities did not locate the plant. Pre-construction surveys will be required to totally discount occurrence of the species in associated suitable habitats. Based on mapping rules for the species, there is limited potential for the species to occur with survey areas 7, 8, 9 and F and all habitats within these properties are mapped 'Ábsence Suspected'.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. Habitats within survey area 7, 8, 9 and F are not considered suitable for Wardell's wattle. It is not possible to totally discount occurrence of the Wardell's wattle within survey area 2 and pre-clearance survey will be required once project footprints have been identified. Based on current knowledge an 'Important Population' is not contained within properties subject to development and hence no long term decrease in population size will be incurred. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in **Criteria 1**. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in **Criteria 1**. In accordance with **Criteria 4**, a significant impact is

Criteria	Evaluation
	not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in **Criteria 1**. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in **Criteria 1**. Known populations occur in association with a major north-east / south-west trending wildlife corridor that lies to the west of the project development area. This wildlife corridor will not be impacted during project development. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1 and 6. Extensive measures to control the introduction and spread of exotic species within tenements are proposed (commitment C099, C179, C188, C183). In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact acacia species are not known to occur. Eddie (2007) suggest *Acacia wardellii* is susceptible to borer attack although there is no indication that increased borer attack will be facilitated by project development activities. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1 and Criteria 6. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Wardell's wattle (*Acacia Wardellii)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant

Rule(s) for survey effort required in accordance with survey guidelines: Wardell's wattle is a perennial shrub species that has distinctive leaf shape with the outer phyllode margin having several gland-tipped teeth. This should allow the species to be identified throughout all seasons regardless of whether fertile material is available. Hence no specific survey timing is required to effectively detect the species.

Ooline / Scrub Myrtle (*Cadellia pentastylis*)

Family: Surianaceae

Status: EPBC Act: Vulnerable; **NC Act**: Vulnerable; **BoT:** Critical

Sensitivity: Extremely High

Recovery plan: A recovery plan has not been prepared for ooline. DECC (2005b) has identified 12 priority actions for management of ooline populations.

Overview of Ooline

Description (based on Stanley & Ross1983; Flora of NSW; Harden *et al*. 2006): Ooline is a tree, typically growing to 10 m but occasionally up to 25 m tall, with hard fissured bark. Leaves are simple, alternatively arranged along the branchlet and broadest in the middle or upper half of the leaf. Leaves are usually 2 to 5 cm long, but can be up to 7 cm long. The leaf venation is distinct and slightly raised on the upper leaf surface. The edge of the leaf is smooth to wavy but not toothed. The flowers occur singularly, or with a few flowers clustered together. There are five petals, which are white and 5 to 7 mm long. The fruit resemble dried flowers, with up to five small, 5 mm long, inflated-looking segments (drupes) clustered together in the centre, surrounded by five papery, reddish sepals up to 10 mm long, making the fruit resemble flowers.

Plate 12. Ooline foliage and bark (Photograph provided by Paul Williams, Vegetation Management Science)

Ecology: Ooline is a long lived tree. Flowering is concentrated in October to December, but can extend to April, with fruit recorded in November and December (Pollock 1997a). Curran and Curran (2005) observed that while flowering and fruiting of ooline is sporadic, fruit is most often seen in dry years. Although their survey occurred during a year with abundant fruiting, it did not find any seedlings, however, root coppicing appears to occur (Curran & Curran 2005). As a tree of dry rainforest and brigalow scrub, ooline is likely to be damaged, or even killed, by fires that are intense enough to burn up to the base of trees.

Habitat: Ooline grows in semi-evergreen vine thickets, brigalow and occasionally in adjacent eucalypt woodland, where it maybe locally dominant in the canopy layer or occur as an emergent (TSSC 2008e). It is also known to occur as isolated trees in cleared non-remnant grazing lands. Ooline tends to grow on soils of low to medium fertility, often with sandy clay or clay consistencies (DECC 2005b). Substrates include clay plains, sandstone and residual ridges (Santos 2007).

Distribution: A large proportion of ooline habitat has been cleared for cropping or grazing in the past (Benson 1993). Ooline is known to occur on the western edge of the NSW north-west slopes, extending into Carnarvon Range, Blackwater and the Callide Valley, south and west of Rockhampton (Harden *et al*., 2006) within Queensland. Its habitat is now restricted to a few scattered sites and is conserved within the Tregole National Park (NP), Sundown NP, and Carnarvon Gorge NP (DNR 2000). It is also known from the area to the west of Gurulmundi State Forest.

Likelihood of occurrence and extent of habitat in the project development area: The species possibly occurs although populations are unlikely to be extensive. Ooline has been collected within the south-western part of the project development area (on Kindon Station in the Wyaga Creek area). However, these collections were made in 1919 and 1938 and the imprecise localities ($\pm$ 16 km accuracy) provided in those early collections mean that an exact location is not available. Therefore there is no certainty that these trees and their habitat remain uncleared. Pollock (1997) considers that "the status of virtually all populations collected before 1962 is unknown". However EPA (2002) describe 'Wyaga-Kindon ooline population' as a special biodiversity area where ooline approaches its eastern limit of distribution. It is possible that the records occurred in habitats associated with brigalow/belah forests along Wyaga Creek. Further surveys are required in the south-western portion of the project development area to confirm that these records still exist.

The majority of ooline habitat within the project development area has been cleared. There is the possibility that isolated paddock trees remain in the project development area, or the tree may be associated with small unmapped pockets of vine thicket on laterite (RE11.7.1).

Ooline has been recorded as very common in brigalow open forest and fragmented softwood scrub vegetation in the Stones Country Resources Reserve in the west Gurulmundi area located approximately 15 km west of the project development area, and the Moonie Range 25 km west of the project development area (DHP 2013). Steep basaltic scree slopes on Captains Mountain near

Millmerran are considered marginal habitat and require further survey. The extent of ooline habitat in the project development area is provided in **Table A27** with spatial reference to areas of potential habitat provided in **Figure A10.**

Table A27. Extent of habitat for ooline within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	0	1412
3d Detailed Mapping Area**	0	0	0
3d Detailed Mapping Area based on EHP (2012)***	0	0	0
Survey areas 2, 7, 8, 9 and F	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: Threats to ooline are broad scale tree clearing, inappropriate fire regimes, and inappropriate grazing regimes (DNR 2000). Other threats include localised extinction due to small and scattered populations; inbreeding which threatens genetic diversity in small populations; low seed viability which threatens breeding success; feral goats and pigs; invasion of habitat by weeds; frequent fires; tunnel and sheet erosion; damage to roadside populations during roadworks; and high insect attack (Fletcher 2002, DECC 2005b in Threatened Species Scientific Committee 2008e). The species is thought to be undergoing slow decline with occurrences in regrowth threatened by re-clearing and fire (EPA 2002).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing; and
- Habitat edge effects such as promoting conditions for invasion of weeds and exotic grasses which induce altered habitat structure along gathering lines, tracks and clearing zones.
- Altered fire regimes, particularly introduction of fire promoting weeds (grasses) into the margins of ooline habitat. Such changes may dramatically increase the intensity of fires which is a particular threat to ooline.

Significance of project related impacts (Unmitigated):

The sensitivity of the species to project related impacts is considered ***Extremely High*** because it is a long lived perennial that is damaged by fires and mechanical disturbance, but with only erratic

recruitment. Any seedlings will take more than 10 years to mature. While ooline has been recorded as an isolated tree within paddocks, the ability of post-disturbance juvenile ooline plants to grow to maturity in a disturbed environment (e.g. through a densely grassed or weedy habitat) is limited.

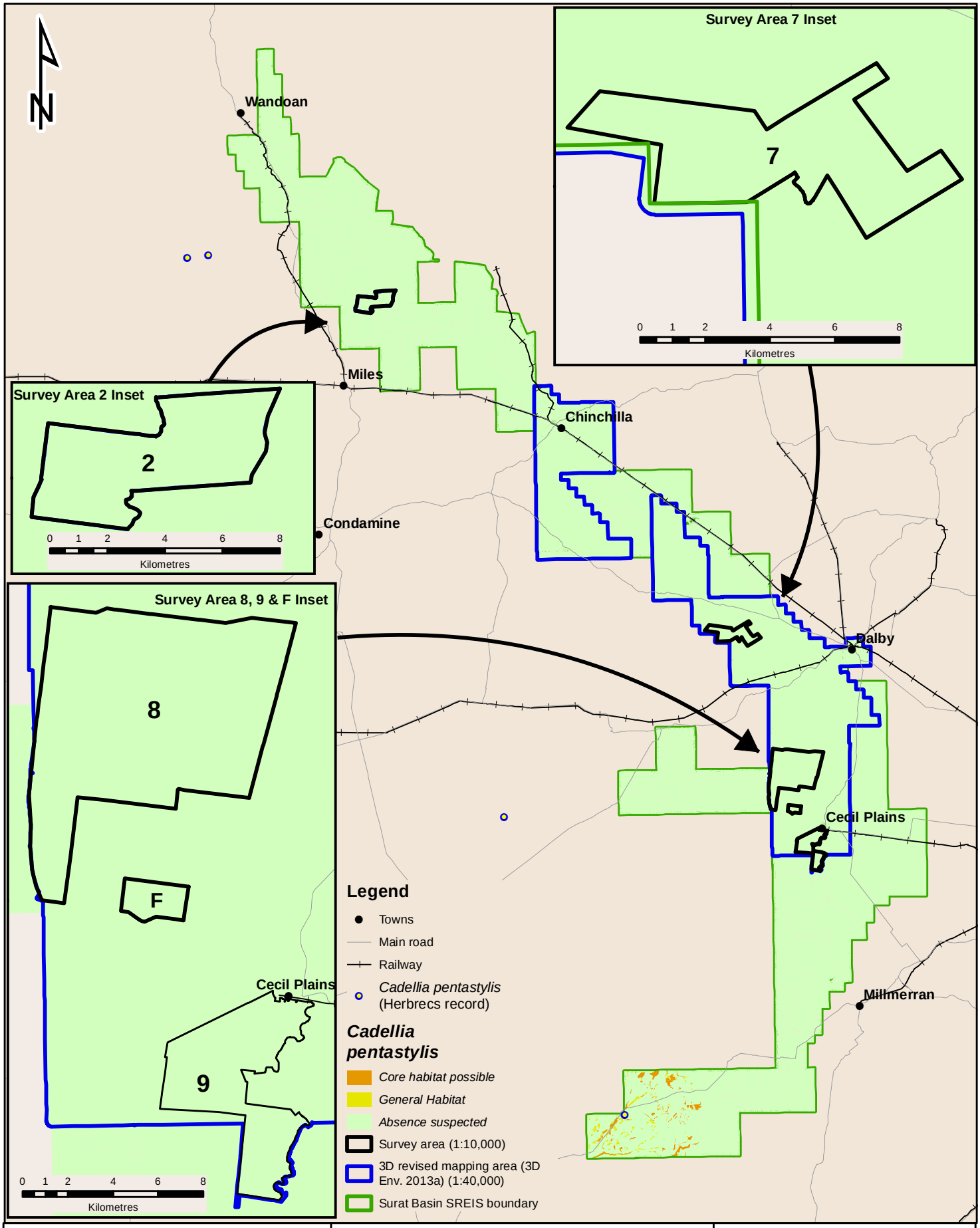
Because of the absence of any confirmed populations of ooline in the project development area and the presence of an intact population to the west, project related activities may result in impacts of ***Moderate*** magnitude to ooline. The unmitigated significance of impact is considered ***High (20)***. The possibility of the species occurring in the Wyaga area area is unknown given the age of the Herbarium records (1919, 1938) and the extent of clearing that has occurred in that area. Any remaining occurrences in the Wyaga locality represents the eastern limit of distribution for the species. These occurrences may occur as scattered individual trees within cleared paddocks and/or non-remnant vegetation. Isolated trees in cleared land have the potential to be cleared by project works. Targeted ground truthing of the development footprint in high-risk locations and avoidance of trees will considerably reduce the risk of impact.

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Ooline will be prioritised.

Summary residual impact assessment: Project related activities may result in impacts of ***High (20)*** significance to potential ooline populations within the project development area. Avoiding habitat and undertaking further survey work within areas of historical populations to ensure impact to individual trees is avoided will result in no impact being incurred. Where avoidance is not possible, the identified impact management measures are considered to be only partially effective with rehabilitation and species translocation being untested. Given that fruit fall is known to be sporadic and successful propagation techniques limited, if avoidance is not possible but other mitigation measures are implemented, project activities may result in impacts of ***Moderate*** magnitude, providing a significance ranking of ***High (20)***.

Residual Impact Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	Moderate	High (20)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A10. Ooline *(Cadellia pentastylis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for Habitat Mapping:

1. Areas of remnant vegetation associated with Land Zone 3 (REs 11.3.2, 11.3.25, 11.3.4) and Land Zone 9 (RE11.9.5) in the Kindon Station and Wyaga Creek areas (west of 150.91 and south of -28.00) should be classed as ‘core habitat possible’ subject to further field survey (‘low’ confidence applies to mapping produced by EHP, 2012a).
2. Areas of mature regrowth (EHP 2012b) of the same REs as EHP 2012a should be considered ‘general habitat’.

Evaluation under MNES Referral Guidelines

Table A28. Evaluation of impact significance for ooline under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area	Based on current knowledge, historical records in the Wyaga area provide the only evidence for occurrence of the species in the project development area. The status of the Wyaga population has not been confirmed and it is unknown as to whether this population still exists. Given that the Wyaga population would represent the eastern geographic limits of ooline in Queensland, it would be considered an 'Important Population' if its persistence in the project development area could be verified. Individual trees in highly disturbed landscapes are however not likely to be viable in the long term and hence their importance is somewhat diminished.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** These properties are not considered to host potential habitat for ooline. Hence no long term decrease in the size of an ooline population is anticipated from development at these locations. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected.

Criteria	Evaluation
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	**Survey areas 2, 7, 8, 9 and F:** Diseases specific to ooline are not known. The species is susceptible to insect attack although it is not considered that this would be facilitated by development activities. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1. If works are to be undertaken in the Wyaga area, pre-clearance surveys will be required to determine the presence of the species and erect exclusion buffers around individual trees to assist possible recovery of the population. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For ooline (*Cadellia pentastylis)* no impact is expected from project development activities. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact).

Rule(s) for survey effort required in accordance with survey guidelines: Ooline is a distinctive tree that would be readily identified throughout the year without the requirement for seasonal consideration.

Gurulmundi fringe myrtle (*Calytrix gurulmundensis)*

Family: Myrtaceae

Status: EPBC Act: Vulnerable; **NC Act**: Vulnerable; **BoT**: Not Listed

Sensitivity: Extremely High

Recovery plan: A recovery plan has not been prepared for Gurulmundi fringe myrtle.

Overview of Gurulmundi fringe mytle

Description (based on Williams 1979 as "*Calytrix* sp."; Stanley & Ross1986 as "*Calytrix* sp.1"; Craven 1986 as *Calytrix gurulmundensis*): An attractive, well branched shrub to 2 m tall. The leaves are 4 to 11 mm long and up to 1 mm wide, alternate or crowded together, slightly 3-angled or flat with a point at the apex, and are aromatic when crushed. The flowers are tubular and clustered at the ends of branches, with narrow cream petals that are yellow at their base, and many long yellow stamen. The fruit are dry, with the sepals form the flowers remaining attached.

Plate 13. Gurulmundi fringe myrtle (*Calytrix gurulmundensis)* foliage and flower. Copyright © Boobook

Ecology: The life span of Gurulmundi fringe myrtle is unknown, but it is likely to live for at least a decade. Flowers have been recorded from June to October (Craven 1986; Halford 1996). Plants as small as 15 cm tall have been observed to flower (Williams 1979). Gurulmundi fringe myrtle can be quite common at sites where it grows, being described in several collection labels as abundant or co-dominant at the collection site (AVH 2013c).

Habitat: Gurulmundi fringe myrtle has been recorded growing in patches of shrubland on very shallow soils (EPA 2002). Soils are lateritic sandstone ridges, which contain yellow sandy-clay that retains moisture (Williams 1979). Vegetation is predominately eucalypt, acacia, casuarina dense shrublands with spinifex, and spinifex grassland with scattered shrubs. This habitat description is consistent with RE 11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks).

The coordinates of Gurulmundi fringe myrtle collections derived from Herbrecs (EHP 2013) place them in areas mapped by as RE 11.7.5; RE 11.10.1/11.7.2; RE 11.7.6; and RE 11.7.7/11.7.4/11.5.1 based on RE mapping provided by EHP (2012a).

Distribution: The species is endemic to the Gurulmundi and Barakula areas north of Chinchilla (Halford 1996).

Likelihood of occurrence and extent of habitat in the project development area: The species has not been recorded in the project development area although possibly occurs based on suitable habitat and known distribution range. The species is known from the Barakula and Gurulmundi State Forests to the east and west of the project development area respectively.

A 1961 collection by M.E. Phillips is held in the Australian National Herbarium (AVH 2013c) which gives the locality as simply Gurulmundi, and has subsequently been given the coordinates of the locality of Gurulmundi by the Australian National Herbarium. This places the coordinates for the collection within the project development area, however, the absence of a more detailed locality description in the 1961 collection notes, including the absence of any coordinates, suggests this collection was made in the general Gurulmundi area, most likely Gurulumundi State Forest 10 km to the west.

Additional populations have the potential to occur in tracts of remnant vegetation and on disturbed roadsides on lateritic duricrusts (land zone 7). In the project development area, suitable habitat occurs to the north of the Leichhardt Highway where the where it overlaps with the continuous remnant vegetation of the Gurulmundi and Barakula State Forests. There is suitable habitat within the northern parts of the project development area in the Binkey State Forest, east of the Leichhardt Highway near Gurulmundi.

Survey area 2, which is approximately 30 km east of the Gurulmundi population, hosts 10 ha of RE 11.7.5, based on detailed vegetation mapping and survey undertaken specifically for the SREIS (3D Environmental 2013). Despite suitability of habitat and intensive survey effort within the property, the species was not recorded. Within survey area 2, RE11.7.5 should be considered ‘general habitat’ and subject to pre-clearance survey once project footprints have been determined. A summary of potential habitat is provided in **Table A29** with spatial representation of habitats provided within **Figure A11.**

Table A29. Extent of habitat for *Calytrix gurulmundensis*e within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
Project development area*	0	61713	0
3D Detailed Mapping Area**	0	0	359
3D Detailed Mapping Area based on EHP (2012)***	0	1175	0
Survey area 2****	0	0	359
Survey area 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: The main threats to the local populations of *C. gurulmundensis* are (based on Halford 1996):

- Destruction of habitat due to clearing or timber harvesting.
- Degradation of habitat due to road construction and maintenance, potentially allowing weed invasion and erosion.
- Inappropriate fire regimes.

Of these, clearing, disturbance for track creation and maintenance and inappropriate fire regimes are the key threats related to this project. At least one population is identified as having been damaged in the past due to gravel extraction (Williams 1979). Due to the absence of any information relating to fire ecology, no data exists as a basis to identify appropriate fire regimes, although it is probable that fire frequency is a key issue, requiring many years between fires for regrowth to mature.

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Inappropriate fire regimes, particularly escaped unplanned fires.

Significance of project related impacts (unmitigated): There is limited known of the ecology of Gurulmundi fringe myrtle including a lack of detailed information on its germination, response to fire and life span. One population is known to have been damaged in the past due to gravel extraction (Williams 1979). Its response to disturbances such as habitat fragmentation, changed fire regimes and edge effects requires further detailed study, and its ease and success of translocation and rehabilitation methods are unknown. Hence the sensitivity ranking for the species is considered to be ***Extremely High***.

Areas of known and possible core habitat of Gurulmundi fringe myrtle are common in the north of the project development area and whilst no confirmed populations are known, its potential core habitat is continuous from the population in Gurulmundi eastwards to the Barakula population. The potential impact magnitude ranking is therefore considered ***High.*** Without mitigation measures, project impacts are expected to occur over the life and scope of the project causing changes to local populations although never species extinction and the unmitigated impact significance is potentially ***Major (23).***

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Gurulmundi fringe myrtle will be prioritised.

Similar to threatened acacia species, the following mitigation should be considered for all fire sensitive species:

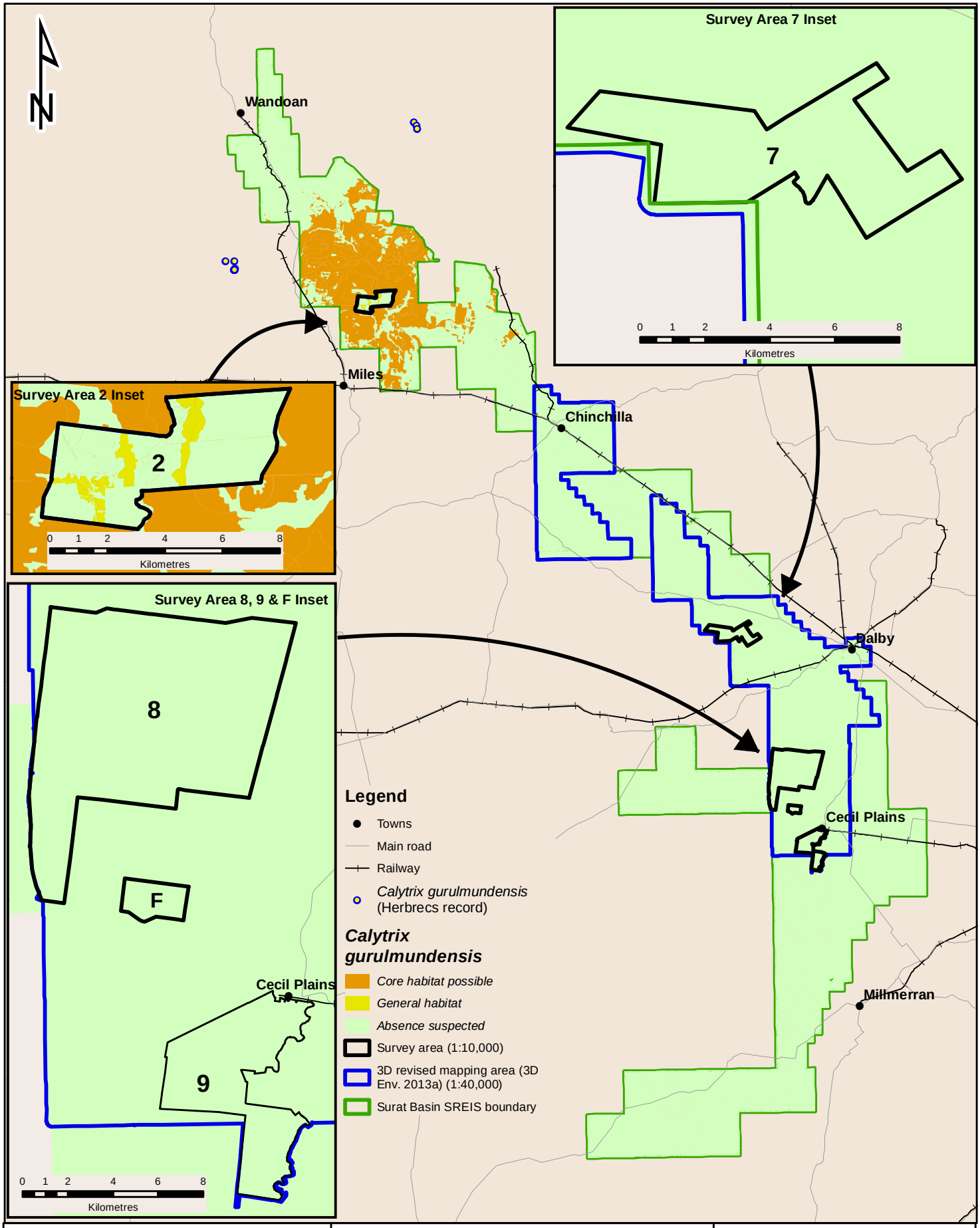
- Ensure habitat adjacent to Gurulmundi fringe myrtle retains sufficient connectivity to allow natural movement of fire throughout the landscape. Consider prescribed fire management for the species where habitat connectivity is interrupted (recommended additional context to fire management contained within the commitment C223).

Summary residual impact assessment: No mitigation measures will alleviate clearing of core habitat and therefore avoidance is the only feasible mitigation measure in these situations. The effectiveness of translocation and/or propagation and rehabilitation programs is unknown and therefore reliance the likelihood of success cannot be confidently inferred. If infrastructure avoids known core habitat, impact is not expected. If other mitigation measures are implemented, such as rehabilitation, the project activities may result in a **Moderate** impact magnitude ranking, which produces a ***High (20)*** significance ranking.

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

* No clearing of vegetation within areas of core habitat known or core habitat possible.
# Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts.



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A11. Gurulmundi fringe myrtle *(Calytrix gurulmundensis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant RE within that buffer treated as “core habitat known” (‘high’ confidence levels apply).
2. All RE polygons coinciding with confirmed high precision records should be treated as “core habitat known” regardless of classification (confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by EHP, 2012a). Mature regrowth (EHP 2012b) polygons are excluded.
3. The following REs within 50 km of known populations should be considered “core habitat possible”:
    - RE 11.7.5, 11.7.2, 11.7.4, 11.7.6, 11.7.7 and 11.10.1 (confidence levels for mapping will be “moderate’ to ‘high’ dependant on whether polygons fall within refined mapping or mapping produced by DEHP, 2012a).
4. All other remnant vegetation and cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules are applied where the relevant regional ecosystems are found within the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A30. Evaluation of impact significance for Gurulmundi fringe myrtle under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, two populations are known from the study area being located within the Gurulmundi and Barakula State Forest areas. The species is currently unknown from the project development area although potential habitat for the species is widespread and abundant in the northern portion of the study area. Due to the highly endemic nature of the species, any additional populations discovered should be considered an 'important population'.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2:** Whilst suitable habitat for the species exists insurvey area 2, the species was not recorded during survey. It is not possible to totally discount occurrence of the species within survey area 2 and pre-clearance survey will be required once project footprints have been identified. **Other Properties:** Survey areas 7, 8, 9, and F are not considered to host potential habitat for the species. Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.

Criteria	Evaluation
	In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Whilst broad scale clearing of propertysurvey area 2 will result in minor impact to a wildlife corridor of state significance, it will not impact the broader east-west trending wildlife corridor which passes to the north. Clearing of propertysurvey area 2 will not introduce landscape scale processes that have potential to affect the breeding cycle of an important population of Gurulmundi fringe mrtle. This would include any alteration to fire regimes that sustain populations contained within wildlife corridors. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact the species are not known to occur. Myrtle rust is known from the Toowoomba Area (DAFF 2013) although is not known to affect species within drier habitats including those contained within the project development area. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	The species currently exists within intact populations in vicinity of the project development area. From current knowledge, these populations is stable and not in the process of recovery from prior disturbance. In accordance with **Criteria 8**, a significant impact is not expected.

Conclusions: For Gurulmundi fringe myrtle (*Caltyrix gurulmundensis)* no impact is expected from development activities.Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant

Rule(s) for survey effort required in accordance with survey guidelines: Gurulmundi fringe myrte is a relatively distinctive shrub that would be identifiable throughout the year without the requirement for seasonal consideration.

Small-leaved denhamia (*Denhamia parvifolia*)

Family: Celastraceae

Status: NC Act: Vulnerable; **EPBC Act**: Vulnerable; **BoT:** High

Sensitivity: Extremely High

Recovery plan: A recovery plan has not been prepared for small-leaved denhamia.

Overview of small-leaved denhamia

Description (based on Stanley & Ross 1986; Chinchilla Field Naturalists Club 1997; Pollock 1997b; Harden *et al*. 2006): A shrub to 3 m with mottled, white bark and orange roots. The alternatively arranged leaves are 0.5-2 cm long, with smooth margins or a few fine teeth. The leaves are broadest in the middle or the upper half and are prominently veined and rigid. The pale yellow flowers are grouped into clusters. The fruit are yellowish capsules that split into three or four sections to expose a black seed covered in red fleshy "aril".

Plate 14. Small-leaved denhamia (*Denhamia parvifolia)* foliage and capsule. Copyright © Boobook

Ecology: Small-leaved denhamia probably lives for at least a decade. Flowering occurs in September to October and fruits are mature in the wet season, December to March (Stanley & Ross 1986; Pollock 1997b). The red fleshy aril covering of the seed is likely to encourage bird dispersal. There is

no information regarding regeneration of small-leaved denhamia, and notes associated with collections do not record the presence of any seedlings.

Habitat: Small-leaved denhamia grows in semi-evergreen vine thickets, vine scrubs and brigalow (*Acacia harpophylla*) softwood communities on fertile, red brown sandy clay loam hillslopes and crests (DNR 2000). It has been collected in non-remnant clusters of vine thicket trees on roadsides and brigalow associations. Potential also exists for this community within basalt landscapes to the south of Millmerran, particularly in association with RE11.8.2a within which small pockets of RE11.8.3 might be scattered.

Distribution: Small-leaved denhamia is restricted to southern Queensland, north from Eidsvold to Chinchilla and east of Kingaroy and the Mundubbera district (Jessup 1994, Harden *et al*. 2006). Populations on the south-west edge of its known range grow to the north and south-west of Chinchilla (Chinchilla Field Naturalists Club 1997, DNR 2000, EHP 2013).

Likelihood of occurrence and extent of habitat in the project development area: The species is known to occur with two previous records existing within the project development area with collections made in 1978 (16000 m precision) and 1981 (1600m precision) (EHP, 2013). The current status of these records is unknown and it is unsure if the populations still exist. Prior records occurred "on ridge country" and in "disturbed vine thicket" (AVH 2013d). In additional to its preferred habitat of remnant brigalow with a softwood species understorey or vine thicket elements (11.4.3, 11.8.3, 11.9.4a, 11.9.5), small-leaved denhamia may grow in small, non-remnant vine thickets throughout the project development area. The field survey did not locate additional populations despite extensive searches being undertaken within suitable habitat contained of the Chinchilla Sporting Shooters Range (which is located on the Chinchilla Sands Local Fossil Fauna Site) (RE11.4.3). The distribution of potential habitat for small-leaved denhamia is represented in **Figure A12** with a quantification of habitat extent indicated in **Table A31.**

Table A31. Extent of habitat for small leaved denhamia within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	2241	0
3D Detailed Mapping Area**	0	933	0
3D Detailed Mapping Area based on EHP (2012a and b)***	0	1065	0
Survey area 2, 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: The species habitat has been heavily fragmented by clearing for agriculture. The remaining habitat, including scattered plants within small clusters of trees, is threatened by clearing and by degradation by invasive weeds such as *Lantana camara,* invasive grasses and by inappropriate grazing regimes (Pollock 1997b).

Potential project-related impacts: Impacts associated with the proposed project development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat and water quality from construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fires damaging trees, which can be fuelled by grasses and lantana that invade habitat following disturbance.

Of these disturbances, probably the most significant is the destruction or degradation of habitat (including erosion) or damage to individual trees. There is a particular risk to trees growing in small clusters, or as isolated trees, which are more difficult to find or recognise because the cluster is associated with non-remnant vegetation, and therefore not easily identified as habitat.

Significance of project related impacts (Unmitigated): Scattered individuals of small-leaved denhamia are susceptible to disturbance in remnant and non-remnant vegetation, both in paddocks and roadside strips in the Chinchilla area. The sensitivity of the species is considered to be ***Extremely High***, because it is a perennial rainforest tree, likely to be susceptible to habitat degradation from weed invasion and damage by fires. In particular, invasion of exotic pasture grasses following mechanical disturbance is likely to degrade habitat and limit its ability to recolonise disturbed areas. It has very limited or erratic germination (no seedling observations have been recorded with collections) and therefore has very limited capacity for natural post-disturbance regeneration. Small-leaved denhamia is known to grow within the project development area, although it is uncommon. It is not known to grow within the 25 km buffer surrounding the project development area, so that all of the known local populations are contained within. However, most known populations occur within a triangle roughly between Chinchilla, Kingaroy and Eidsvold and potential habitat, based on remnant and mature regrowth mapping provided by EHP (2013a and 2013b) represents approximately 1% of the project development area. The local collections of this tree are from small unmapped patches of vine thicket that are too small to have been distinguished on the existing mapping databases.

Therefore, the possible habitat of this species is difficult to quantify and hence the magnitude of potential impacts is considered ***Moderate***, with a significance ranking for this species of ***High (20)***.

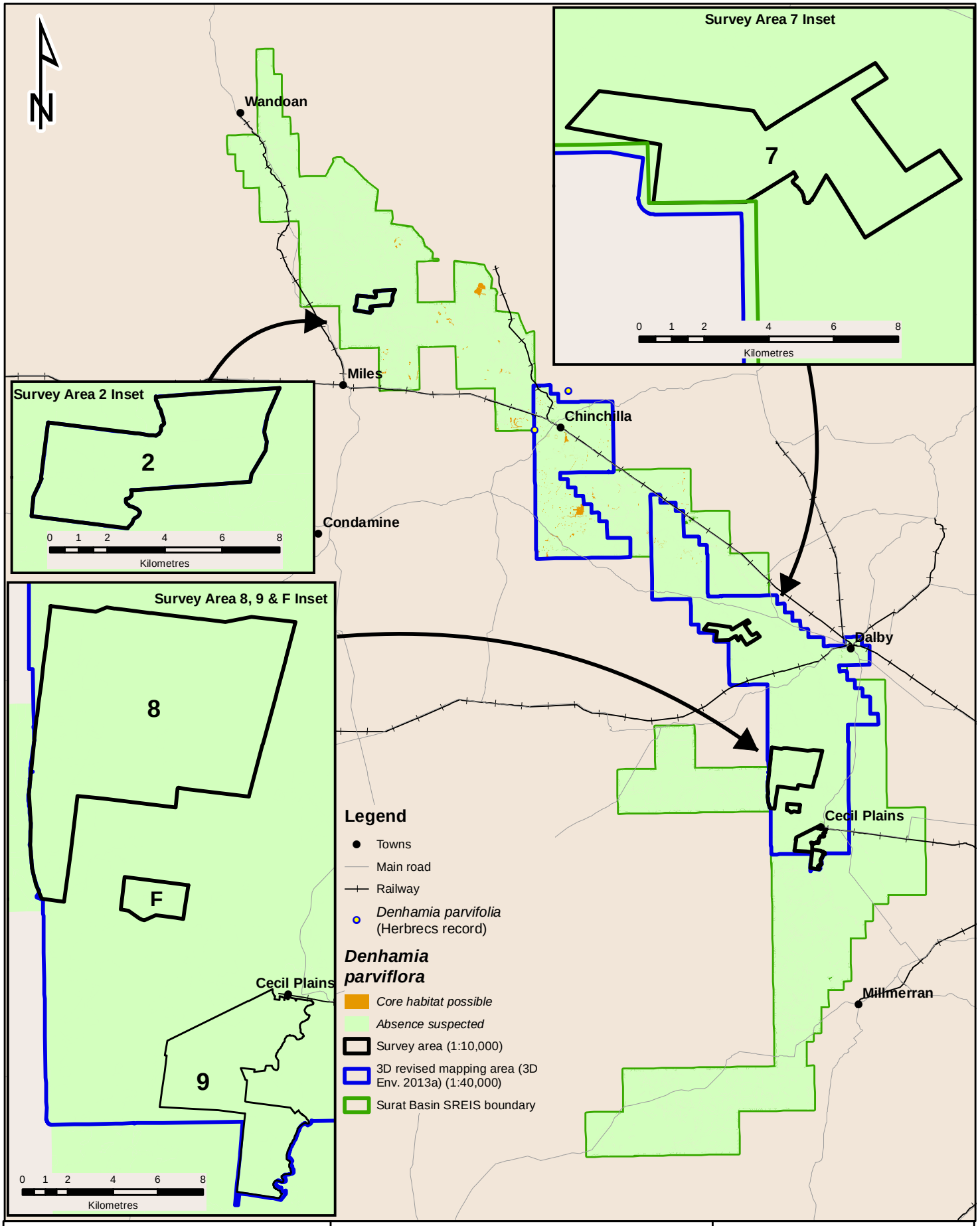
Species specific mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of small-leaved denhamia will be prioritised.

Summary residual impact assessment: The unmitigated impact significance for this species is considered to be ***High (20)***. Brigalow associations on Land zones 3, 4 and 9 constitute possible core habitat for small-leaved denhamia. It is of note however that small-leaved denhamia has been collected in vine thickets too small to be included in remnant habitats. Avoiding 'core habitat known' will completely mitigate against impacts with surveys required within 'core habitat possible' areas to verify or exclude presence. Where the species is avoided, not impacts are expected

Where buffers around populations of small-leaved denhamia cannot be maintained, impact management measures outlined above, especially weed seed hygiene, retaining clusters of some undisturbed trees and rehabilitation, will reduce the impact magnitude to ***Moderate***. The resulting residual impact significance using alternative mitigation measures would be ***High (20)***. This significance ranking remains high due to the sensitivity of small-leaved denhamia to disturbance, the likely post-disturbance impacts from weeds and the lack of known of rehabilitation success for this species.

Residual Impact Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	Moderate	High (20)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A12. Small leaved denhamia *(Denhamia parviflora)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Any confirmed, precisely location (± 500 m) should be buffered by a 1 km circumference and all remnant REs contained within treated as “core habitat known” (‘high’ confidence applies):
2. The following regional ecosystems in the Chinchilla area (within 50 km from town centre, -26.7381, 150.6252) should be classed as “core habitat possible” (includes, mature regrowth, EHP 2012b:
    - RE11.8.3, RE11.9.5, RE11.9.4 and RE11.4.3 (low confidence applies where applied to mapping produced by EHP (2012a and b) with ‘high’ confidence applied to the refined mapping layer, 3D Environmental, 2013).
    - Non-remnant brigalow/belah type regrowth and vine thicket regrowth on alluvium (land zone 3) and clay plains (land zone 4) (extent of habitat unquantified and many of these habitats will not be of mappable extent other than at 1:10 000 scale).
    - Non-remnant, small clusters of vine thickets, often along roadsides or within paddocks (extent of habitat unquantified extent of habitat unquantified and many of these habitats will not be of mappable extent other than at 1:10 000 scale).
3. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A32. Evaluation of impact significance for small leaved denhamia under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area	Based on current knowledge, historical, low precision records in the Chinchilla area provide the only evidence for occurrence of the species in the project development area. The current status of the historical records is unknown. Given that any population of the species in the Chinchilla area would represent the south-west limits of species distribution, any population contained within the project development area would considered an 'important population'.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** These properties are not considered to host potential habitat for small leaved denhamia. Hence no long term decrease in the size of a small-leaved population is anticipated from development at these locations. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected.

Criteria	Evaluation
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	**Survey areas 2, 7, 8, 9 and F:** Diseases specific to small-leaved denhamia or the Celestraceae family in general are not known. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For small-leaved denhamia (*Denhamia parvifolia)* no impact is expected from development activities. Impacts are not considered significant on the subject properties (Survey area 2, 7, 8, 9, F) when assessed under MNES criteria, based on the assumption that the species is not present. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. The level of impact is considered known and predictable (no impact) and reversibility is not relevant.

Rule(s) for survey effort required in accordance with survey guidelines: Small-leaved denhamia is a distinctive small tree that would be readily identified throughout the year without the requirement for seasonal consideration.

Kogan waxflower (*Philotheca sporadica)*

(originally described as *Eriostemon sporadica*)

Family: Rutaceae

Status: EPBC Act: Vulnerable; **NC Act:** Vulnerable; **BoT:** Not Listed

Sensitivity: Moderate

Recovery plan: A species recovery plan has not been developed for Kogan waxflower. Permits to collect seed and propagate cuttings have been issued to Powerlink to conduct research and propogation trials (Kanowski 2005).

Overview of Kogan waxflower

Description (based on Bayly 1994): *Philotheca sporadica* is a multi-stemmed, spreading shrub to 1.5m high. Upper branchlets are green, with dark corky areas developing sporadically along the stem with age. The leaves are only 1 to 4 mm long 1–4 mm long, hairless, glandular below and fairly terete and broadest in the upper half – i.e. shaped like a club. The white flowers are solitary and occur on short stalks to 0.7 mm long at the end of branchlets.

Plate 15 (left). Kogan waxflower on the margins of Beelbee Road near Kogan (Photograph 3D Environmental) and **Plate 16.** Flower and foliage habit (Photograph © Boobook).

Ecology: Kogan waxflower is a perennial shrub, though its life span is not known. As it has been recorded from along roadsides, it has some ability to regenerate after disturbance, though whether this regeneration is from seedlings or vegetative coppice shoots is not documented. The response of the species to fire is unknown (TSSC 2008j). Translocation has been attempted (Kanowski 2005) and from observation, appears to have been successful (D. Fell and D. Stanton; personal observation 2010). Related species have been successfully propogated from cuttings (Halford 1995c). Flowers have been recorded in July to September, and fruit in September.

Habitat: The majority of records are in low open forest and woodland of *Acacia burrowii*, *Eucalyptus exserta*, *Eucalyptus crebra*, *Eucalyptus fibrosa* subsp. *nubila* and *Callitris glaucophylla* (Halford 1995 in TSSC 2008j), and also on residual hills which are remnants of laterised Cretaceous sandstones, where the soils are shallow, uniform sandy loams to clay loams of extremely low fertility and poor condition (Dawson, 1972 in TSSC 2008j). Herbrecs records (EHP 2013) placed over the Queensland Herbarium regional ecosystem mapping (EHP2013j) indicates records of Kogan waxflower coincide within the following habitats:

- RE 11.7.4; *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust).
- RE 11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.
- RE 11.7.7; *Eucalyptus fibrosa* subsp*. nubila* +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

Kogan waxflower has been collected during the field survey in woodland *of Eucalyptus exserta, Eucalyptus crebra, Callitris glaucophylla, Corymbia trachyphloia* and *Acacia burrowii*, consistent with RE11.7.4. There are also a few collections recorded within:

- RE 11.5.1; *Eucalyptus crebra, Callitris glaucophylla*, *Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.
- RE 11.3.14; Eucalyptus spp., Angophora spp., Callitris spp. woodland on alluvial plains. Sandy soils
- RE 11.3.18; *Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium.

It is expected that these collections may indicate inaccuracies in RE mapping databases rather than core habitat for the species.

Distribution: Kogan waxflower is a Queensland and bioregional endemic known from south-east Queensland, from just north of Tara, to approximately 12 km east of Kogan (TSSC 2008j). Of the 11 known populations, seven occur on road verges, seven extend onto freehold land and one population is within Braemar State Forest (Halford 1995c in TSSC 2008j). The species was also collected 40 km northeast of Goondiwindi during the EIS field survey within a tenement which has subsequently been relinquished by Arrow.

Likelihood of occurrence and extent of habitat in the project development area: The species is known to occur within the project development area. A number of discrete population clusters occur on the western margin of the project development area within the Braemar Creek Catchment and the species has been recorded during field surveys in *Eucalyptus exserta, Eucalyptus crebra, Callitris glaucophylla* woodland (RE11.7.6) on the Beelbee Rd near Kogan, plus a disjunct population recorded approximately five km south of Wyaga Creek off the Wyaga Creek road during the field survey. Additional populations have the potential to occur in tracts of remnant vegetation and on

disturbed roadsides on lateritic duricrusts (land zone 7). Similar habitat occurs elsewhere in the project development area which suggests additional populations may be present. Known species locations and extent of habitat is shown in **Figure A13**.

Table A33. Extent of habitat for Kogan waxflower within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	1251	34553	71979
3D Detailed Mapping Area**	762	5143	6758
3D Detailed Mapping Area based on EHP (2012)***	1251	7766	22761
Survey area 2 ****	0	0	1281
Survey area 7 ****	0	0	0
Survey area 8 ****	0	936	907
Survey area 9 ****	0	0	332
Survey area F****	0	58	41

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: The loss of habitat and the absence of any secure populations within conservation reserves are considered serious risks to the populations of Kogan waxflower. Roadsides populations are at risk from general road maintenance activities and other disturbances (TSSC 2008j). Potential threats are grazing, invasive weeds, and inappropriate fire regimes.

Potential project-related impacts: Impacts associated with development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Altered and inappropriate fire regimes.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

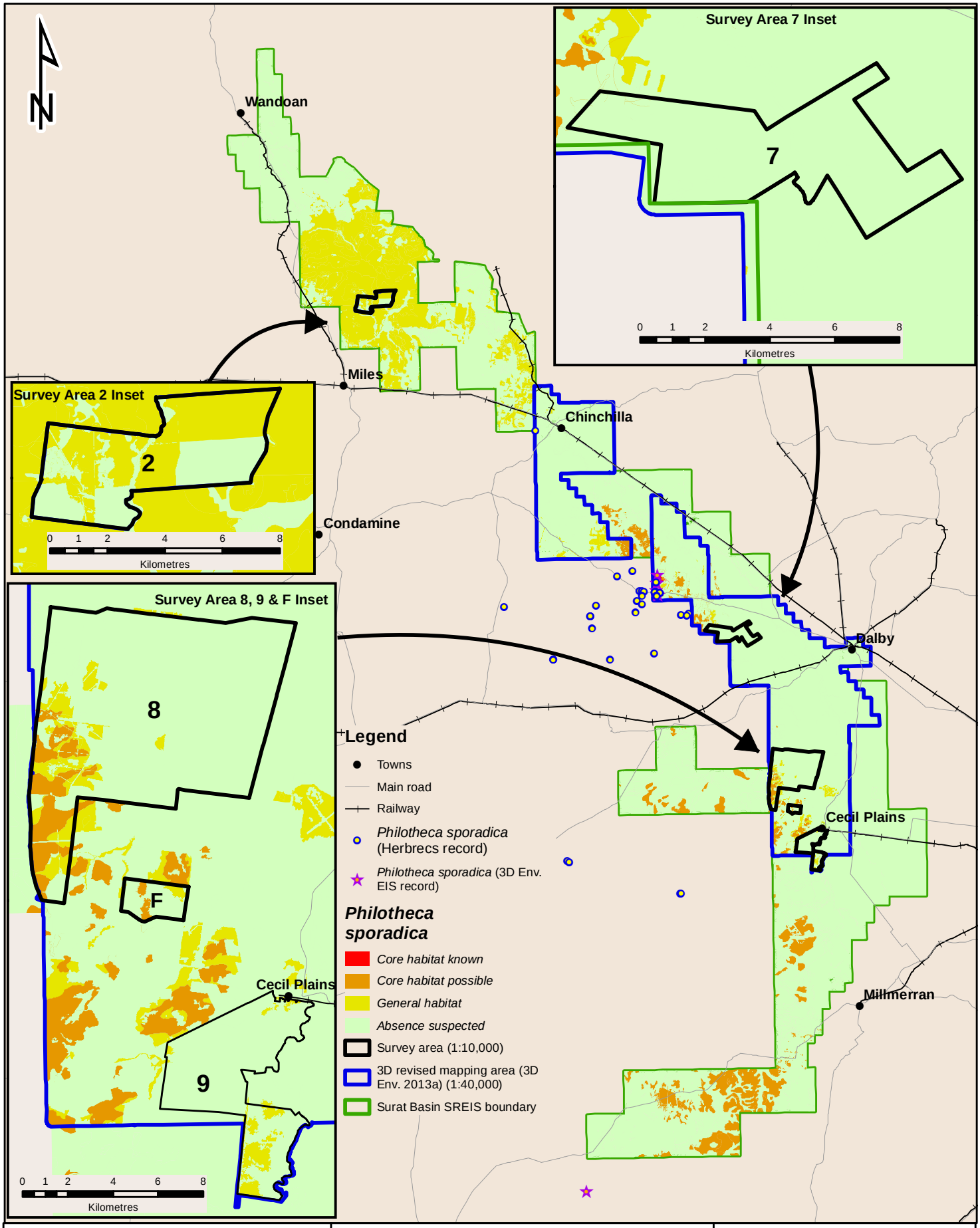
Significance of project related impacts (unmitigated): The sensitivity of Kogan waxflower to unmitigated impacts is considered to be ***Moderate***. This acknowledges the limited knowledge of the ecology of this perennial shrub, but which is known to have some ability to regenerate after disturbance, and has been successfully translocated. Kogan waxflower grows along roadsides so appears to have some ability to persist in disturbed areas. Approximately a quarter of the known populations occur within the project development area and suitable habitat ('core habitat known' and 'core habitat possible') accounts for approximately 7 % of available habitat based on RE mapping provided by EHP (2012a). There is considerable risk of broad scale impacts to this species during gas field development coupled with cumulative impacts of adjoining non-Arrow coal seal gas developments. Roadside populations along Beelbee Rd to the north and south of the Kogan Rd are particularly susceptible to disturbance. It has therefore been given an impact magnitude ranking of ***Major***. The species is considered to have an unmitigated impact significance ranking of ***High (22)***.

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table 1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Kogan wax flower will be prioritised.

Summary residual impact assessment: In the absence of mitigation, impacts of ***High*** **(22)** significance will possibly occur. Avoiding areas identified known habitat and undertaking further survey work within areas of possible habitat is expected to completely mitigate against impact and result in no impact**.** Clear identification of any additional populations will allow adjustment and/or minimising of disturbance areas and establishment of suitable buffer zones. Where avoidance is not possible, the development of a threatened species management plan may be required to guide rehabilitation programs which include propagation from seed or cuttings, and translocation. Other mitigation measures will mostly mitigate impacts which may result in impacts of ***Moderate (13)*** significance.

Residual Significance Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A13. Kogan waxflower *(Philotheca sporadica)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence is applied). .
2. Regional ecosystems with confirmed records (<500 m precision) should be classed as “core habitat known” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by DEHP, 2012a and 2012b).
3. The following regional ecosystems should be classed as “core habitat possible” (confidence as in 2 apply):
   - RE11.7.5, 11.7.4, 11.7.6, 11.7.7
4. The following regional ecosystems should be classed as “general habitat” (confidence as in 2 apply):
   - RE 11.5.1, RE 11.3.14, RE 11.3.18
   - All REs for ‘core habitat possible’ where they occur north of Chinchilla (-27.75).
5. Roadsides in the Kogan area and regrowth (including mature regrowth as per EHP 2012b) derived from RE 11.7.5, 11.7.4 and 11.7.7, particularly in the Braemar Creek Catchment, should also be considered “general habitat”
6. All other remnant vegetation and all cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A34. Evaluation of impact significance for Kogan waxflower under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	The species shows a high level of endemicity and all populations are contained largely within intact habitat. Populations are all viable in the long-term and are important for preservation of genetic diversity. As such they are considered 'important populations'. Survey areas 2, 7, 8 and F host potential habitat for Kogan waxflower (core habitat possible) although the species was not recorded during field survey.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, and F:** Possible habitat for Kogan waxflower is contained within these properties although the species was not recorded during field survey. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount species occurrence.. Based on current knowledge, an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. Pre-clearance survey will be required to totally discount the occurrence of the species within finalised impact footprints. Propertysurvey area 9 does not contain suitable habitat for Kogan waxflower. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.

Criteria	Evaluation
	In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Arrow has developed a number of mitigation measures to manage the spread of exotic species (commitment C099, C179, C188, C183). In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	The species is not known to be affected by any disease which could be potentially introduced into the project development area. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Kogan waxflower (*Philotheca sporadica)* no impact is expected from development activities although this relies on the comprehensive pre-clearance surveys being undertaken in the stages prior to project construction, particularly on survey areas 8 and F where core habitat possible has been mapped.

Based on the current information, impacts are not considered significant when assessed under MNES criteria. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. Impact is considered known and predictable (no impact) and reversibility is not relevant. This assessment assumes appropriate pre-clearance survey is undertaken and the species is not found.

Rule(s) for survey effort required in accordance with survey guidelines: Kogan waxflower is a distinctive shrub that would be readily identified throughout the year without the requirement for seasonal consideration.

Machin's macrozamia (*Macrozamia machinii*)

Family: Zamiaceae

Status: EPBC Act: Vulnerable; **NC Act:** Vulnerable; **BoT:** Critical

Sensitivity: Extremely High

Recovery plan: A species management profile for *Macrozamia machinii* has been prepared by Halford (1997). A multi-purpose recovery plan has also been developed for cycads (Queensland Herbarium 2007) which may have information relevant to the management of Machin's macrozamia.

Overview of Machin's macrozamia

Description (based on EHP 2012c; Flora of Australia Online, Jones and Forster 1994 referenced in DEWHA 2009; Halford 1997a): Machin's macrozamia is a cycad with an underground trunk that can branch to produce multiple growing points in a clump. There are one to eight leaves in a crown. These leaves are frond-like, blue to grey-green, 60 to 90 cm long and silky hairy when young. The leaflet arrangement along the central frond stalk (i.e. rachis) is moderately keeled (i.e. opposing leaflets inserted at 45–60° on rachis). The rachis is strongly spirally twisted. Each frond contains 80 to 140 leaflets, which are up to 32 cm long and 1 cm wide, much paler underneath than above. The basal leaflets are not reduced to spines, which are seen in some other cycads. The plants reproduce by male and female cones, which develop on separate plants. The female cones resemble pineapples with aggregated seed segments. The seeds are red and 2.5 to 3 cm long.

Ecology: Many perennial cycads live for several decades, if not centuries (Benson and McDougall 1993). The ability of the underground stem of Machin's macrozamia to re-shoot multiple crowns probably indicates a strong regenerative ability after soil surface disturbance. Indeed, most if not all Australian cycads survive fires through vegetation regeneration and some can survive some minor level of mechanical disturbance (Forster 1997). However, it is unknown what level of disturbance would kill Machin's macrozamia plants. The leaves and fruits of Machin's macrozamia are poisonous to domestic stock and there are suspicions that some graziers have tried to eradicate it in the past (Halford 1997). Collection by cycad enthusiasts for horticulture may also have caused some population declines (Halford 1997). The mechanism of pollination for macrozamia species in general is poorly understood although generally involves a relationship with a particular insect, a thrip or a beetle. Mature cones of Machin's macrozamia have been recorded from September to December. Ripe seeds are present between February and April although as for all macrozamia species, the fresh seed is not ready to germinate for another 12 months, due to the delayed fertilisation process unique to cycads (Norstog and Nicholls 1997). Delayed fertilisation renders them susceptible to disturbance. Cones may not be annual when conditions are unfavourable. (Halford 1997).

Habitat: The primary habitat of Machin's macrozamia is smooth barked apple (*Angophora leiocarpa*, , white cypress pine (*Callitris glaucophylla*), and budgeroo (*Lysicarpus angustifolius*) woodlands on hills

with deep sands or lateritic rocky surfaces (Halford 1997). Previous collections typically fall within three main REs:

- RE 11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri*, *Eucalyptus* chloroclada, *Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces on deep sands.
- RE 11.7.4; Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust.
- RE 11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rock.
- RE 11.7.7; *Eucalyptus fibrosa subsp. nubila* +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

Distribution: Machin's macrozamia is restricted to an area to the north and south of Inglewood in south-east Queensland. It is thought to span eight known populations in that area (Halford 1997). Some key populations occur in state forest in areas of remnant vegetation, with several populations on private or leasehold land, and one population along a stock route (TSSC 2008h).

Likelihood of occurrence and extent of habitat in the project development area: Known to occur in the project development area. Approximately half of the 41 collections of this cycad have been collected within the Wondul Range (including the National Park) section of the project development area to the north of Inglewood. It was not recorded in field surveys. The extent of habitat in the project development area is indicated in **Table A35** with distribution of habitat shown in **Figure A14.**

Table A35. Extent of habitat for Machin's macrozamia within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	1534.22	24432.16	0
3D Detailed Mapping Area**	0	0	0
3D Detailed Mapping Area based on EHP (2012)***	0	0	0
Survey areas 2, 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: Loss and damage through forestry operations, inappropriate fire regimes (which kills surface seed and young seedlings); failure of the insect pollination mutualism; vulnerability to illegal collecting; trampling of seedlings by stock; and deliberate killing; are considered as the major threats (TSSC

2008h). Other major threats are genetic inbreeding with possible impact on long term population viability (Forster 2004; Forster 2007 in TSSC 2008h), and trampling of seedlings by stock.

Potential project-related impacts: Impacts associated with develoment activities could include:

- Direct loss of individuals during habitat clearing from mechanical removal.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Fragmentation of contiguous vegetation which modifies the natural movement of fire through the landscape.

Significance of project related impacts (unmitigated): The sensitivity of Machin's macrozamia is considered to be ***Extremely High.*** This ranking is based on the fact that, while its ecology is poorly known, it has some capacity to regenerate from vegetative coppicing, and possibly seedlings. However, it is very likely to be a slow maturing, long lived species, so that rehabilitation after disturbances may not produce a successful result for decades, if ever. Around half of the known populations of Machin's macrozamia occur within the project development area. On this basis, the magnitude of unmitigated impacts to populations within the project development area is considered ***Major***. Therefore the significance of unmitigated impacts *is* ***Major (25).***

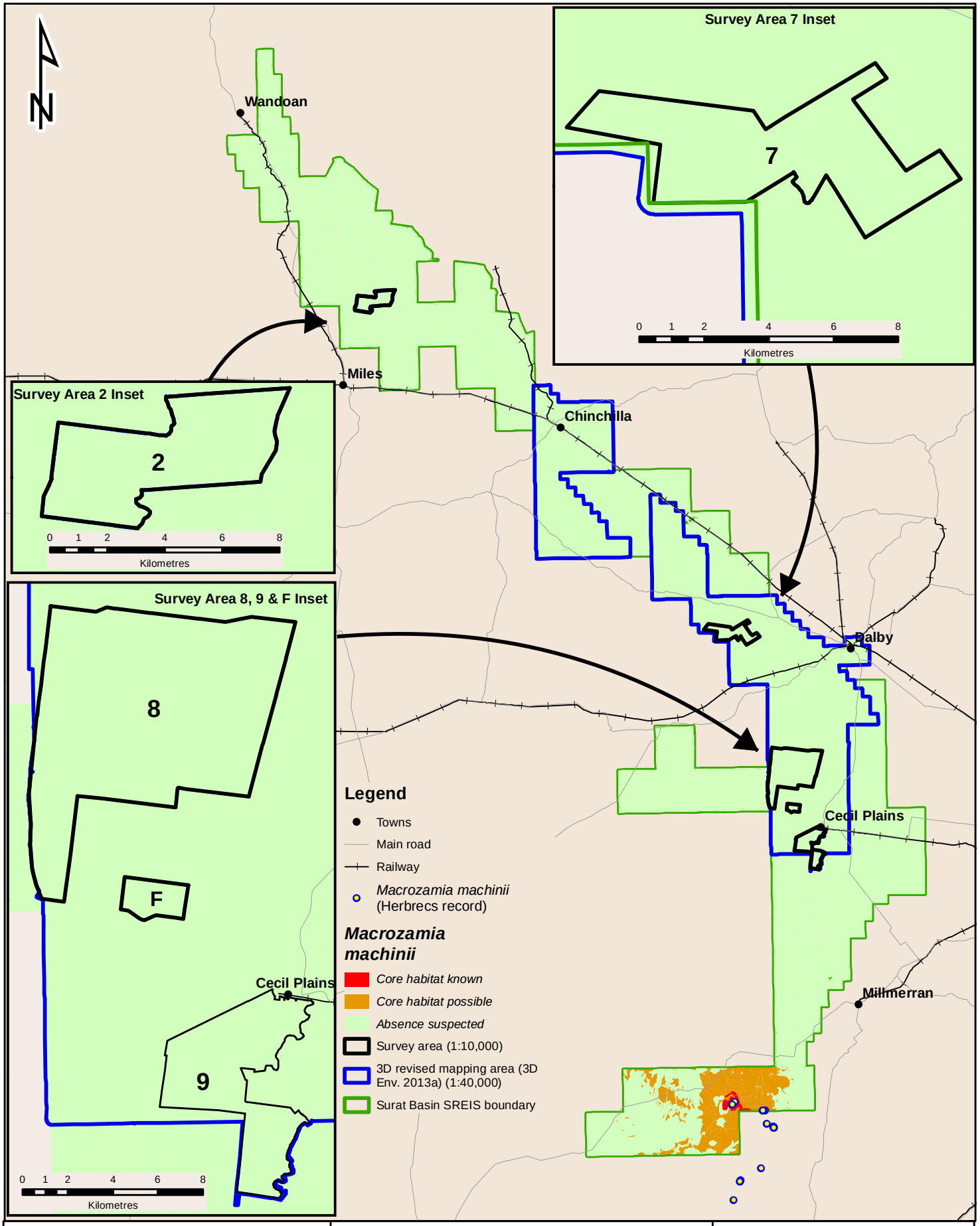
Species specific mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of Machin's macrozamia will be prioritised. The following mitigation measure is recommended, additional to current commitments:

- Ensure that the location of any newly identified populations of this species are not made public due to the sensitivity of the species to plant collection, Identification of this species will be reported to relevant authorities.

Summary residual impact assessment: In the absence of mitigation, a significance ranking impacts of ***Major*** **(25)** significance will potentially occur. Avoidance of core habitat in remnant vegetation in the south west of the project development area is the most effective mitigation measure and if habitat and individuals are avoided, no impact will be incurred**.** Some cycads are amenable to translocation and this measure could be investigated, although there is no means of being sure without ecological trials. Therefore, the impact magnitude with mitigation measures (other than avoidance) remains ***Major (25).***

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	High	Major (25)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A14. Machin's macrozamia *(Macrozamia machinii)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and all remnant REs, regardless of classification treated as "core habitat known" ('high'confidence is applied).
2. RE polygons with confirmed records (≤500 m precision) should be treated as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. Mature regrowth (EHP 2012b) is not included in the habitat calculations.
4. The following regional ecosystems in the Wondul Range area, encompassing the associated north-south trending wildlife corridor should be classed as "core habitat possible":
    - RE 11.10.1, 11.5.4, 11.5.1, 11.7.5, 11.7.4 (confidence levels in 2 apply).
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A36. Evaluation of impact significance for Machin's macrozamia under MNES guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	The habitat for Machin's macrozamia is centred on intact vegetation within the southern portion of the project development area, containing half of all known records. Due to the high degree of endemicity and viability of populations which are associated with intact vegetation, all populations should be considered important populations. No property considered for development contains habitat for Machin's macrozamia.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9, and F:** It is not considered that these properties host potential habitat for Machin's macrozamia. An 'Important Population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9, and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.

Criteria	Evaluation
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. These properties will not impact on the north-south trending wildlife corridor within which the species occurs. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact macrozamia species are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, 9, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Machin' (*Macrozamia machinii)* no impact is expected from development activities. The level of impact caused by development on subject properties (Survey areas 2, 7, 8, 9 and F) will result in no impact to Machin's macrozamia. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions. Provided pre-clearance activities are undertaken in areas where potential habitat is mapped, and any populations are avoided, impact is considered known and predictable (no impact).

Rule(s) for survey effort required in accordance with survey guidelines: Machin's macrozamia is a perennial that should be readily identified throughout all seasons regardless of whether fertile material is visible. Hence no specific survey timing is required to effectively detect the species.

Tara wattle *(Acacia lauta)*

Family: Mimosaceae

Status: NC Act: Vulnerable **EPBC Act:** Vulnerable; **BoT:** Not Listed

Sensitivity: Moderate

Recovery plan: A national species recovery plan has not been developed for Tara wattle (*Acacia lauta*).

Overview of Tara wattle

Description: A sprawling shrub to 2 m tall and very closely allied to *Acacia johnsonii* . The phyllodes 20–40 mm long, 1.5–2.5 mm wide, patent to reclined, midrib slightly raised and rather distinct (when dry). The eccentrically rostellate mucro occurs at right angles to laminae. Peduncles are sparsely puberulous. *Acacia lauta* is a member of the '*Acacia johnsonii* group' and its relationship to its very close relative, *Acacia. Johnsonii*, warrants further study (Maslin, 2005 cited in TSSC 2008o).

Plate 17. Tara wattle (*Acacia lauta).* Photograph Copyright © Boobook

Ecology: The typical life span of Tara wattle is unknown. As a hard-seeded legume, the seed banks of *Acacia lauta* are likely to be long lived. Like many acacia species, there is potential for vegetative regeneration from root suckers, and fire-promoted germination is possible. Tara wattle flowers during

August–September and sets fruit in December (Pedley 1979, Maslin, 2005). The impacts of stock grazing are unknown, but damage from grazing by feral goats has been observed.

Habitat: Associated with sandy soils hosting ironbark woodland. Known populations have been mapped within REs 11.7.7, 11.7.4 and 11.7.5. These REs provide a representative mix of shrubland and woodland of which ironbark (*Eucalyptus crebra, Eucalyptus sideroxylon or Eucalyptus fibrosa)* forms a dominant to sub-dominant component. Habitat descriptions from Herbrecs (EHP 2013)

indicate that the species may also be associated with REs 11.5.4 and 11.5.1 and some collections have been associated with spinifex patches which occur in sandy soils over lateritised sandstone. A single record in the study area occurs in mature regrowth vegetation (RE11.5.1).

Distribution: Confined to a small region of the Darling Downs in south-east Queensland, between Inglewood and Tara. Three populations are known being 15 km north of Tara at Spinifex Corner (five collections); 16 km east of Tara (three specimens); and one specimen from Marron Glen, 15 km south of Inglewood (TSSC, 2008o). The populations occur within both road reserve and freehold land. Tara wattle is not known to occur within any protected area. A single record is also known from Barakula State Forest to the north of Chinchilla although the precision of this record is unknown (AVH, 2013g).

Likelihood of occurrence in project development area: The species is not known to occur within the project development area with the nearest record 17 km west of the boundary and 63 km west of Dalby. Eight collections of Tara Wattle have been made within the study area (EHP 2013). Whilst not known to occur within the project development area, the proximity of known collections, the availability and suitability of habitat for the species suggests that its occurrence cannot be discounted. **Table A37** provides an indication of the extent of Tara wattle habitats within the project development area with broad distribution indicated in **Figure A15.**

Table A37. Extent of habitat for Tara wattle within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	49889	5180
3D Detailed Mapping Area**	0	7155	4779
3D Detailed Mapping Area based on EHP (2012a and 2012b)***	0	13401	3129
Survey area 7****.	0	118	0
Survey area 8****.	0	1544	201
Survey area 2, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The species is poorly known and ecology poorly documented. Being associated with road side verges, road widening is considered a major threat. Too frequent fire is considered to potentially destroy soil seed banks (TSSC 2008o) although this does not take into account fire intensity and the patch burn size. For populations occurring on roadside verges, the invasion of exotic grasses,

particularly buffel and African love grass has potential to significantly impact the species due to their ability to modify fire behavior and increase fire intensity and frequency.

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, changed fore regimes, altered habitat structure along gathering lines, tracks and clearing zones.

Significance of project related impacts (unmitigated): The species is not known to occur in the project development area and as such, known populations will not be impacted. The major risk will be to populations that have not yet been discovered. Further survey of potentially suitable habitats is required prior to disturbance to ensure potential impacts to the species are accounted for. Whilst the ecology of the species is poorly studied, like many acacia species, the seed bank is likely to be long lived and the shrub will likely be capable of regenerating vegetatively. Hence the sensitivity of the species is considered to be ***Moderate***. The species is not known to occur in the project development area although an abundance of suitable habitat suggests that the magnitude of potential habitats may be ***Moderate*****.** The magnitude of impact may need to be re-assessed if new populations are discovered within the project development area although based on current knowledge, the significance of unmitigated impacts is considered to be ***Moderate*** **(13)**.

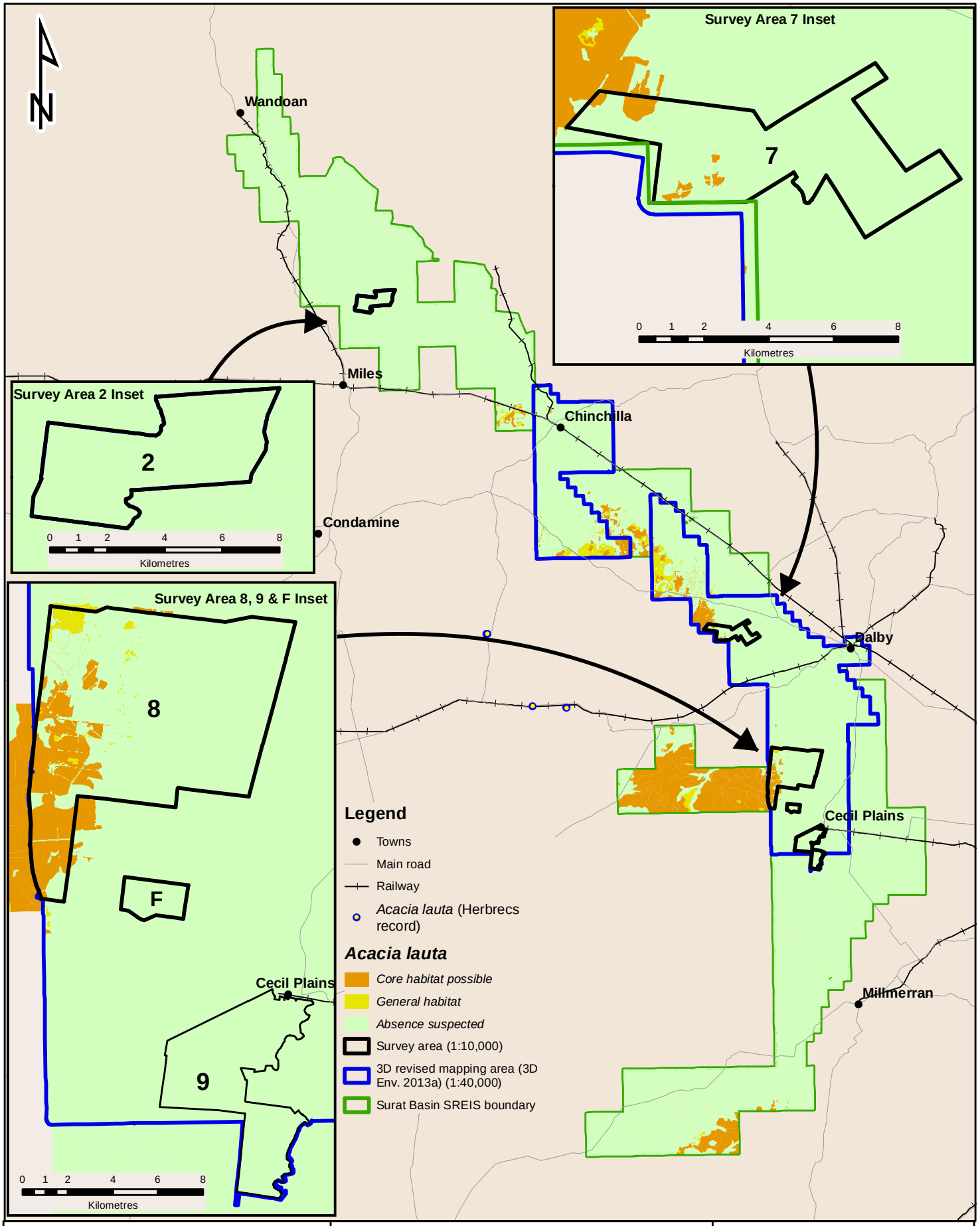
Species specific management/ mitigation measures: Management of this species is covered by Arrow commitments defined in **Table A1** and **Table A2**. Infrastructure design and site selection that seeks to avoid core habitat known of Tara wattle will be prioritised.

Summary residual impact assessment: Avoiding 'core habitat possible' areas is the preferred mitigation measure and will completely mitigate against impact. In the absence of mitigation, impacts of ***Moderate (13)*** significance are likely**.**

Where potential habitat cannot be avoided, further survey work prior to clearing in an attempt to determine the presence or absence of the species will be necessary. The invasion of exotic grasses can be managed by strict weed hygiene measures being imposed on all machinery. Based on application of a range of generic mitigation measures, the resulting residual impact significance would be ***Low (8).***

Residual Significance Assessment				
Avoidance*			Others#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Low	Low (8)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A15. Tara wattle *(Acacia lauta)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species record (<500m precision) should be buffered by a 1km circumference and all remnant habitats regardless of RE classification treated as 'core habitat known' (high confidence levels apply). This includes mature regrowth datasets (EHP 2012b).
2. Regional Ecosystem polygons with the confirmed record (<500m precision) should be treated as 'core habitat known'('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping (3D Environmental 2013) and 'low' when applied to mapping produced by EHP, 2012a).
3. The following regional ecosystems within 50 km of known records should be classed as "core habitat possible" (confidence levels as in 2 apply):
   - RE11.7.4, RE11.7.5, RE11.7.6, RE11.7.7, RE11.5.1, RE11.5.4
4. Mature regrowth of potential habitat (REs as per core habitat possible) within 50 km of records is considered "general habitat" (low confidence levels apply)
5. All other remnant and non-remnant vegetation in the project development area should be treated as 'absence suspected'.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A38. Evaluation of impact significance for Tara wattle under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge three populations of Tara wattle occur to the west of the project development area with an additional population present in Barakula State Forest to the east. The survey areassurvey area 8 andsurvey area 7 contains "core habitat possible" for the species. There remains potential for the species to exist however and pre-construction surveys will be required to totally discount occurrence of the species in suitable habitats. Other development locations (survey area 9,survey area 2 and Survey area F) are not considered to contain suitable habitat. Whilst no populations are known in the project development area, the highly endemic nature of the species, would render any additional population found an 'important population'.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 7, 8,:** Field survey failed to locate this species within suitable habitat. It is not possible to totally discount occurrence Tara wattle within the property and pre-clearance survey will be required once project footprints have been identified. No other property is considered likely to host Tara wattle populations. Other survey areas 2, 9 and F are not considered to contain suitable habitat for the species. Based on current knowledge an 'important population' is not contained within properties identified for development and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 9, 7, 8, F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey area 2, 9, 7, 8, F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 9, 7, 8, F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.

Criteria	Evaluation
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 2, 9, 7, 8, F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 9, 7, 8, F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Whist *Eucalyptus virens* populations are associated with state wildlife corridors, these corridors will not be impacted by the proposed development. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 9, 7, 8, F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of exotic species within tenements are proposed. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact acacia species are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey area 2, 9, 7, 8, F:** Will not interfere with the recovery of the species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Tara wattle (*Acacia lauta)* no impact is expected from development activities. Impacts are not considered significant when assessed under MNES criteria provided pre-clearance survey is undertaken in survey areas 7 and 8 where potential habitat is mapped and mitigations are applied to any populations located. There is limited potential for cumulative impacts to be reinforced through the proposed Arrow development actions. Impact is considered known and predictable (no impact) assuming appropriate pre-clearance surveys are applied and the species is not found.

Rule(s) for survey effort required in accordance with survey guidelines: Tara wattle is a perennial shrub species that should be apparent throughout all seasons. It may however be difficult to distinguish Tara wattle from *Acacia johnsonii* in the absence of fertile material. For the purpose of certainty, survey during its fertile period from August to December is recommended.

Queensland white gum (*Eucalyptus argophloia*)

Family: Myrtaceae

Status: NC Act: Vulnerable **EPBC Act**: Vulnerable; **BoT:** Critical

Sensitivity: Moderate

Recovery plan: A national species recovery plan has not been developed for Queensland white gum (*Eucalyptus argophloia*). A species management manual has been prepared by Halford (1997b).

Overview of Queensland white gum

Desription (based on Boland 2004, Brooker and Kleinig 2004, EHP 2012d): Queensland white gum is a medium sized to tall tree growing to 40 m and the tall, erect habit makes this tree very distinctive (Boland et al. 2006). The bark is smooth, grey and reddish over yellow weathering which may be white and powdery (Brooker and Kleinig, 2004). The trunk is free of branches for one-half or more of the total tree height. The smooth bark is shed in strips and has a mottled appearance with patches of yellow, pinkish grey, reddish grey, bluish grey and white. The juvenile leaves are linear to narrowly lance-shaped, up to 9cm long by 1.4cm wide, greyish-green in colour and arranged at first in opposite pairs then alternating along the branch. The dull, green, adult leaves are lance-shaped and measure up to 13cm long by 1.3cm wide. A prominent feature of the leaves is the intra-marginal vein being remote from the leaf edge (EHP 2012d). The flowers are simple, axillary and sometimes terminal, in groups of up to 7 and buds are ovoid to almost globular (Boland et al. 2006). The seed capsules are hemispherical to cup-shaped and are 2.5-5mm long by 4-7mm diameter with 4-6 valves opening at rim level or slightly exerted. (Brooker & Kleining 2004).

Plate 18. Queensland white gum (*Eucalyptus argophloia)* buds and foliage. Photograph Copyright © Boobook

Ecology: The typical life span of Queensland western white gum is unknown. Much of its current population exists in disturbed regrowth vegetation and the species regenerates from seed. The species is highly tolerant of frost and drought and its use in forestry plantations suggests that its seed is readily harvested and available for regeneration. It is a fast growing species.

Habitat: The existing natural population exists largely in highly disturbed regrowth vegetation with associated tree species including brigalow (*Acacia harpophylla),* grey box (*Eucalyptus molluccana/ Eucalyptus microcarpa)* white cypress pine (*Callitris glauca)* and poplar box *(Eucalyptus populnea).* The tree is associated with red loams, grey brown clays and clay loams of moderate to high fertility (Boland et al. 2006). According to TSSC (2008p), no known populations occur in vegetation classified as remnant under the VM Act. Possible REs providing habitat include RE11.4.3, 11.3.1, 11.4.7, 11.4.12, 11.5.1 and 11.5.20.

Distribution: The species has a highly restricted distribution contained within an area of 40 km long and 12 – 15km wide in an area to the north of Chinchilla, Queensland (Boland et al, 2004).

Likelihood of occurrence in project development area: The nearest record of Queensland white gum is located 7 km from the edge of the project development area, 16 km north east of the Chinchilla town centre. A total of thirteen records are known from the study area. It is considered likely that due to the distinctive nature of this tree, the existing locations have been well documented. There however remains the possibility that this species will occur within the project development area in the Chinchilla area. The species is used extensively in plantation throughout the region and these should not be confused with local natural populations. **Table A39** provides an indication of the extent of Queensland white gum habitats within the project development area with broad distribution indicated in **Figure A16.**

Threats: The main threats to the local populations of Queensland western white gum are:

- Habitat destruction for agriculture.
- Timber harvesting.
- Lack of seedling regeneration due to weeds and planted pasture species (TSSC 2008p).

Table A39. Extent of habitat for Queensland white gum within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	4138	0
3D Detailed Mapping Area**	0	640	0
3D Detailed Mapping Area based on EHP mapping***	0	1936	0
Survey area 2, 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones;

Significance of project related impacts (unmitigated): The species can regenerate via seed in disturbed habitats and can be propagated readily from seed. Hence the sensitivity of Queensland white gum to project related impacts is considered ***Moderate.*** All known natural populations occur outside the project development area and any occurrences contained within are likely to be scattered individuals. Hence the potential magnitude of impacts is considered to be ***Low (8).***

Species specific management/ mitigation measures: Management of this species is covered in Arrow commitments provided within **Table A1.** Infrastructure design and site selection that seeks to avoid core habitat known of Queensland white gum will be prioritised.

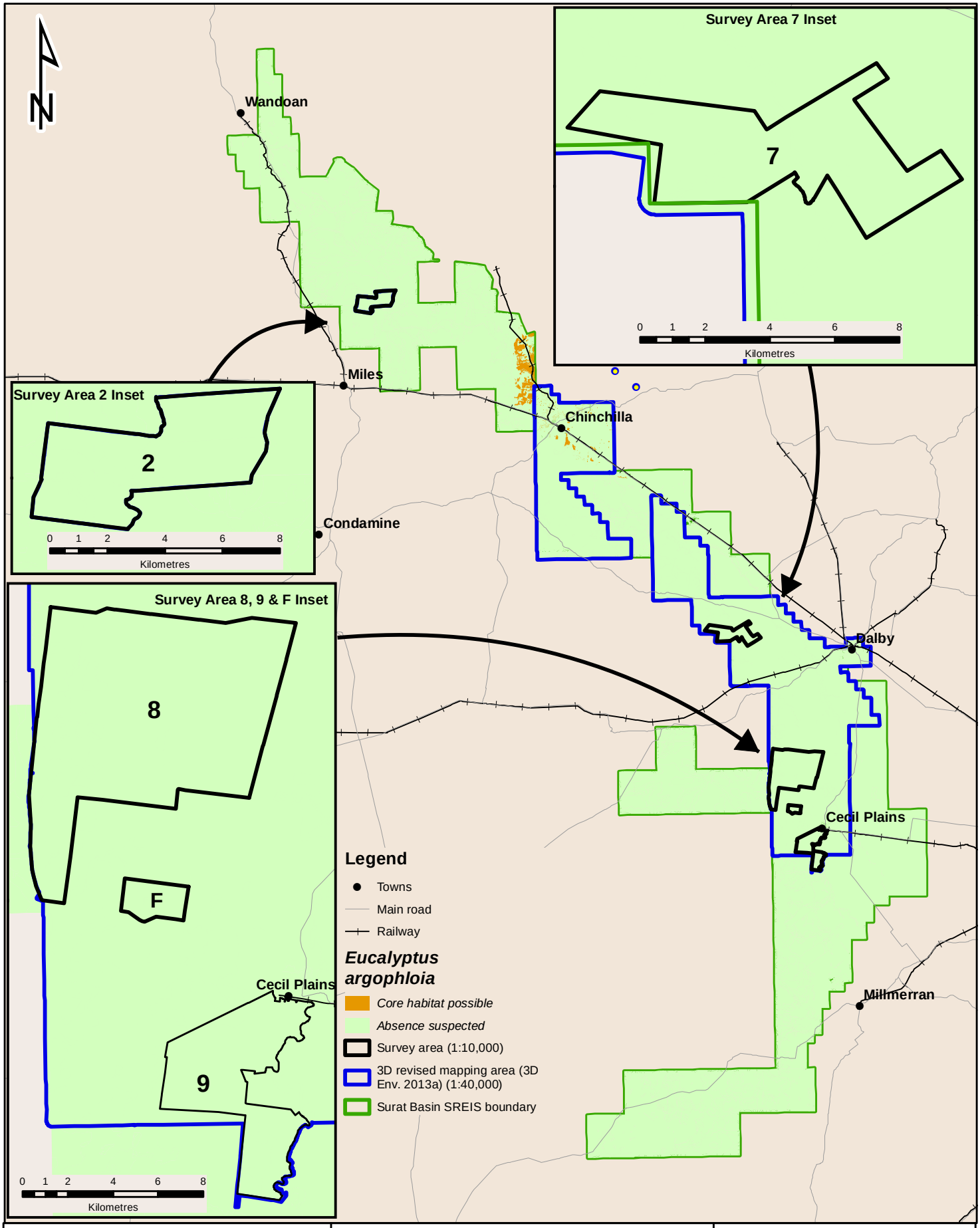
Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Low (8)*** significance to Queensland white gum populations within the project development area. Whilst the species is not known to occur in the project development area, there is potential for scattered individuals to occur within disturbed habitats in the vicinity of Chinchilla. Mature trees should be readily avoided and mitigation measures are considered largely effective. Assuming habitat and individual trees can be avoided, there will be no residual impact incurred. With mitigation measures other than avoidance, residual impact will be ***Low*** (4).

Residual Impact Assessment				
Avoidance*			Others#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Extremely Low	Low (4)

*Includes appropriate application of management buffers

Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts.



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A16. Queensland white gum *(Eucalyptus argophloia)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (high confidence applies) for all RE and mature regrowth (EHP 2012a and 2012b) contained within the buffer
2. RE and mature regrowth polygons with the confirmed record (<500m precision) should be treated as ‘core habitat known’ (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by EHP, 2012a).
3. All remnant and mature regrowth habitats (from EHP 2012a and 2012b) within 20 km of confirmed records should be considered ‘core habitat possible’ (confidence levels as in 2 apply).

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A40. Evaluation of impact significance for Queensland white gum under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area	Based on current knowledge, with the exception of populations occurring in plantation, Queensland white gum does not occur in the project development area. Given that any record of a non-cultivated specimen that is located in the project development area would be considered a range extension, any natural population occurring would qualify as an important population. Populations occurring within plantations should not be considered important to the survival of the species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9 and F:** These areas are not considered to host potential habitat for Queensland white gum. Hence no long term decrease in the size of a Queensland white gum population is anticipated from development at these locations. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected.

Criteria	Evaluation
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	**Survey area 2, 7, 8, 9 and F:** Diseases specific to Queensland white gum are not known although the species may be susceptible to thrip and borer attack. It is considered unlikely that an increase in such attack would be facilitated by development activities. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey area 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on information provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For Queensland white gum (*Eucalyptus argophloia)* no impact is expected from development activities. Further assessment will however be required in areas where core habitat possible for the species is mapped when working more broadly in the project development area. Provided pre-clearance survey are appropriately applied, impact is considered known and predictable (no impact) and reversibile if the species is identified. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: Queensland white gum is a distinctive tree species that will be apparent throughout all seasons. Specific survey timing is not warranted for this species.

Eucalyptus virens

Family: Myrtaceae

Status: NC Act: Vulnerable **EPBC Act**: Vulnerable

Sensitivity: High

Recovery plan: A national species recovery plan has not been developed for *Eucalyptus virens*. A species management manual has been prepared by Halford (1998).

Overview of *Eucalyptus virens*

Description (Based on Brooker and Kleinig 2004): *Eucalyptus virens* is a small to medium sized tree that is ironbark throughout with bark that is sometimes soft and flaky and soft and corky on branchlets. The juvenile leaves are petiolate, opposite for three or four pairs, then alternating. Adult leaves are concolorous, bright glossy green and densely reticulated. The buds are pedicellate and rhomboidal with a conical operculum with fruit that are obconical, 0.5 x 0.5 cm. The white flowers emerge in November and persist to February (Brooker & Kleining 2004).

Plate 25. *Eucalyptus virens* buds and foliage. Photograph Copyright © Boobook

Ecology: Limited information is available on the ecology of *Eucalyptus virens* and its typical life span is unknown. Its typical flowering period occurs from November through to February (Brooker & Kleining 2004).

Habitat: The species is known to inhabit plateaus and sandstone escarpments and sandy soils which form low rises. Based on Herbrecs data (EHP 2013), populations are mapped as occurring in association with REs11.7.7, 11.7.4. 11.7.5, 11.7.6 and11.5.1, all associated with residual soils with the initial three occurring on lateritic sandstones.

Distribution: The species is restricted to four disjunct populations near Inglewood, Tara, northeast of Eidsvold and near Mt Moffat. The species is endemic to Queensland (Brooker and Kleinig, 2004). Two herbarium records of the species occur in the study area although these are located 18 km southwest of the project development area boundary and 60 km west of Dalby.

Likelihood of occurrence and extent of habitat in the project development area: The nearest confirmed record is located 18 km south-west of the project development area and 16 km NE of Tara with two prior collections in the study area. The species in not known to occur in the project development area although due to proximity and suitability of habitat, it is considered a possible occurrence, particularly on lateritic and sandstone rises in the Kumbarilla area. **Table A41** provides an indication of the extent of *Eucalyptus virens* habitats within the project development area with broad distribution indicated in **Figure A17.**

Table A41. Extent of habitat for *Eucalyptus virens* within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	0	0
3D Detailed Mapping Area**	0	3536	4544
3D Detailed Mapping Area based on EHP (2012)***	0	0	0
Survey areas 2, 9, 8 and F****.	0	0	0
Survey area 7****	0	100.24	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The main threats to the local populations of *Eucalyptus virens* are:

- Timber harvesting.
- Disturbance of habitat during timber clearing.
- Wholesale clearing of habitat (TSSC 2008q).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

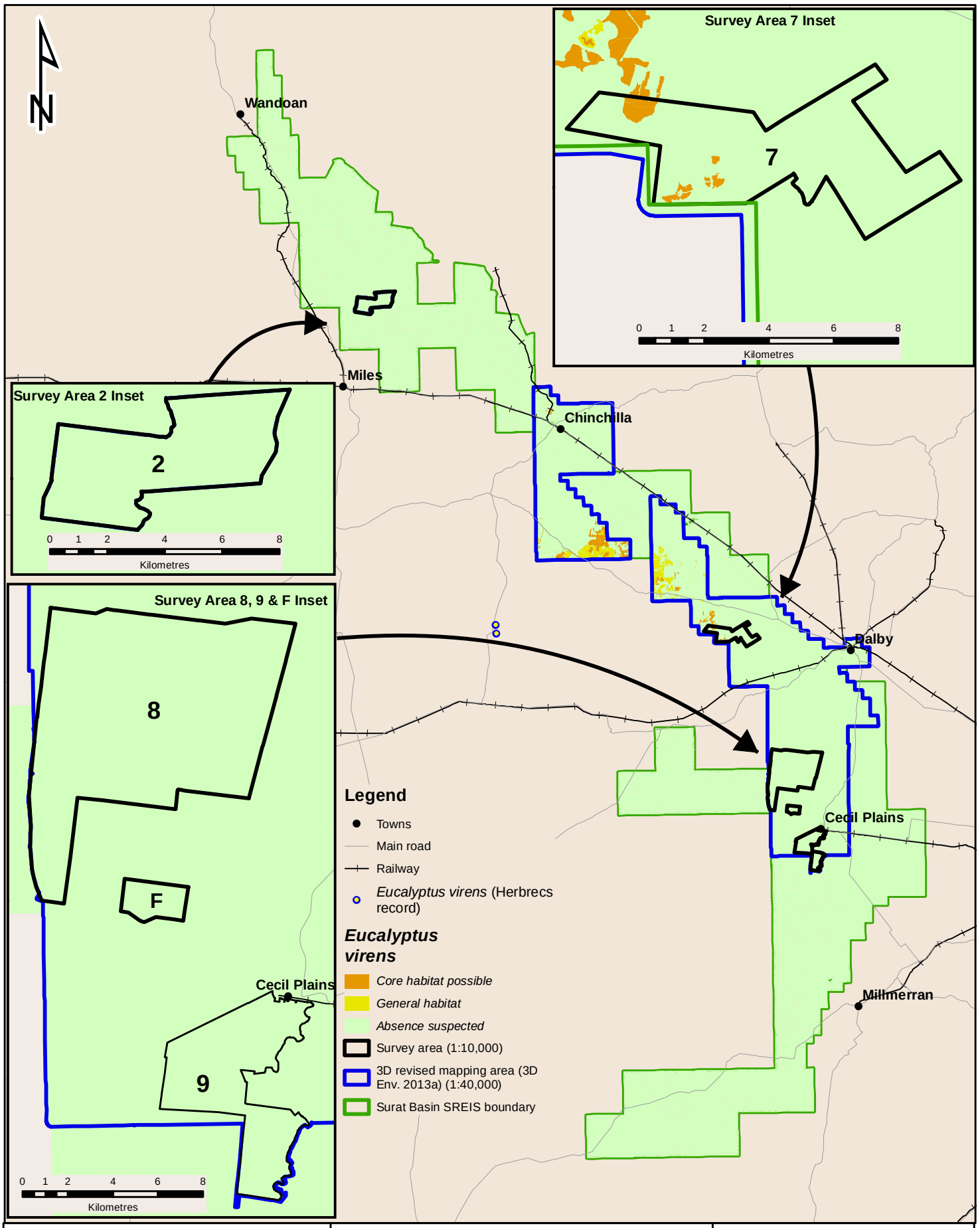
Significance of project related impacts (unmitigated): The species is not known to occur in the project development area and hence any impacts incurred will be within previously unrecognised populations. Reproduction ecology is unknown although the species is expected to regenerate through seeding and like other related eucalypt species, is likely to re-generate via coppicing. Seedlings may take many years to mature. The species sensitivity is considered ***High*** and the potential magnitude of project related impacts, based on the availability of potential habitat in the project development area, is considered ***Moderate***. The significance of unmitigated impacts is potentially ***Moderate (17)***.

Species specific management/ mitigation measures: Management of this species is covered in Arrow commitments provided within **Table 1.** Infrastructure design and site selection that seeks to avoid core habitat known of *Eucalyptus virens* will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Moderate (17)*** significance to *Eucalyptus virens* populations within the project development area. Whilst the species is not known to occur, there is potential for additional populations to be identified, particularly in escarpment and sandstone areas in the vicinity of Tara. All identified populations should be avoided during disturbance activities. The suitability of the species for rehabilitation is unknown and hence this is not considered a viable mitigation measure until further tested. Assuming avoidance of populations, no residual impact will be incurred. Other methods of mitigation, including use of seedlings in rehabilitation will result in impacts of ***Moderate (12)*** significance.

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

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A17. *(Eucalyptus virens)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (high confidence applies).
2. The RE polygons within which the species occurs should be mapped as ‘core habitat known’ (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping (3D Environmental 2013) and ‘low’ when applied to mapping produced by EHP, 2012a).
3. All habitats comprising REs 11.7.5, 11.7.4, 11.7.6, 11.7.7 and 11.5.1 within 50 km of known populations should be considered ‘core habitat possible’ (confidence levels as in 2 apply). mature regrowth datasets (EHP 2012b) and regrowth habitats (3D Environmental 2013) derived from ‘core habitat possible’ REs are attributed ‘general habitat’.
4. All other vegetation should be considered ‘absence suspected’.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A42. Evaluation of impact significance for *Eucalyptus virens* under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, four populations of *Eucalyptus virens* are known although these all occur outside the project development area. The proposed facility site at survey area 7 contains "core habitat possible" for the species. Pre-construction surveys will be required to totally discount occurrence of the species in suitable habitats. Other development locations (survey areas 8, 9, 2 and F) are not considered to host potential habitat for the species based on known distribution. Whilst no populations are known in the project development area, the highly endemic nature of the species, would render any additional population found an 'important population'.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 7:** Field survey failed to locate this species within suitable habitat. It is not possible to totally discount occurrence of the *Eucalyptus virens* within the property and pre-clearance survey will be required once project footprints have been identified. No other property is considered likely to host *Eucalyptus virens* populations. Based on current knowledge an 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 4. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is

Criteria	Evaluation
	not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Whist *Eucalyptus virens* populations are associated with state wildlife corridors, these corridors will not be impacted by the proposed development. In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 5. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	Diseases which impact eucalyptus species are not known to occur. In accordance with **Criteria 8,** a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey area 2, 7, 8, 9 and F:** Will not interfere with the recovery of the species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For *Eucalyptus virens* no impact is expected from development activities and impacts are not considered significant when assessed under MNES criteria. Provides pre-clearance surveys are adopted in areas mapped as possible habitat and appropriate mitigations are applied, impact is considered known and predictable (no impact) and reversibility is not relevant. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: The tree may be easily overlooked as other ironbark species and although foliage is characteristic, there is a necessity to collect fertile material for positive identification. Optimal survey timing is from November through to March.

***Prostanthera* sp. (Dunmore D.M.Gordon 8A)**

Family: Lamiaceae

Status: EPBC Act: Vulnerable; **NC Act:** Vulnerable; **BoT**: Not Listed

Sensitivity: Extremely High

Recovery plan: A national species recovery plan has not been developed for *Prostranthera* sp. (Dunmore D.M. Gordon 8A).

Overview of *Prostanthera sp.* (Dunmore D. M. Gordon 8A)

Description (based on Stanley and Ross 1983, TSSC 2008k, DNR 2000): Low, upright, aromatic shrub, to 1 m tall but often only 50 cm tall. Leaves are with whorled, stalk-less (i.e. sessile), linear leaves 0.8 to 1.2 cm long, and up to 2 mm wide. The leaf margins are curved underneath back towards the midrib. Flowers are clustered into terminal racemes or panicles, two-lipped, mauve to purple-blue and about 8 mm long.

Ecology: The life span of *Prostanthera* sp. (Dunmore D.M.Gordon 8A) is not known, other than being a perennial. Flowering plants have been documented in June, August and October (Wang 1996). No other ecological information is known, other than habitat preferences.

Habitat: *Prostanthera* sp. (Dunmore D.M.Gordon 8A) grows in sandy soils and on stony ridges, including amongst rocks (Wang 1996). Regional ecosystems likely to form habitats include:

- RE 11.5.1; Eucalyptus and Callitris woodland in shallow sandy soil or Eucalyptus woodland on hard sandstone ridge tops.
- RE 11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri, Eucalyptus chloroclada, Angophora leiocarpa* on Cainozoic sand plains.
- RE 11.7.4; *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on lateritic duricrust.
- RE 11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.

The species has not been recorded in regrowth or otherwise “non-remnant” vegetation.

Distribution: A Queensland and bioregional endemic known only from four locations in a small area west of Millmerran, southern Queensland with a total extent of occurrence of less than 100 km² (TSSC 2008l). One population occurs on private land and three within state forest, including one on the border with Wondul Range National Park (EHP 2013, TSSC 2008k). Populations are possibly stable (EPA 2002). All collections occur south of Cecil Plains. The distribution of the species coincides with relatively contiguous tracts of remnant vegetation and the occurrence in the project development area coincides with a broad north-south trending wildlife corridor (see **Figure A18**).

Likelihood of occurrence and extent of habitat in the project development area: *Prostanthera* sp. (Dunmore D. M. Gordon 8A) is known to occur within one of the six previous Herbrecs records

occurring within the project development area boundary between Wondul Range National Park and Bulli State Forest (EHP 2013). The species was not recorded during field surveys.

Table 43. Extent of habitat for *Prostanthera sp.* (Dunmore D. M. Gordon 8a) within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	1312	40318	0
3D Detailed Mapping Area**	0	765	0
3D Detailed Mapping Area based on EHP (2012)***	0	1623	0
Survey area 2, 7, 8, 9, F	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Habitat disturbance, including timber harvesting or mechanical activities and inappropriate fire regimes are possible threatening processes for the species (DNR 2000, TSSC 2008k).

Potential project-related Impacts: Impacts associated with the proposed development activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Altered and inappropriate fire regimes.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

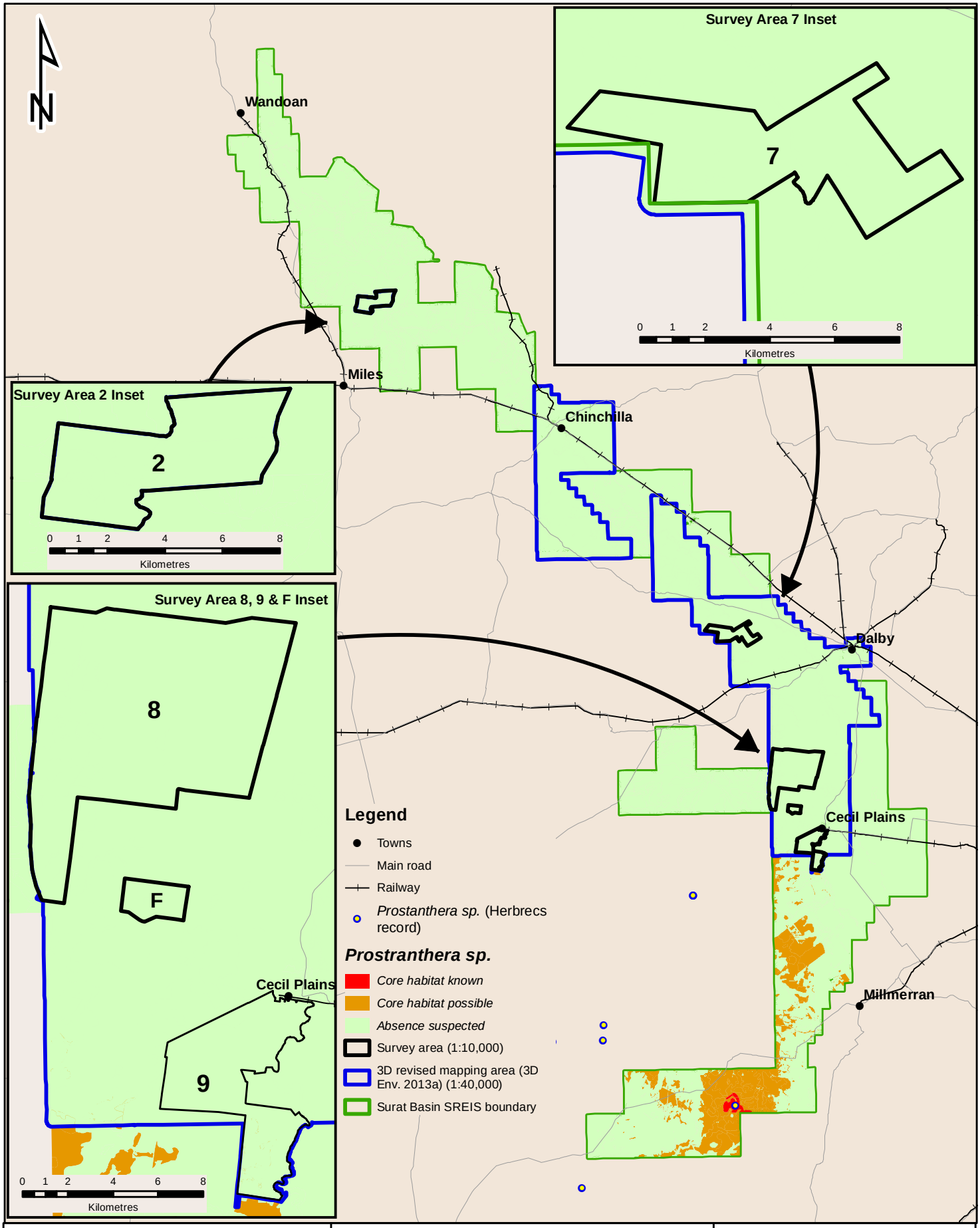
Significance of project related impacts (Unmitigated): The species is considered to have an ***Extremely High*** sensitivity to disturbance. This is based on the absence of any ecological information, especially regarding seed germination and post-disturbance regeneration. The genus prostanthera has several threatened species listed under the EPBC Act, so that it is possible that the ability of the genus to recover after disturbance is limited. However, there is suitable habitat within the project development area that could support as yet unknown populations. The consequences of unmitigated impacts on a local population may be ***High*** with an unmitigated impact significance of ***Major* (25).**

Specific management/ mitigation measures: Mitigations for management of this species are covered by generic recommendations made within **Appendix A1**. Infrastructure design and site selection that seeks to avoid core habitat known of Prostanthera sp. (Dunmore D, M. Gordon),

Summary residual impact assessment: In the absence of mitigation, impacts of ***Major*** **(25)** significance will possibly be inflicted upon populations in the vicinity of disturbance. Avoidance of core and possible habitat in remnant vegetation, including management buffers around known populations, will totally mitigate impact and residual impact will not be incurred**.** Due to the species sensitivity and the untested nature of many mitigation measure, any disturbance will result in residual impact that is potentially ***High (20).***

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

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A18. *Prostranthera sp.* (Dunmore D.M. Gordon) distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. The species in not recorded north of Cecil Plains (-27.53).
2. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence applies) for all REs contained within the buffer. .
3. Regional ecosystem polygons coninciding with confirmed records (<500m precision) should be classed as “core habitat known” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping (3D Environmental 2013) and ‘low’ when applied to mapping produced by (EHP, 2012a). mature regrowth datasets (EHP 2012b) are not considered.
4. The following regional ecosystems in the in the project development area to the south of Cecil Plains should be classed as “Core Habitat Possible” (confidence levels as in 3 apply).
    - RE11.7.4, RE11.7.5, RE11.5.1, RE11.5.4 (‘low’ confidence applies where applied to EHP datasets (EHP 2012a)).
5. All other remnant and regrowth vegetation, cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

Evaluation under MNES referral guidelines

Table A44. Evaluation of impact significance for *Prostanthera* sp. (Dunmore D. M. Gordon) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Due to the high degree of endemicity of the species, known from a limited number of locations to the west of Millmerra, all populations should be considered important populations. No property considered for development contains habitat for *Prostanthera* sp. (Dunmore D. M. Gordon).
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9, and F:** It is not considered that these properties host potential habitat for *Prostanthera* sp. (Dunmore D. M. Gordon). An 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9, and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9, and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9, and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9, and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. These properties will not impact on the north-south trending wildlife corridor within which the species occurs.

Criteria	Evaluation
	In accordance with **Criteria 6**, a significant impact is not expected.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9, and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected.
Criteria 8: introduce a disease	There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area. In accordance with **Criteria 8**, a significant impact is not expected.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, 9, and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected.

Conclusions: For *Prostanthera sp.* Dunmore (DM Gordon No. 8), no impact is expected from development activities. No impact will be incurred on the species by the proposed development on any survey area and habitat for the species will not be affected. The activities proposed by Arrow will not contribute to the cumulative impact to this species across a range of proponents. Impact is considered known and predictable (no impact) and reversibility is not relevant. Pre-clearance survey will be required when working in areas of potential habitat to ensure significant impact is not incurred when working more broadly in the project development area.

Rule(s) for survey effort required in accordance with survey guidelines: Limited ecological information is available to guide survey requirements for this species. The likely availability of fertile material in the period from June through October suggests that this period presents the optimal timing for survey. It is likely however that this species can be identified in the absence of fertile material.

Grasses

Lobed blue grass (*Bothriochloa biloba*)

Family: Poaceae

Status: EPBC Act: Vulnerable; **NC Act**: Least Concern; **BoT:** Not Listed

Sensitivity: Moderate

Recovery plan: A recovery plan has not been prepared for lobed blue grass.

Overview of lobed blue grass

Description (based on Sharp and Simon 2002; Harden 1993): An erect or decumbent, tufted perennial grass to 1 m high. The ligule (i.e. membrane at the base of the leaf against the stem) is fringed with hairs. The leaves are 3 to 5 mm wide with margins that are slightly rough. The flowering stalk is often branched at the nodes. The inflorescence (i.e. the flower and seed head) consists of 3 to 6 arms, each 4 to 10 cm long, which emerge from almost the same point, resembling fingers on a hand. Each arm of the flower/seed head has long white hairs (6.5 to 8 mm long), giving a silky look. The lemmas (i.e. the lower of two bracts enclosing each flower) that are awned (i.e. with bristles) are two-lobed.

Plate 26. Specimen of lobed blue grass (*Bothriochloa biloba).* Copyright © Boobook.

Ecology: Lobed blue grass is a perennial grass related to some of Australia's most valuable pasture species, yet it may be fairly unpalatable to stock. Bean (1999) saw no evidence that cattle grazed lobed blue grass and was told by NSW graziers that when other grasses are available, stock do not graze it.

Lobed blue grass has been collected in flower or with seed heads between November to June (EHP 2013; Sharp and Simon 2002). Compared with some other bothriochloa species, lobed blue grass produces low levels of viable seed. This is mainly due to a high proportion of seed formation following

a process called apomixes, where the seed are produced asexually without pollen from a second plant (Yu *et al*. 2003). Many of the lobed blue grass seeds formed through the apomixes process do not mature into viable seed.

Habitat: Lobed blue grass has a preference for heavier-textured brown or black clay soils (Bean 1999); although Fensham (1998) felt that it appeared "relatively unspecific" in its habitat preference. On the Darling Downs region it is often found in cleared alluvial sandy clay sites. It has been collected in cleared eucalypt forests with derived non-remnant grasslands in alluvial areas, often on the edge of RE 11.3.4; disturbed roadside habitats of the Condamine flood plain; Queensland blue grass (*Dichanthium sericeum*) grassland on heavy alluvium (RE11.3.21), as well as within road and rail reserves where heavy alluvium occurs (EHP 2013; EHP 2012b).

Lobed blue grass was found during the in EIS surveys within the project development area in open grassy woodland dominated by Queensland blue gum (*Eucalyptus tereticornis*) on the flood plain of the Condamine River. The woodland structure of the habitat where the species was collected has been heavily disturbed by extensive timber extraction and heavy grazing pressure to the extent that the site is considered non-remnant.

Distribution: Known from the Darling Downs district in south east Queensland, south along the western slopes of the Great Dividing Range into NSW to North Star, Warialda, Bingara and Merriwa (Quinn *et al.* 1995; NSW Scientific Committee 2004). Recorded from Miles (2 km south of Condamine River), in the locality of Cecil Plains, and; 10 km north, 14 km NE and 6 km E of Goondiwindi at Yelarbon, Yellowbank (EHP 2013). A vouchered survey record was collected from 5 km NNE of Cecil Plains. The species is documented to be common within the bioregion and has been delisted in Queensland to common status (EPA 2002). The Darling Downs represents the northern geographic limit of the species.

Likelihood of occurrence and extent of habitat in the project development area: Lobed blue grass is known to occur within the project development area with three previous records contained with Herbrecs (EHP 2013) located to the south of Miles and the Cecil Plains area. A collection during baseline surveys 5 km NNE of Cecil Plains (project vegetation survey site AS346) strongly suggests that the species will occur relatively extensively on alluvial habitats associated with the Condamine River floodplain. Lobed blue grass has also been collected to the east of Goondiwindi, approximately 50 km to the south of the project development area. This falls within a polygon mapped by the Herbarium as RE 11.5.14 although the record precision is considered low (± 16000 m) and REs associated with Land Zone 5 should at best be considered 'general habitat'. Lobed bluegrass has potential to occur within all areas proposed for development although suitable habitat is most prevalent in survey area 9, survey area 7 and survey area 8. A summary of potential habitat within the project development area is provided in **Table A45** with spatial representation of records and habitats provided in **Figure A19.**

Table A45. Extent of habitat for lobed bluegrass within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
Project development area*	1477	23965	0
3D Detailed Mapping Area**	364	6352	12822
3D Detailed Mapping Area based on EHP (2012)***	51	8788	0
Survey area 2	0	56	0
Survey area 7	0	77	7
Survey area 8	0	104	1277
Survey area 9	0	137	402
Survey area F	0	0	42

* Based on attribution of regional ecosystem mapping of EHP (2013) following mapping rules detailed within this profile. Level of confidence = ***Low***

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

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

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

Threats: Threats to lobed blue grass are identified by Fensham (1998, 1999), NSW Scientific Committee (2004) and Quinn *et al*. (1995) in Threatened Species Scientific Committee (2008d) include:

- Competition from exotic species such as coolatai grass (*Hyparrhenia hirta*), nut grass (*Cyperus rotundus*) and lippia (*Phyla nodiflora*); African love grass (*Eragrostis curvula*), *Paspalum dilatatum,* Guinea grass (*Megathrysus maximus*)*,* feathertop (*Pennisetum villosum*)*,* and Johnson grass (*Sorghum halepense*).
- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.
- Heavy ongoing grazing pressure.

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Habitat edge effects such as promoting conditions for invasion of weeds and exotic grasses which induce altered habitat structure along gathering lines, tracks and clearing zones.
- Direct loss of individuals during habitat clearing, and
- Direct loss of habitat through construction of facilities and development and maintenance of access tracks.

Significance of project related impacts (Unmitigated): The known populations of lobed blue grass occur in the vicinity of roadsides, and on river frontages. It is a species often collected within non-

remnant cleared or otherwise disturbed areas. As a perennial grass, it is likely to be able to vegetatively survive some disturbances, with some seed germination. Therefore, given its demonstrated ability to survive in disturbed habitats, and its likely ability for vegetative survival and some seed germination, it is given a sensitivity ranking of ***Moderate***.

Half of the eight collections of lobed blue grass known from the study have been collected from within the project development area. This indicates a high proportion of the local populations are known from within the areas that are potentially disturbed. Approximately 20% of the project development area contains "core habitat possible" based by mapping of EHP (2012a) and in addition, the species is well represented in non-remnant habitats, indicating that it may be fairly widespread with the distribution of local populations difficult to predict. There is a high potential for invasion of aggressive grassy weeds along disturbance corridors, and these weeds are considered primary threats to this species. Therefore the potential impact magnitude is considered to be ***High.***

Species specific management/ mitigation measures: The following measures are considered specific to the management of impacts to lobed blue grass:

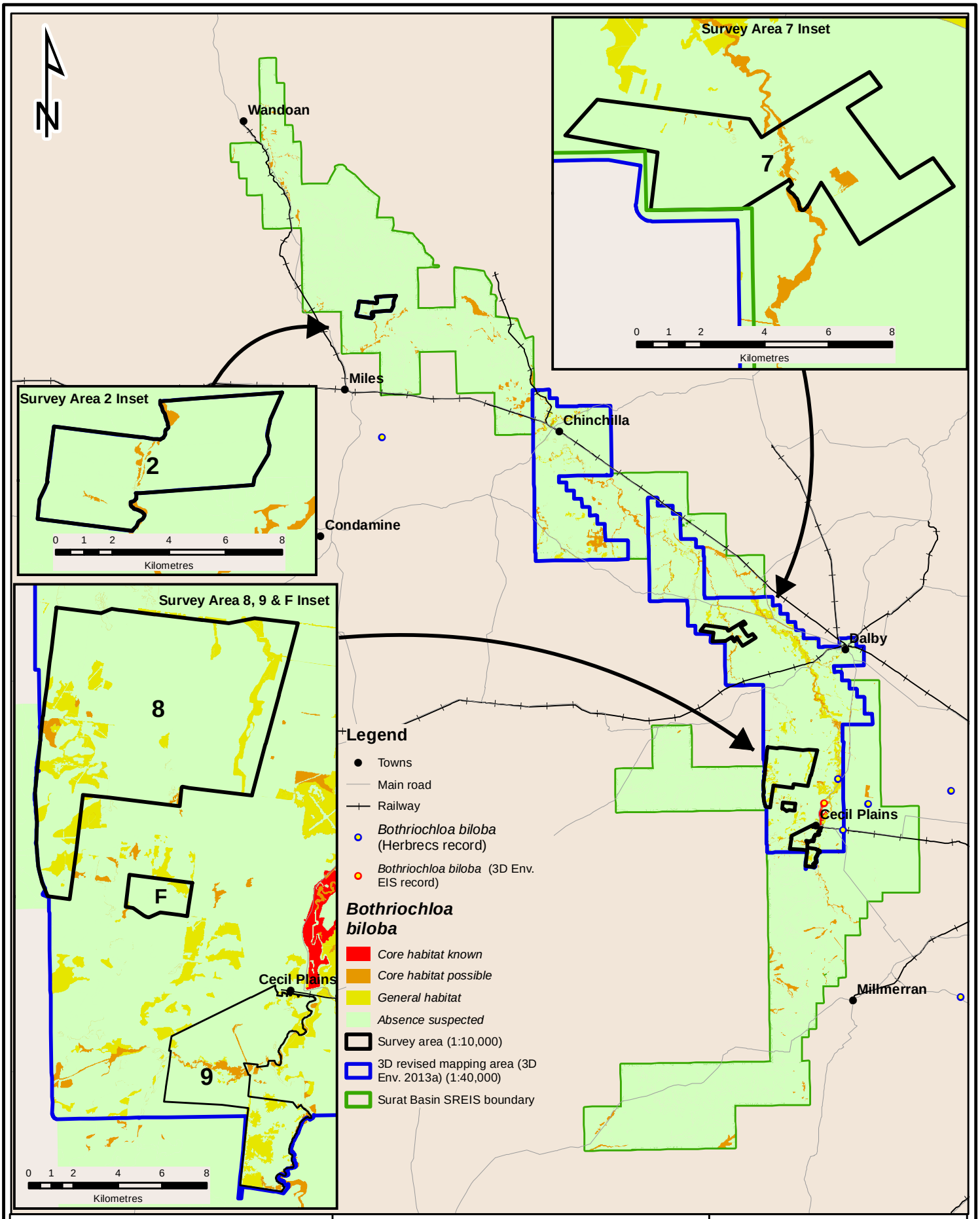
- Extend pre-clearance surveys into non-remnant areas, particularly derived grassland habitats associated with the Condamine River floodplain to allow sensitive placement of infrastructure in relation to lobed bluegrass populations.
- Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort.

Infrastructure design and site selection that seeks to avoid core habitat known of Lobed blue grass will be prioritised.

Summary residual impact assessment: Project related activities may result in impacts of ***Moderate* (18)** significance to potential lobed bluegrass populations within the project development area**.** The avoidance of grassland and poplar box woodlands on alluvium will significantly reduce potential impacts although development activities must be cognisant that this species also occurs within non-remnant habitats. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against impacts to a large degree, to the extent that minor loss in a local population of significant species is expected. If infrastructure avoids core habitat and individual species, no impact will be incurred. If other mitigation measures are implemented, particularly those requiring translocation and rehabilitation, project activities may result in impacts of ***Moderate (13)*** significance.

Residual Significance Assessment				
Avoidance*			Other mitigation measures	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A19. Lobed blue grass *(Bothriochloa biloba)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for Habitat Mapping

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence applies).
2. Regional Ecosystem polygons with confirmed records (<500 m precision) should be treated as “core habitat known” (‘high’ confidence applies to refined vegetation mapping layers).
3. Derived native grasslands should also be mapped as ‘core habitat known’ where they coincide with high precision records (3D Environmental (2013) datasets).
4. The following regional ecosystems occurring should be classed as “core habitat possible”:
    - RE11.3.2, RE11.3.3, RE11.3.4, RE11.3.21 (‘high’confidence applies to refined vegetation mapping with ‘low’ confidence applied to mapping produced by EHP (2012a)).
5. Non-remnant derived grassland on land zone 3 should be classed as “general habitat” (‘high’ confidence applies).
6. RE 11.5.1 and RE11.5.4 should be considered general habitat except where survey indicates habitat suitability is low (‘high’confidence applies to refined vegetation mapping with ‘low’ confidence applied to mapping produced by EHP (2012a)).
7. All other remnant and non-remnant vegetation in the project development area should be treated as “absence suspected”.

For heterogeneous polygons, the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A46. Evaluation of impact significance for lobed blue grass under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, lobed blue grass is relatively broadly dispersed throughout the project development area with scattered occurrences focused mostly on previously disturbed alluvial habitats. The project development area, being within the Darling Downs represents the northern limit of the species range and hence any population should be considered an 'Important Population'. It is likely that a number of discrete local populations of the species occur in the project development area although these are all largely contained in highly disturbed locations and not likely to be viable in the long term. They are however potentially important for preserving genetic diversity of the species. Potential habitat ('core habitat possible' or 'general habitat') for the species is indicated in all survey areas although the most extensive habitat is indicated in survey area 8, and 9. Field survey did not confirm the presence of this species within these properties.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. Particular habitats within survey area 9, survey area 8 and survey area 7 are considered suitable habitat for lobed bluegrass and it may be present. Comprehensive pre-clearance surveys are required within potential habitats prior to disturbance. The species is considered amendable to translocation and relatively insensitive to habitat disturbance. It is therefore unlikely that project development in these location will lead to a long term decrease in the size of an important population when a full range of mitigation measures are introduced. In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in **Criteria 1**. In accordance with **Criteria 2**, a significant impact is not expected to occur.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur.

Criteria	Evaluation
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance. In accordance with **Criteria 4**, a significant impact is not expected to occur.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Pre-clearance searches are required within potential habitats to ascertain the presence of the species. Based on current knowledge, impacts to areas of suitable habitat will not lead to a decline of the species In accordance with **Criteria 6**, a significant impact is not expected to occur.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** The project proposes all activities be guided by a detailed weed management plan to prevent facilitated invasion of exotic species which have potential to out-compete lobed bluegrass. In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	Diseases which impact lobed blue grass are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in **Criteria 1**. In accordance with **Criteria 9**, a significant impact is not expected to occur.

Conclusions: For lobed blue grass (*Bothriochloa biloba)* no impact is expected from development activities provided preclearance surveys are undertaken and methods employed are suitable for detection of grasses. Whilst suitable habitat for the species exists on survey area 9, 8 and 7, the species has not been previously recorded and impacts are not considered significant when assessed under MNES criteria, provided mitigation strategies are employed. There is limited potential for cumulative impacts associated with development conducted by other proponents to be reinforced through the proposed Arrow development actions and impacts are considered known, predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable.

Rule(s) for survey effort required in accordance with survey guidelines: Lobed blue grass is a perennial grass species that requires fertile material for positive identification. Suitable periods for field

identification are from November to June when the species has been collected in flower or with seed heads. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

King blue grass (*Dichanthium queenslandicum*)

Family: Poaceae

Status: EPBC Act: Endangered (status upgraded from Vulnerable in January 2013 (TSSC 2013a and 2013b); **NC Act**: Vulnerable; **BoT:** Not Listed

Sensitivity: High

Recovery plan: A recovery plan has not been prepared for king blue grass. A draft recovery plan for the 'bluegrass (Dichanthium spp.) dominant grassland of the Brigalow Belt Bioregions (north and south)' endangered ecological community is relevant to the species (Butler 2007)

Overview of king blue grass

Description (based Stanley and Ross 1989 and Sharp and Simon 2002): A tufted, perennial grass to 80 cm tall. Culms (i.e. flowering stalks) with 4 to 5 nodes, the middle nodes with a circle of hairs. The ligule (i.e. membrane at the base of the leaf against the stem) is a fringed membrane, 1 to 1.5 mm long. Leaves are 9 to 18 cm long, 3 to 5 mm wide. Racemes (i.e. flowering branches) are 5 to 10 cm long, usually occur singularly, but sometimes have two branches. Individual flowers and seeds have awns up to 2 cm long.

Plate 27. King blue grass habit, occurring within native grasslands (Photograph: 3D Environmental) and **Plate 28.** Seed head (raceme) of king blue grass (Photograph 3D Environmental).

Ecology: King blue grass flowers mainly in the wet season, November to January (Sharp and Simon 2002) although the species has been recorded in flower during May (pers. observation 3D Environmental). This perennial grass is a palatable stock grazing species and can decline with heavy grazing pressure (Fensham 1999). Some sections along stock routes in the Darling Downs contain healthy populations of king blue grass (Fensham 1999). Vogler *et al*. (2006) found that king blue grass significantly increased in density after experimental burning and also after mowing treatments, regardless of the season of treatment.

Habitat: King blue grass grows in remnant and non-remnant derived grasslands on alluvium, cracking clays, and basalt. All collections within the Darling Downs have been from non-remnant areas. In fact, 70% of the entire 67 collections of this species stored in Australian Herbaria, overlay areas mapped by the Queensland Herbarium as non-remnant.

Where king blue grass has been collected within remnant ecosystems (all from > 150 km north of the project development area), 80% have been within RE 11.8.11: *Dichanthium sericeum* grassland on Cainozoic igneous rocks; and RE 11.8.5: *Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks. Whilst these ecosystems are not known from the project development area, RE11.3.21 offers similar native habitat features.

Outside the project development area, king blue grass has also been collected within an area mapped as a mixture of RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains), RE 11.3.3 (*Eucalyptus coolabah* woodland on alluvial plains), and RE 11.3.11 (Semi-evergreen vine thicket on alluvial plains).

Distribution: King blue grass has been collected from Dalby to north of Hughenden. The greatest density of known populations is on black clay soils around Emerald. Fensham (1998 and 1999) considered king blue grass may have become restricted to the Central Highlands with the Darling Downs population now extinct, because at the time of their reports the species had not been collected in the Darling Downs since 1951. However king blue grass has recently been collected growing along the Warrego Highway roadside and adjacent stock route, near Jondaryan, south east of Dalby, in 2001, 2004 and 2011 (EHP 2013). It has also been reported to have been recently seen near Roma (W.J. Scattini, unpublished data, in Silcock *et al*. 2007). However, there is no Herbarium voucher specimen for the recent Roma sighting, so it must be considered only a possible population.

Likelihood of occurrence and extent of habitat in the project development area: King blue grass possibly occurs although has not been collected within the project development area and was not observed during field survey. The only three collections in the Darling Downs since 1951 are located approximately 20 km east of the project development area growing alongside the Warrego Highway within at stock route, south east of Dalby. All other collections (representing 91% of all the total collections of king blue grass) are located in central Queensland, over 150 km north of the project development area. There is a gap of approximately 250 km between the Darling Downs and Central Queensland collections. **Table A47** provides an indication of the extent of king blue grass habitats within the project development area with broad distribution of habitat indicated in **Figure A20.**

Table A47. Extent of habitat for king blue grass within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	16552	0
3D Detailed Mapping Area**	0	1344	7649

3D Detailed Mapping Area based on EHP mapping***	0	6976	0
Survey area 2	0	0	0
Survey area 7	0	0	21
Survey area 8	0	0	329
Survey area 9	0	90	70
Survey area F	0	0	4

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The species grassland habitat has been heavily fragmented by clearing for agriculture and replacing native grasses within exotic pasture species. Remaining habitat in the darling Downs, which is currently only known from roadside and adjacent stock routes, is threatened by degradation from exotic pasture grasses, invasive weeds, inappropriate grazing regimes and mechanical disturbance.

Potential project-related impacts: Impacts associated with the proposed development activities could include:

- Direct loss of individuals during habitat clearing from mechanical removal.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

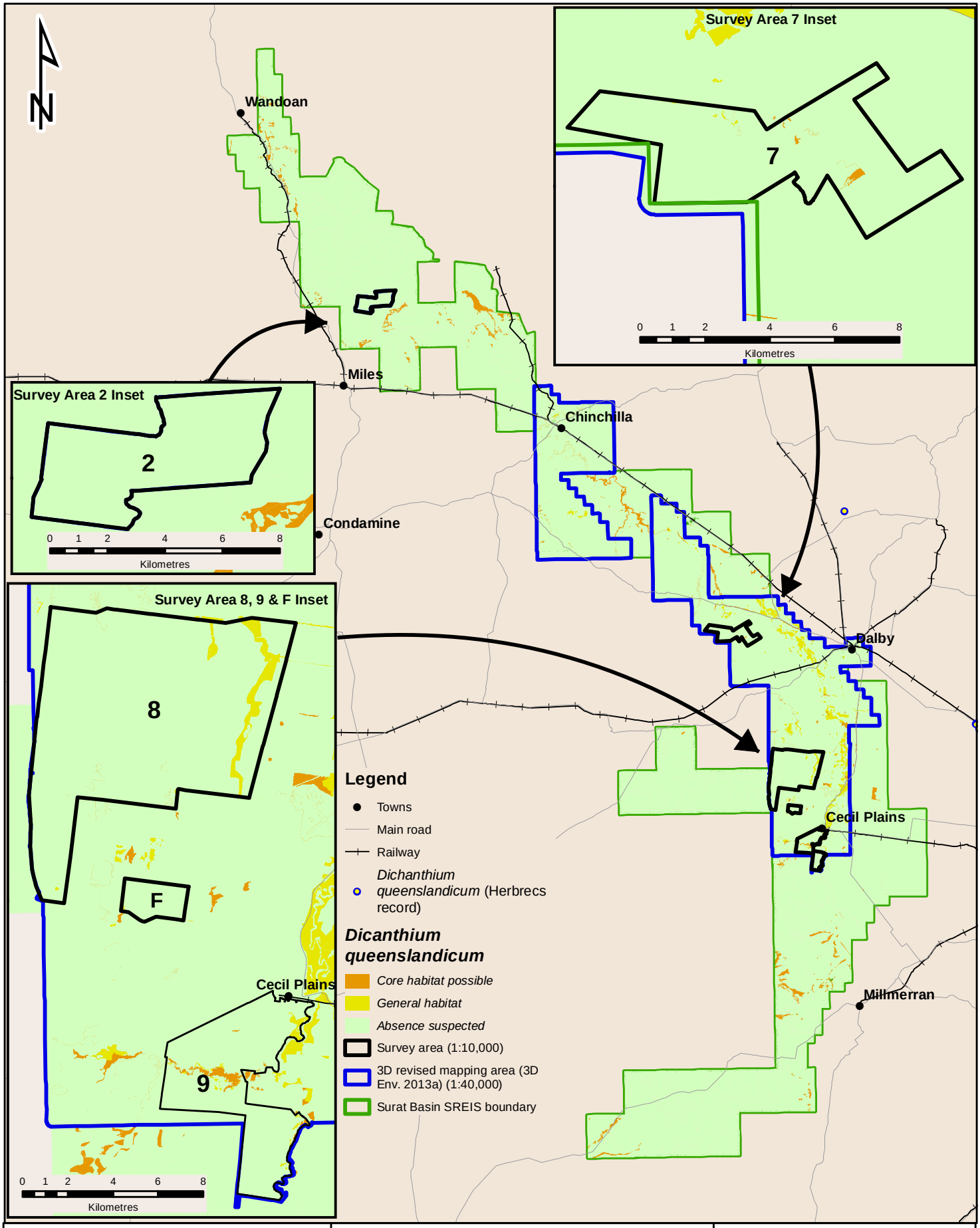
Significance of project related impacts (Unmitigated): The sensitivity of king blue grass is considered to be ***High.*** This ranking is based on king blue grass being a perennial species, likely to be capable of some vegetative regrowth via coppicing, and probably some seed germination. It is particularly sensitive to replacement by exotic pasture grasses and weeds that occur in the area. It is also sensitive to heavy grazing pressure. However, it is known to be tolerant of disturbed habitats, specifically roadsides. The species is not known from the project development area however potential habitat occurs within remnant grasslands on alluvium (RE11.3.21) and derived grasslands. Further survey is required to determine the extent of populations in tracts of remnant and non-remnant vegetation on alluvial soils of land zone 3. Based on this information, the magnitude of unmitigated impacts to populations within the project area is considered ***Low***.

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort. Infrastructure design and site selection that seeks to avoid core habitat known of king blue grass will be prioritised.

Summary residual impact assessment: The possibility of this species occurring is low, however areas mapped as potential habitat warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding possible habitat in stock routes and road reserves supporting grasslands and grassy woodlands on alluvium is preferable and will completely mitigate against impacts with no impact incurred. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree although the suitability of the species for translocation or re-seeding requires further investigation. The significance of impacts after alternative mitigation measures remains ***Moderate (12).*** Grassland and grassy woodland habitats support a number of other EVNT flora species and are particularly vulnerable to mechanical disturbance. Implementation of mitigation measures such as rehabilitation of disturbance areas using seeding of native grasses of local provenance, and management of exotic grass and herb invasion, should reduce the potential impacts on this species.

Residual Impact Assessment				
Avoidance*			Others[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Low	Mod (12)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A20. King blue grass *(Dicanthium queenslandicum)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	1:1,083,672	Drawn By	DG	Checked	DS	File Path	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	Date	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence is applied) where it intersects remnant habitats.

The following regional ecosystems in the project development area should be classed as “core habitat possible”:

- RE11.3.21, 11.3.2 and 11.3.3 (‘high’ confidence applied to property scale vegetation mapping; ‘moderate’ confidence applied to revised RE mapping at 1:40 000 scale and low confidence applied to RE mapping produced at 1:100 000 (EHP 2012a)).

The following habitats should be classified as “general habitat”

- Non-remnant derived grasslands on land zone 3 (‘high’ to ‘moderate’ confidence applies).
- Regrowth vegetation derived from REs classified as “core habitat possible” including those from mature regrowth (EHP 2012b)

All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A48. Evaluation of impact significance for king blue grass under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, king blue grass does not occur in the project development area and is restricted to non-remnant habitats within 20 km from the margins of the project development area boundary. The Darling Downs represents the southern limit of the species range and any population that occurs or is found within the project development area would be considered an important population. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species and important sources of seed dispersal. Therefore, all populations should be considered important and requiring preservation. Core habitat for the species occurs in survey area 7 with general habitat for the species is indicated in survey area 7, 8, 9 and F. Field survey did not confirm the presence of this species. Other properties are not considered to contain suitable habitat for the species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 7, 8, 9 and F:** SREIS Field survey within these properties did not locate the species. It is considered unlikely that an important population of king blue grass exists within these properties and hence no decrease in the size of an important population is likely. There is no suitable habitat within survey area 2. In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 3: fragment an existing important population	**Survey area 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 7, 8, 9 and F::** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. Suitable habitat for the species exists within survey area 8 and survey area 9 although it has fairly general habitat requirements and can

Criteria	Evaluation
	withstand moderate levels of disturbance. In accordance with **Criteria 4**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Suitable habitat is contained within properties survey area 8 and survey area 9 and pre-clearance survey will be required to discount the occurrence king blue grass on these properties. In accordance with **Criteria 6**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	Diseases which impact blue grass habitats are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance. In accordance with **Criteria 8**, a significant impact is not expected to occur
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur

Conclusions: For king blue grass (*Dicanthium queenslandicum)* no impact is expected from development activities provided preclearance surveys are undertaken. Methods employed must be suitable for detection of grasses and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: King blue grass is a perennial grass species that requires fertile material for positive identification. The most suitable periods for field identification are from November to May when the species has been collected in flower or with seed heads. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

.

Finger panic grass (*Digitaria porrecta*)

Family: Poaceae

Status: EPBC Act: Endangered; **NC Act:** Near Threatened; **BoT**: Not Listed

Sensitivity: High

Recovery plan: A draft recovery plan has been prepared by Halford (1995b).

Overview of finger panic grass

Description (based on Sharp and Simon 2002; Halford 1995a): A perennial grass to 80 cm tall, which can spread along rhizomes. The ligule (i.e. membrane at the base of the leaf against the stem) is a hairless membrane, 2 to 3 mm long. Leaves are flat, 6 to 15 cm long, 2.8 to 4 mm wide, with rough hairs along the margins. The inflorescence (i.e. seed head) is a wide, compound, panicle, similar in outline to a panicum grass seed head. The angle of the primary inflorescence branches is roughly horizontal (compared to the more vertical branching in some closely related digitarias). Each raceme arm is up to 27 cm long.

Ecology: Finger panic grass is a spreading perennial that can reproduce vegetatively (Halford 1995b). Older clumps are reported to die in the centre, with the outer edges of the clump becoming separate plants. Seeds drop to the ground when mature, but appear to have a six month to one year dormancy prior to germinating (Halford 1995b). This is similar to some other sub -tropical grasses, such as black spear grass, and delays germination until the wet season rains. The species produces fertile material from March to April (TSSC 2008f).

Habitat: Finger panic grass grows in grasslands, woodlands and open forests with a grassy understory, on black soil plains of the Darling Downs, and lighter textured soils to the west (Goodland 2000, Halford, 1995a; Fensham 1998). Fensham (1998) found it is most abundant in grassland, but is "relatively unspecific" in its habitat preference. It is not restricted to high quality native grasslands, but also grows along roadsides and can be found in highly disturbed sites (Goodland 2000). Finger panic grass been recorded inside the project development area, within roadside remnant grasslands on dark cracking clay plains (RE11.3.21); poplar box (*E. populnea*) open forest and woodland with grassy understorey, on dark cracking clay plain (RE11.3.2); and along disturbed railway reserves on dark cracking clay soils (EHP 2013). The primary habitats for this species in the project development area are RE11.3.2, RE 11.3.21 and non-remnant derived grasslands.

Distribution: Finger panic grass is known from four disjunct areas extending over 1000 km across NSW and Queensland. The Queensland distribution includes broad populations in the Nebo district; the Central Highlands between Springsure and Rolleston; and from Jandowae south to Warwick. In NSW, it is known from near Inverell, south to the Liverpool Plains near Coonabarabran and Werris Creek (TSSC 2008f).

Likelihood of occurrence and extent of habitat in the project development area: The species is known to occur in the project development area. Finger panic grass was not recorded during field

survey, however there are eight Queensland Herbarium records from the eastern parts near Dalby, and a total of 28 records from within a 25 km buffer surrounding the project development area. Of these 28 collections, 89% are recorded from within non-remnant vegetation, based on Queensland Herbarium RE mapping (EHP 2012a). The non-remnant habitat of finger panic grass is often on roadsides and rail way reserves on heavy clay soils. It should be noted that only a single collection of this species has been made within the study area post 1995 with a 2010 collection made in the project development area buffer 27 km to the north of Dalby. It is not known as to whether populations of the species have declined dramatically post 1995.

The two remnant habitats that finger panic grass has been collected within the study area are; RE 11.3.2, poplar box (*Eucalyptus populnea*) woodland on alluvial plains; RE 11.3.21, Queensland blue grass (*Dichanthium sericeum*) and/or mitchell grass (*Astrebla* spp.) grassland on alluvial plains with cracking clay soils. The extent of habitat is provided in **Table A49** with spatial representation of habitats and prior records provided in **Figure A21**.

Table A49. Extent of habitat for finger panic grass within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	13100	16324	0
3D Detailed Mapping Area**	591	1331	7104
3D Detailed Mapping Area based on EHP (2012)***	259	7968	0
Survey area 2	0	0	0
Survey area 9	0	90	70
Survey area 8	0	0	369
Survey area 7	0	16	3
Survey area F	0	0	4

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The grassland habitat for this species has been heavily fragmented by clearing for agriculture, and sowing of exotic pasture grasses that can replace finger panic grass. It is mainly restricted to stock routes and road reserves and threatened by degradation from mechanical disturbance, invasive weeds and inappropriate grazing regimes. Goodland (2000) notes that finger

panic grass can withstand disturbance, although populations decline where introduced species (e.g. Rhodes grass) become dominant.

Project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Competition from exotic species, such as coolatai grass (*Hyparrhenia hirta*), Guinea grass (*Megathrysus maximus*), feathertop (*Pennisetum villosum*), and Johnson grass (*Sorghum halepense*).
- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

Significance of project related impacts (Unmitigated): Many of the known populations of finger panic grass in the region grow along roadsides and railway lines. Therefore it is able to survive in disturbed habitats. It is a perennial grass known to be capable of vegetative spread (Halford 1995b) and it probably also has some seed germination after disturbance. However, it is very likely to be particularly sensitive to being smothered by exotic grasses. Given its demonstrated ability to survive in disturbed habitats, but its sensitivity to exotic species, it is given a sensitivity ranking of ***High***.

Eight of 28 known populations (29%) of finger panic grass within the study area have been collected within the project development area. That is, a high proportion of the local populations are known from within areas that may potentially be disturbed. Whilst the remnant ecosystems that finger panic grass has been collected within account for approximately 3 % of the project development area (based on mapping produced by DEHP, 2012a), this grass is primarily known from roadsides and disturbed areas. Therefore potential habitat may be relatively extensive and difficult to predict, particularly within the Dalby district. Due to the relatively large number of prior records and potentially extensive nature of suitable habitat within the project development area, the potential impact magnitude is considered to be ***High.***

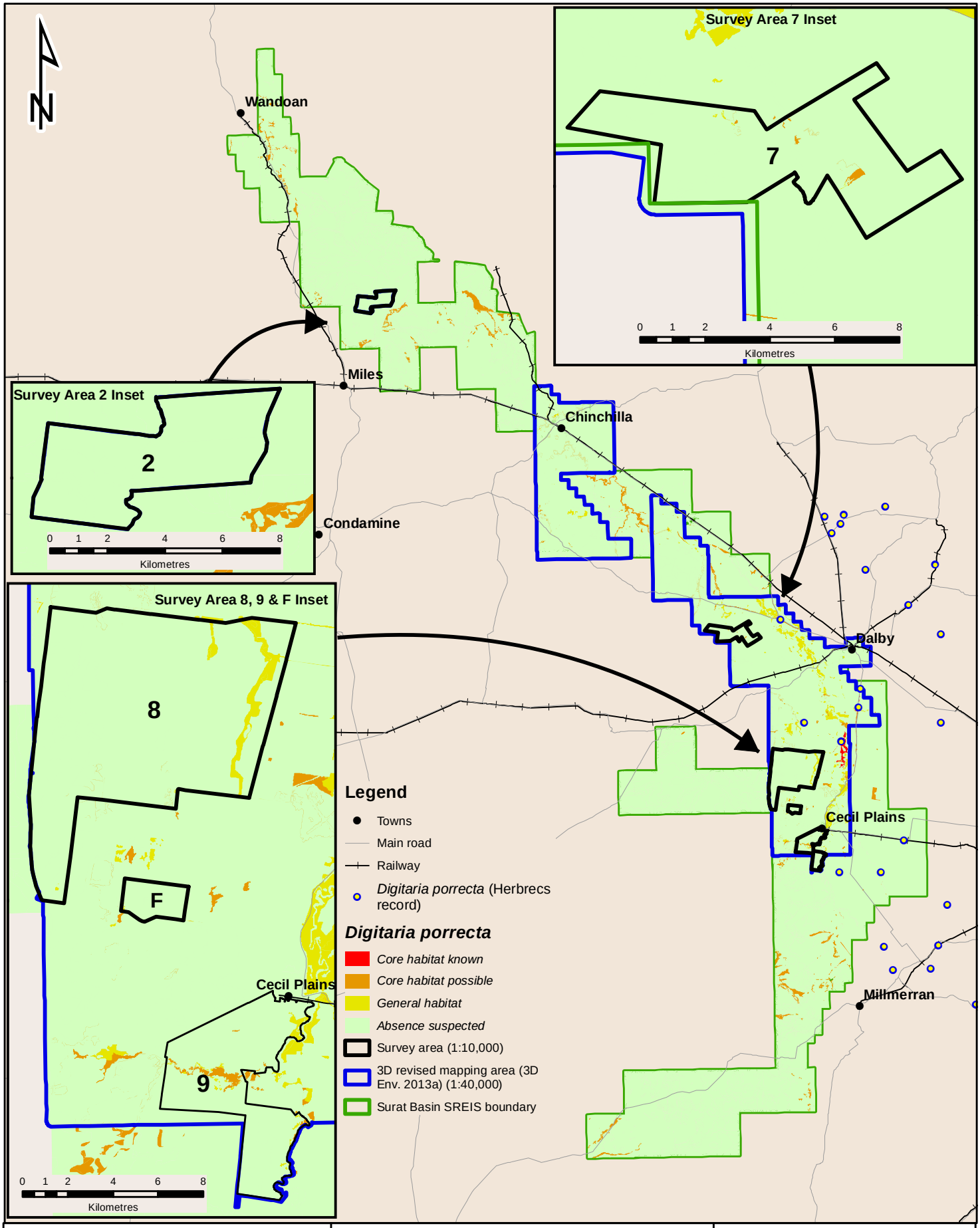
Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table 1** are considered sufficient to mitigate impacts to the species. Infrastructure design and site selection that seeks to avoid core habitat known of finger panic grass will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***High(21)*** significance to finger panic grass populations within the project development area**.** The avoidance of finger panic grass populations will significantly reduce potential impacts. Areas mapped as core and general habitat may warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding likely areas of core habitat (especially grassland and poplar box woodlands on alluvium, and areas known to have previous records of finger

panic grass) will totally mitigate against impact.. Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree, to the extent that minor loss in a local population may occur. The resulting impact significance would be ***Moderate*** **(12).**

Residual Impact Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Low	Moderate (12)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A21. Finger panic grass *(Digitaria porrecta)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence is applied) where it intersects remnant habitats.
2. RE polygons with confirmed records (<500 m precision) should be treated as “core habitat known” (‘high’ when applied to property specific mapping (3D Environmental 2013), ‘moderate’ when applied to 1: 40 000 scale mapping (3D Environmental 2013) and ‘low’ when applied to mapping produced by DEHP, 2012a and 2012b).
3. Derived grassland and mature regrowth (EHP 2012b) should also be treated as ‘core habitat known’ when applied as rules 1 and 2.
4. The following regional ecosystems should be classed as “core habitat possible”:
    - RE11.3.2, RE11.3.21 and RE11.3.24 (confidence levels as applied in 2).
5. Non remnant derived grassland and regrowth woodland habitats derived from RE11.3.2 should otherwise be treated as “general habitat” (confidence levels as applied in 2).

All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A50. Evaluation of impact significance for finger panic grass under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, finger panic grass is scattered throughout non-remnant and remnant habitats with most records in the project development area occurring between Dalby and Cecil Plains. Other major occurrences are found to the north of Dalby, outside the project development area. The sub-populations that occur in the Dalby area are part of a much broader population occurring within the Darling Downs region that extends from Warwick in the south, Toowoomba in the east and Dalby in the north. Local populations in the Dalby area are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important and requiring preservation.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important sub-population of finger panic grass exists within these properties and hence no decrease in the size of an important population is likely. Suitable habitat for finger panic grass is however present within survey area 7, survey area 8, survey area 9 and pre-clearance survey is required to discount the species from within the finalised project footprint. Provided preclearance surveys are undertaken and appropriate mitigations applied when necessary, no significant impact to populations is expected. In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.

Criteria	Evaluation
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance. In accordance with **Criteria 4**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Suitable habitat for the species occurs within survey area 7, survey area 8 and survey area 9. Pre-clearance survey will be required within these habitats when project footprints are finalised. Based on current knowledge, project related development will not modify, destroy, remove or isolate or decrease habitat leading to the decline of the species. In accordance with **Criteria 6**, a significant impact is not expected to occur.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	Diseases which impact finger panic grass habitats are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur.

Conclusions: For finger panic grass (*Digitaria porrecta)* no impact is expected from development activities provided preclearance surveys are undertaken, survey methods employed are suitable for the detection of grasses in areas where possible habitat is mapped (survey areas 7, 8, 9) and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: Finger panic grass is a perennial grass species that requires fertile material for positive identification. The most suitable periods for field identification is from March to April when the species is known to produce fertile material. There are currently no formalised assessment techniques for survey of this species although those described in Nelder et al (2012) provide background information on quadrat sampling. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately searched for.

Belsons panic (*Homopholis belsonii*)

Family: Poaceae

Status: EPBC Act: Vulnerable; **NC Act:** Endangered **BoT:** Not Listed

Sensitivity: High

Recovery plan: A draft recovery plan has been prepared by Menkins (1998).

Overview of Belson's panic

Description (based on Sharp and Simon 2002; Harden 1993): A perennial grass which grows to 50 cm in height, with rhizomes that allow it creep horizontally to form mats across the ground. The base of the leaf partially clasps around the stem, and has a membranous ligule, 8 to 1.5 mm long. Leaves are flat, 3 to 15 cm long, 2 to 4.5 mm wide. The inflorescence (i.e. seed head) is a compound, open panicle, similar in shape to a panicum grass seed head. The seed head branches are stiff and up to 15 cm long.

Plate 29. Belson's panic (*Homopholis belsonii)*. Copyright © Boobook

Ecology: Belson's panic tends to grow in shade under trees, but can grow in cleared regrowth. As a rhizomatous perennial grass, it probably is capable of living for many years, and to have some tolerance to fire and at least low levels of grazing. It is reported to spread out very rapidly (Menkins 1998). Flowers have been recorded between February and May (Sharp and Simon 2002).

Habitat: Belson's panic prefers moderate to highly fertile soils, especially those derived from basalt and fertile alluvial flats. It is generally associated with poplar box and brigalow woodlands on light red/brown earths (Fensham and Fairfax 1997, Goodland 2000). It has been collected from the following remnant ecosystems (EHP 2013):

- RE 11.3.1; *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.
- RE 11.3.17; *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.
- RE 11.3.2/11.5.1: *Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces.
- RE 11.3.25/11.3.19/11.3.2: *Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines / *Callitris glaucophylla*, Corymbia spp. and/or *Eucalyptus melanophloia* woodland on Cainozoic alluvial plains / *Eucalyptus populnea* woodland on alluvial plains.
- RE 11.9.5: *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.
- RE 11.9.5/11.9.10: *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks / *Acacia harpophylla, Eucalyptus populnea* open forest on fine-grained sedimentary rocks.

Belson's panic is also capable of growing within disturbed habitats. Of the 22 collections within the study area, 15 (68%) are located in non-remnant areas such as roadside easements. It has been seen growing among fallen timber at the base of trees or shrubs, among branches and the bottom of netting fences (Trémont & Whalley 1993 in TSSC 2008g).

Distribution: In Queensland, major populations occur on the Darling Downs near Oakey, Jondaryan, Bowenville, Dalby, Acland, Sabine, Quinalow, Goombungee, Gurulmundi and Millmerran, and further west between Miles and Roma (Goodland 2000, EHP 2013). Also known from the north-western slopes and plains of NSW (TSSC 2008g).

Likelihood of occurrence and extent of habitat in the project development area: Known from within the project development area from one historical record from Dogwood Creek north of Miles. It was not recorded during field surveys. A further 20 collections have been made of Belson's panic within the study area. A record on the Inglewood road reserve south of Millmerran in brigalow regrowth suggests the high likelihood that it will be present within similar remnant and non-remnant roadside brigalow-belah habitats in the project development area. The extent of habitat within various portions of the project development area is provided in **Table A51** with spatial representation provided in **Figure A22**.

Table A51. Extent of habitat for Belson's panic within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	Core Habitat Possible (Ha)	General Habitat (Ha)
Project development area*	0	9783	112633
3D Detailed Mapping Area**	0	1723	12370
3D Detailed Mapping Area based on EHP (2012)***	0	2554	22489
Survey area 2	0	0	966
Survey area 9	0	1	38
Survey area 8	0	2	817
Survey area 7	0	20	470
Survey area F	0	1	42

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General threats to the species::** Loss of habitat from vegetation clearing, pasture improvement, and overgrazing is a major threatening process (TSSC 2008g). Belson's panic declines in abundance with grazing pressure and appears to grow best under tree or shrub cover. Roadside populations are threatened by invasion of pasture grasses such as green panic (*Megathyrsus maximus* var. *trichoglume*), and road works (Goodland 2000), however it is known to re-colonise disturbed areas if tree cover is available (Menkins 1998 in TSSC 2008g).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Competition from exotic species such as coolatai grass (*Hyparrhenia hirta*), Guinea grass (*Megathrysus maximus*),feathertop (*Pennisetum villosum*), and Johnson grass (*Sorghum halepense*).
- Inappropriate management of roadside grasslands (i.e. spraying, low slashing, heavy grazing) which promotes the spread of weeds and aggressive weedy grasses.

- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

Significance of project related impacts (unmitigated): Many of the known populations of Belson's panic in the region grow along roadsides, so it is able to survive in disturbed habitats. It is a perennial grass known to be capable of vegetative spread in mats. It may also have some seed germination capacity after disturbance. However, it is very likely to be particularly sensitive to being smothered by exotic grasses. Given its demonstrated ability to survive in disturbed habitats, but its sensitivity to exotic species, it is given a sensitivity ranking of ***High***. One of the 22 known local populations, 9% of these have been collected from within the project development area. The remnant REs that Belson's panic has been collected within account for approximately 12 % of the project development area. The potential area of occupancy is however much larger than this because it is also known from roadsides and disturbed areas. Therefore many of potential habitats are not accounted for in project vegetation mapping (both EHP 2012a and more specific mapping undertaken for this exercise). Due to an inability to accurately account for potential habitat without broad scale and intensive survey, the potential magnitude of impact is considered to be ***High***.

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort. Infrastructure design and site selection that seeks to avoid core habitat known of Belson's panic will be prioritised.

Summary residual impact assessment:

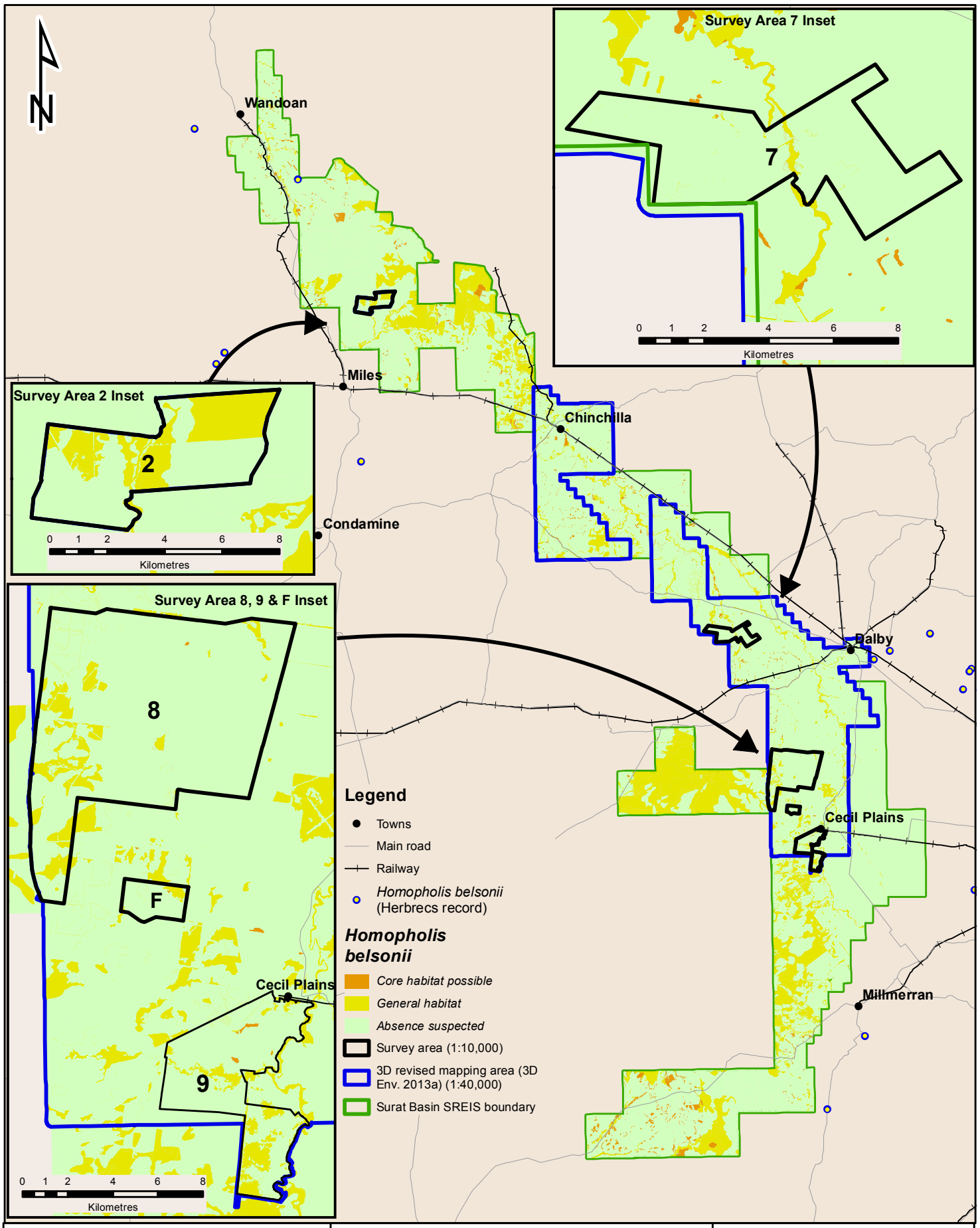
Unmitigated project related activities may result in impacts of ***High*** **(21)** significance to potential Belson's panic populations within the project development area**.** The avoidance of Belson's panic populations will significantly reduce the potential for impact.

Areas mapped as core habitat (both known and possible), may warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding likely areas of core habitat (especially poplar box and brigalow woodland on alluvium, and areas known to have prior collections of Belson's panic) is the prefered option and will totally mitigate against impact. Adjacent habitat may remain vulnerable to edge effects (invasion of exotic pasture grasses) if canopies are disturbed.

Where avoidance of Belson's panic habitat is not possible, the identified impact management measures should be mostly effective and may mitigate against an impact to a large degree, to the extent that minor loss in a local population may occur. This is based on the knowledge that Belson's panic currently grows in disturbed locations and therefore is likely to be successfully rehabilitated. The resulting impact significance would be ***Moderate (12)*****.**

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Low	Moderate (12)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A22. Belson's panic *(Homopholis belsonii)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’confidence is applied) where it intersects remnant habitats.
2. RE polygons and derived regrowth vegetation (including mature regrowth as per EHP 2012b) with confirmed records (<500 m precision) should be treated as “core habitat known” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by DEHP, 2012a).
3. The following regional ecosystems and derived regrowth should be classed as “core habitat possible”:

   - RE 11.3.1, RE 11.3.17, RE 11.9.5, RE 11.4.3, RE 11.4.10 and RE 11.9.10 (confidence levels as per 2).

   The following habitats should be considered “general habitat” (confidence levels as per 2).

   - RE11.3.2, RE11.3.25, RE11.5.1 and non-remnant derived grasslands on land zone 3.
   - Regrowth derived from REs listed as potential habitat. General habitat should be removed where ground inspection demonstrates habitat to be unsuitable.
4. All other remnant and non-remnant vegetation in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A52. Evaluation of impact significance for Belson's panic grass under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, Belson's panic is scattered throughout non-remnant and remnant habitats in the study area with only a single record occurring in the project development area. The majority of populations occur to the east of the project development area, forming a component of a much broader regional population that is centred on the area between Dalby and Toowoomba. Populations in the Dalby area are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important and requiring preservation.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 9:** Survey area 9 contains minor remnants of brigalow and RE11.3.17 which are potential habitat for the species. Despite intensive survey in these habitats, Belson's panic was not recorded. No long term decrease in the size of an important population is expected to occur during development at this site. Pre-clearance survey is required prior to disturbance to identify any populations that have not been accounted for. **Survey area 8, 7, 2 and F:** Intensive field survey within these properties did not locate the species and habitat contained within is considered sub-optimal. It is considered unlikely that an important sub-population of finger panic grass exists within these properties and hence no decrease in the size of an important population is likely. In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance
Criteria 2: reduce the area of occupancy of an important population	**Survey area 9, 8, 7, 2 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 3: fragment an existing important population	**Survey area 9, 8, 7, 2 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is

Criteria	Evaluation
	not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 9, 8, 7, 2 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate levels of disturbance. In accordance with **Criteria 4**, a significant impact is not expected to occur.
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 9, 8, 7, 2 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 9, 8, 7, 2 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. Pre-clearance surveys within survey area 9 are required to discount occurrence from survey area 9 if potential habitats are to be disturbed. In accordance with **Criteria 6**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 7: result in the establishment of an invasive species	**Survey area 9, 8, 7, 2 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 6. In accordance with **Criteria 7**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 8: introduce a disease	Diseases which impact Belson's panic habitats are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat prior to disturbance.

Conclusions: For Belson's panic (*Homopholis belsonii)* no impact is expected from development activities provided preclearance surveys are undertaken in potential habitat (survey areas 7, 8, 9 and

F), survey method is suitable for the detection of grasses, and where a potential habitat is identified, appropriate mitigation is applied. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: Belson's panic grass is a perennial grass species whose positive identification is aided by collection of fertile material. The most suitable periods for field identification is from February to May when fertile material material has been previously recorded Intensive meander searches will be required to ensure that the species is adequately searched for. Quadrat searches are likely to be less effective as ground cover in suitable habitat is typically sparse.

Herbs (including ground orchids)

Microcarpaea agonis

Family: Scrophulariaceae

Status: EPBC Act: Endangered; **NC Act:** Endangered; **BoT:** Not Listed

Sensitivity: Extremely High

Recovery plan: A species recovery plan has not been prepared for this species.

Overview of Microcarpaea agonis

Description (based on Bean 1997; TSSC 2008i): *Microcarpaea agonis* is a small herb, which grows to 5 cm tall, spreading to 10 cm wide. Stems are hairless but angular. Leaves are simple, opposite each other along the branchlets, linear and up to 9 mm long and 0.5 mm wide. The flowers occur singularly in the axils of leaves. They are tubular, white, with the tube approximately 3 mm long, and 2-lipped at the apex. *Microcarpaea agonis* is distinguished from the closely related *M. minima* by having longer linear leaves and an unribbed green calyx.

Ecology: Very little is known about the ecology of this very restricted and recently described species, other than that it is an annual herb of wetlands.

Habitat: Occurs on the margins of a seasonally inundated swamp dominated by sedges (*Eleocharis* spp *and Cyperus* spp) on sandy soil (EHP 2013, Bean 1997). The wetland habitat is consistent with RE11.3.27.

Distribution: A Queensland and bioregional endemic known only from a small population in the Boondandilla State Forest, approximately 55 km west of Millmerran, south east Queensland (Bean 1997). This locality is approximately eight km northwest of its closest point on the boundary of the project development area.

Likelihood of occurrence in project development area: The species possibly occurs in the project development area although has not been previously recorded. The species has not been found in areas that have been comprehensively surveyed, including Lake Broadwater and the Chinchilla district (see Bean 1997). The only known locality of this species is from a small seasonal wetland dominated by sedges, which is probably a small example of RE 11.3.27. However the wetland is too small to have been delineated in current RE mapping (EHP 2012a). The known collection site is located on the boundary of two mapped woodlands being; RE 11.3.18 (*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium) and RE11.5.1 (*Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces). As a precautionary measure, any small ephemeral wetlands in the Yarril and Wyaga Creek catchments within the project development area within 50 km of the known population should be considered potential habitat. Wetlands of this nature are not represented in DEHP mapping and hence the distribution of potential habitat (core habitat possible) is difficult to

predict. The extent of habitat within various portions of the project development area is provided in **Table A53** with spatial representation provided in **Figure A23**.

Table A53. Extent of habitat for *Microcarpaea agonis* within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	0	2225.7
3D Detailed Mapping Area**	0	0	0
3D Detailed Mapping Area based on EHP (2012a)***	0	0	0
Survey area 2, 7, 8, 9 and F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Threats to the single population of 10 individuals are draining of the wetland, smothering by aggressive exotic wetland plants, grazing, road works and trampling by cattle (Bean 1997).

Project-related impacts: Impacts associated with development activities could include:

- Direct loss of individuals during habitat clearing.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks, including damage that affects wetland hydrology.
- Altered and inappropriate fire regimes in this seasonally dry wetland.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.
- Damage to the wetland habitat caused by accidental release of saline water from well heads.

Significance of project related impacts (unmitigated): Based on known threats, the sensitivity of the habitat, and extremely limited knowledge in regard to the species ecology, the species is considered to have an ***Extremely High*** sensitivity. That the only know population occurs just outside the project development area, any impact to an identified extant population would be of ***Major*** magnitude. Unmitigated impact significance and any impacts would be of ***Major* (25)** significance.

Species specific management / mitigation measures: The following mitigation measures are recommended, additional to current commitments, specific to the management of *Microcarpaea agonis* populations that may be identified within the project development area during field surveys:

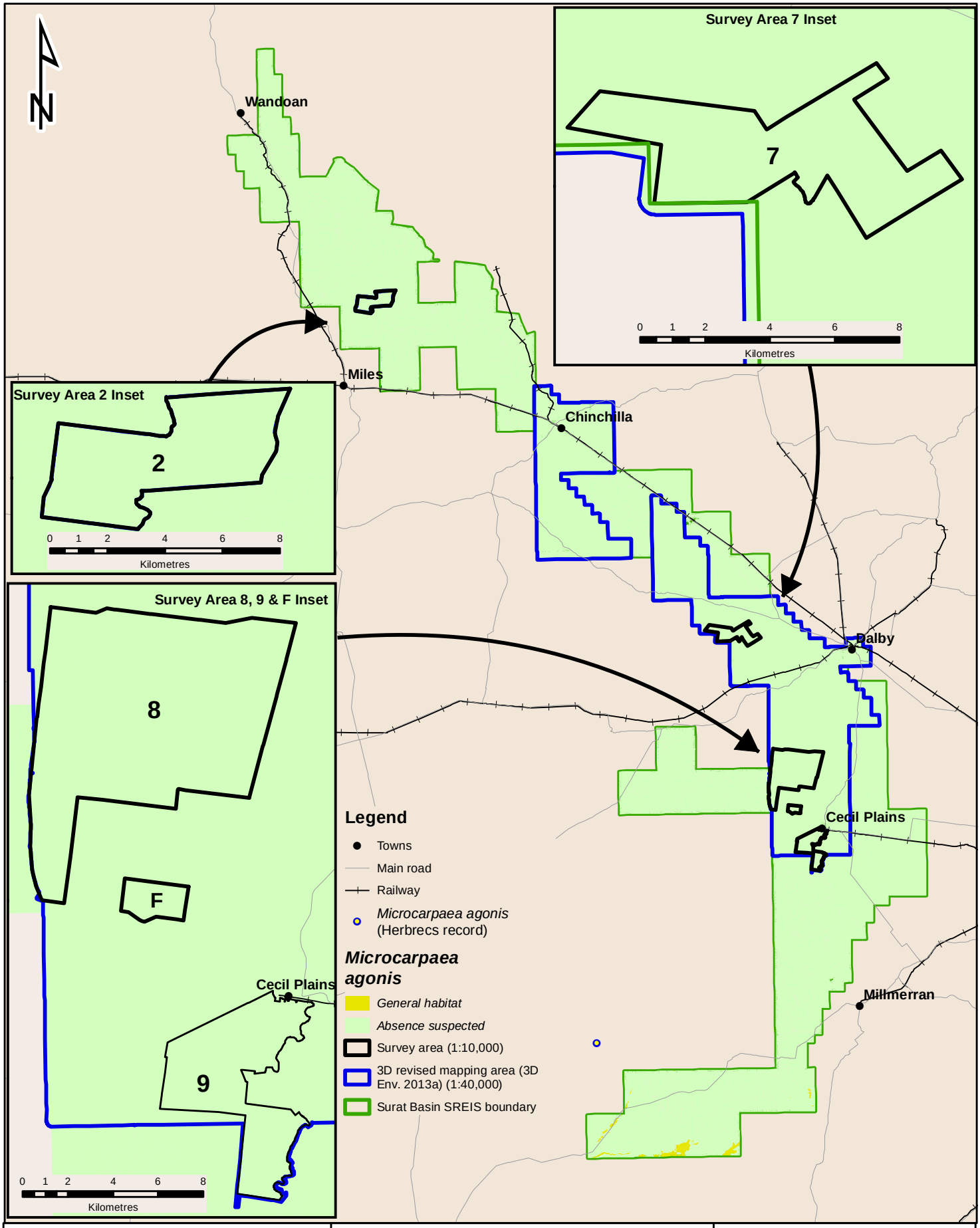
- Develop a site specific plan to minimize changes to wetland habitat hydrology, including water quality, in areas of ground truthed populations.
- Errect permanent exclusion fences around ground truthed populations.

Infrastructure design and site selection that seeks to avoid core habitat known of *Microcarpaea agonis* will be prioritised.

Summary residual impact assessment: In the absence of mitigation, impacts of ***Major Significance*** **(25)** will potentially occur. Avoidance of possible habitat and populations is the most effective mitigation measure and will completely avoid any residual impact**.** Where avoidance is not possible, further survey of possible habitat in areas designated for disturbance will clearly identify populations and allow opportunity for minimisation of disturbance. Due to limited information on species ecology including resilience, any disturbance would be considered to have a residual impact that is ***Major (23)****.*

Residual Significance Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	High	Major (23)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013)

Figure A23. *(Microcarpaea agonis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

- Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (‘high’ confidence is applied) where they intersect remnant vegetation regardless of the RE. .
- The following regional ecosystems in the Yarril and Wyaga Creek catchments (within 50 km of known populations) should be classed as “core habitat possible”:
    - 11.3.27 (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by DEHP, 2012a). It should be noted many of these habitat are beyond resolution of existing mapping databases and are not represented in DEHP databases in the region. Hence ‘core habitat possible’ for the species is not shown.

3. The following regional ecosystems in the Yarril and Wyaga Creek catchments should be classed as “general habitat” (confidence levels as in 2 apply):
    - 11.3.25 (with associated ephemeral swamps)
    - 11.3.4 (with associated ephemeral swamps)
    - 11.3.18 (with associated ephemeral swamps)
4. All other remnant vegetation and non-remnant cleared land in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A54. Evaluation of impact significance for *Microcarpaea agonis* under MNES guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Due to the high degree of endemicity of the species, known from only one location, all populations should be considered 'important populations'. No property considered for development contains habitat for *Microcarpaea agonis*.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9 and F:** It is not considered that these properties host potential habitat for *Microcarpaea agonis*. An 'important population' is not contained within properties identified for development in the short term and hence no long term decrease in population size will occur. In accordance with **Criteria 1**, a significant impact is not expected to occur.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur.
Criteria 3: fragment an existing important population	**Survey area 2, 7, 8, 9 and F:** Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected to occur
Criteria 5: disrupt the breeding cycle of an important population	**P Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected to occur.

Criteria	Evaluation
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected to occur
Criteria 8: introduce a disease	There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area. In accordance with **Criteria 8**, a significant impact is not expected to occur
Criteria 9: interfere with the recovery of the species	**Survey area 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur

Conclusions: For *Microcarpaea agonis* no impact is expected from development activities provided preclearance surveys are undertaken and avoidance is applied as a mitigation to any populations identified. Impact is considered known and predictable (no impact) in survey areas and more broadly in the project development area when specifiec mitigation is applied (see **Table A3**). It is unknown if impacts incurred to the species are reversible as translocation and rehabilitation have not been tested. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: *Microcarpaea agonis* is a perennial herb that has habitat requirements specific to ephemeral wetlands. Surveys may not adequately account for the species during periods of high water levels or seasonal drought when the habitat dries. Hence, survey should undertaken during these periods should not provide justification for suspected absence of the species.

Hawkweed (*Picris evae*)

Family: Asteraceae

Status: EPBC Act: Vulnerable; **NC Act:** Vulnerable; **BoT:** High

Sensitivity: Moderate

Recovery plan: A national species recovery plan has not been developed for Hawkweed. NSW government has developed a Priority Action Statement for the species (DECC, 2005c).

Overview of hawkweed

Description (based on Stanley and Ross 1983): Hawkweed is an annual herb, which grows up to 1.7 m tall. The stems can be reddish and are longitudinally ribbed with stiff hairs. The leaves lack a stalk (i.e. are sessile). Lower basal leaves are up to 30 cm long and 3 cm wide, often with a toothed or lobed margin. Leaves on the stem and apex of the plant are much smaller than basal leaves. Flowers are daisy-type, yellow and 8–10 mm wide. Seeds are "achnes" 5 to 8 mm long, with feathery apexes up to 8 mm long.

Ecology: As an annual daisy, hawkweed is likely to germinate to some extent in disturbed areas. Seeds are wind dispersed, which allows colonization across the landscape. The abundance of Hawkweed is thought to be reduced by moderate and heavy grazing (Fensham 1998). It is unclear whether this is due to being consumed by cattle, or damaged by trampling. The response of the species to fire and requirements for burning are unknown.

Habitat: All of the three collections contained within the study area occur in non-remnant vegetation, particularly roadsides. In regards to remnant vegetation, hawkweed may also occur in eucalypt woodland (e.g. *Eucalyptus melliodora*) with a grassy understorey composed of *Dichanthium* spp. (TSSC 2008k), in grassland of *Dichanthium sericeum* adjacent to cultivated paddocks on black clay soil (EHP 2013), and in grasslands to woodlands on ridges (Goodland 2000). Regional ecosystems likely to provide habitat for hawkweed in the project development area include:

- RE 11.3.2: *Eucalyptus populnea* woodland on alluvial plain.
- RE 11.3.21: *Dichanthium sericeum* and/or Astrebla spp. grassland on alluvial plains on cracking clay soils.

Non-remnant derived grassland also provides potential habitat for the species.

Distribution: Hawkweed occurs from the Darling Downs and Moreton pastoral districts in south-east Queensland (Bostock & Holland 2010), to north of the Inverell area on the NSW northern tablelands (DECC 2005c). In the Darling Downs, it has a restricted distribution but may be locally abundant along roadsides (Goodland 2000). The nearest vouchered record is on a roadside south of Dalby, approximately 10 km east of the project development area.

Likelihood of occurrence and extent of habitat in the project development area: The species is considered likely to occur. Herbrecs (EHP 2013) records it on the eastern margin of the project development area on the Millmerran-Pittsworth Road within remnant bluegrass habitats (RE11.3.21). Similar habitat occurs in the project development area which suggests that the species is likely to occur, particularly in the Dalby area. It may also occur along disturbed roadsides and on the margins of cultivated areas and grazed paddocks. Occurrences on non-alluvial habitats are difficult to predict. The extent of habitat within the project development area is indicated in **Table A55** with spatial representation provided in **Figure A24**.

Table A55. Extent of habitat for hawkweed within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	13750	0
3D Detailed Mapping Area**	0	1344	6415
3D Detailed Mapping Area based on EHP ***	0	5356	0
Survey area 2	0	0	0
Survey area 9	0	90	36
Survey area 8	0	0	266
Survey area 7	0	0	0
Survey area F	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Hawkweed is often found growing mixed with roadside species. It therefore tolerates some light disturbance, but may be impacted by road works. As mentioned above, hawkweed is thought to be reduced by moderate and heavy grazing (Fensham 1998). In New South Wales, it is considered to be threatened by weed invasion, inappropriate fire regimes, habitat fragmentation and clearing of vegetation for cropping and grazing (DECC 2005c).

Potential project-related impacts: Impacts associated with proposed development could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

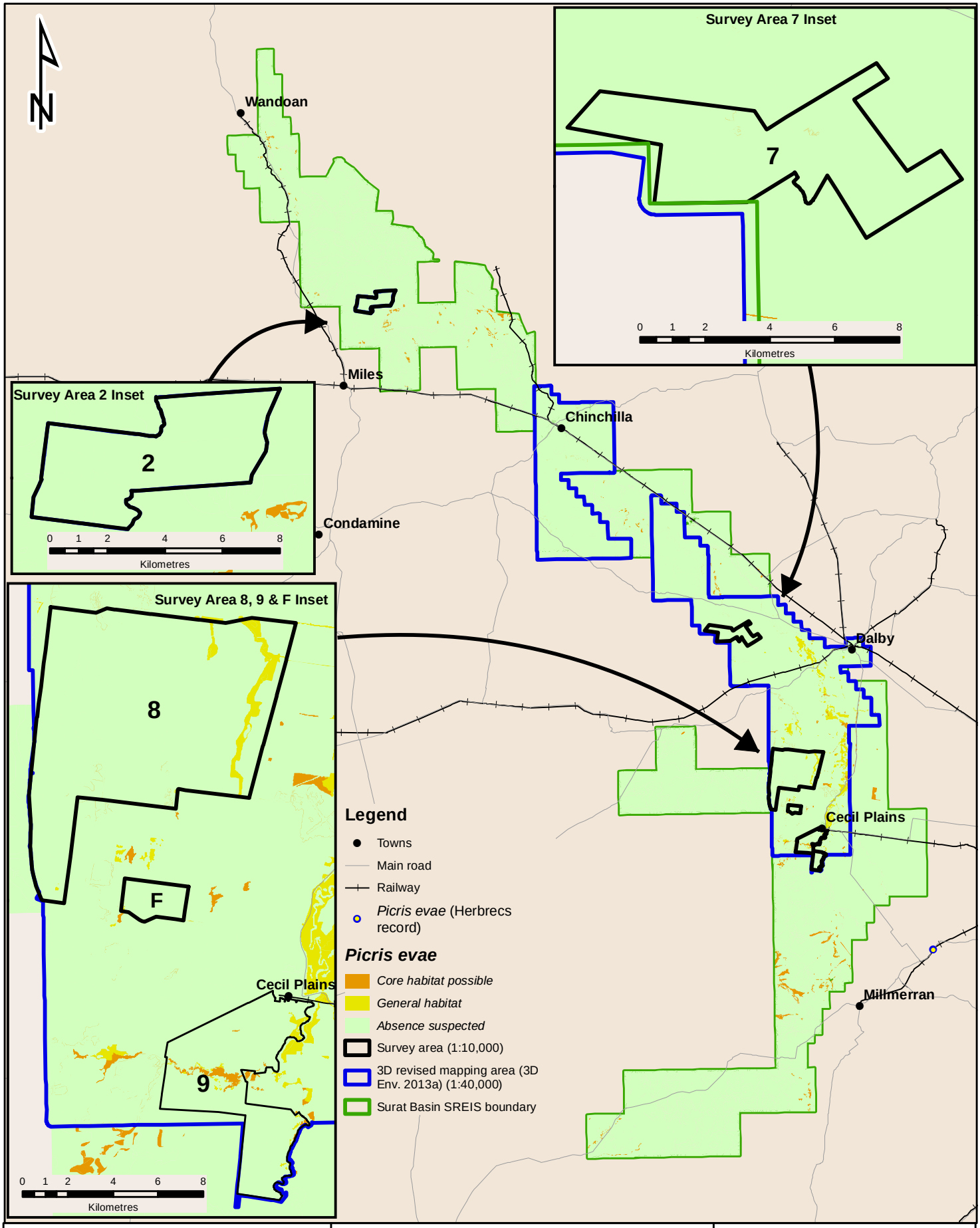
Significance of project related impacts (unmitigated): Hawkweed is considered to have a ***Moderate*** sensitivity. This is because it is an annual species, capable of regular germination and capable of surviving adjacent to disturbed road sides. It has wind dispersed seed which assist the colonisation of adjacent areas. Hawkweed has not been recorded in the project development area but is known from about 10 km away to the south-east. As its habitat is often within stock routes and road reserves, it is at risk of mechanical disturbance associated with linear infrastructure such as pipelines and to follow on effects, such as invasion of introduced grasses and herbs. Therefore the potential magnitude of impact for disturbances within the project development area is considered to be ***Moderate***. The potential significance of unmitigated impacts is considered ***Moderate*** **(13).**

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table A1** are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied as detailed within the Specific Recommendations for Ecological Survey Effort.

Summary residual impact assessment: In the absence of mitigation, impacts of ***Moderate*** **(13)** significance will potentially occur. If infrastructure disturbance avoids hawkweed habitat, no residual impact will be incurred**.** Where avoidance is not possible, application of generic mitigation measures will result in impacts of low magnitude and the resultant residual impact will be ***Low*** **(8).**

. **Residual Significance Assessment**				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Low	Low (8)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A24. Hawkweed *(Picris evae)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. As a precautionary measure the following regional ecosystems within the project development area should be classed as “core habitat possible”:
    - RE 11.3.2, RE11.3.21 (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by EHP, 2012a). The mature regrowth dataset (EHP 2012b) is to be included within calculations.
2. The following should be classed as ‘general habitat’:
3. Non-remnant derived grasslands on land zone 3 (‘High’ level of confidence applied).
    - Regrowth vegetation derived from relevant regional ecosystems (confidence as in 2 apply).
4. All other remnant vegetation in the project development area and cleared agricultural and grazing land should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A56. Evaluation of impact significance for Hawkweed under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, hawkweed does not occur in the project development area. with the nearest record 10 km east of the boundary and 40 km south east of Dalby. Any record occurring within the project development area would represent the northern limits of the species range and hence be considered an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species and be a useful source of seed for both natural dispersal and propagation. Therefore, all populations should be considered important and requiring preservation. Potential habitat (core habitat possible) for the species is indicated in survey area 9 with 'general habitat' indicated in survey area 8 although field survey did not confirm the presence of this species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of hawkweed exists within these properties and hence no decrease in the size of an important population is likely. Pre-clearance survey is required within possible habitats for full clearance when final development footprints are developed. **Survey areas 2, 7 and F:** Habitats within these properties is not considered suitable for hawkweed. Based on this information, no long-term decrease in the size of an important population is likely to result from development activities. In accordance with **Criteria 1**, a significant impact is not expected to occur
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Development will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. The species has fairly general habitat requirements and can withstand moderate

Criteria	Evaluation
	levels of disturbance. In accordance with **Criteria 4**, a significant impact is not expected to occur.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected to occur
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected to occur
Criteria 8: introduce a disease	Diseases which impact hawkweed or the family Asteraceae are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur

Conclusions: For hawkweed (*Picris evae)* no impact is expected from development activities provided preclearance surveys utilising suitable methods of assessment and appropriate mitigation is applied to any populations identified. Potential habitat is most widespread on survey areas 8 and 9. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species. Potential impacts to the species are not considered significant when assessed under MNES significant impact guidelines.

Rule(s) for survey effort required in accordance with survey guidelines: Hawkweed is a perennial species where identification would be assisted by the availability of fertile material for positive identification. The most suitable periods for field identification are likely to be from September through to May, although specific periods of fertility have not been documented. Intensive formalised quadrat and meander searches will be required to ensure that the species is adequately accounted for. Background information on quadrat sampling techniques are provided in Neldner et al (2012).

Cobar greenhood orchid (*Pterostylis cobarensis*)

Family: Orchidaceae

Status: EPBC: Vulnerable; **NC Act:** Not Listed; **BoT:** Not Listed

Sensitivity: High

Recovery plan: A national species recovery plan has not been developed for Cobar greenhood orchid. EHP (2012b) identifies 11 priority actions to assist species recovery.

Overview of Cobar greenhood orchid

Description (Based on Harden 1993; Jones 1993; TSSC 2008l): A ground orchid with approximately 7 to 12 basal rosette leaves. The leaves are narrow, broadest in the middle, up to 2.5 cm long and 8 mm wide. Flowers are fairly transparent with brown and green markings and approximately 12 mm long. The stalk flower is 40 cm tall, with several stem-sheathing leaves along its length.

Ecology: Flowering of Cobar greenhood orchid has been recorded in September to November, with seeds maturing after that. They are pollinated by the males of small gnats which are attracted to the scent of the flower (DEH 2012b). Cobar greenhood orchids die back annually to below ground tubers following seed maturity (TSSC 2008l). New rosettes of leaves are produced following soaking autumn and winter rains. Vegetative spread is not common in this group of orchids, but it is possible that a daughter tuber may be vegetatively produced sometimes (TSSC 2008l).

Habitat: Records from the Barakula and Chinchilla districts occur in woodland of cypress pine (EHP 2013). In NSW, it is known from eucalypt woodland, open mallee, or cypress shrubland on low stony ridges and slopes, among rocks on low hills, and on slopes above streams (DEH 2012b, Jones 1993). Cobar greenhood orchids usually grow in very localised populations with potential habitat contained within:

- RE 11.3.2; *Eucalyptus populnea* woodland on alluvial plains, sometimes with *Callitris glaucophylla*
- RE 11.5.1; *Eucalyptus crebra, Callitris glaucophylla*, A*ngophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces
- RE 11.5.4; *Eucalyptus crebra, Callitris glaucophylla, Callitris endlicheri, Eucalyptus chloroclada, Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces, with deep sands
- RE 11.5.5; E*ucalyptus melanophloia, Callitris glaucophylla* woodland on Cainozoic sand plains/remnant surfaces, on deep red sands
- RE 11.5.21; *Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces

The species has not been recorded in regrowth or non-remnant vegetation although may be able to withstand some soil disturbance.

Distribution: Queensland populations of Cobar greenhood orchid are known from four records in the Darling Downs district and a single collection from the Maranoa (Bostock and Holland 2010). These represent the northern limit of the species distribution. It also occurs in the far western of plains of NSW within the Nyngan–Cobar–Bourke district (TSSC 2008l).

Likelihood of occurrence and extent of habitat in the project development area: The species has been recorded from a single low precision (± 11 000 m) record near Chincilla (AVH 2013e) although it is not known if the collection was made within the project development area. A further two records are located on the margins of the project development area to the north of Chinchilla within cypress pine woodland approximately 7 km north of Chinchilla on Auburn Rd. The records occur within Barakula State Forest. This small terrestrial orchid is a difficult species to detect, and likely to occur in cypress pine habitats on sandy loams north of Chinchilla. It was not recorded during field surveys although has potential to be widely distributed with few collections made due to the cryptic nature of the species. The extent of suitable habitat within the project development area is provided in **Table A57** with spatial distribution illustrated in **Figure A25**.

Table A57. Extent of habitat for Cobar greenhood orchid. within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	133558	0
3D Detailed Mapping Area**	0	7431	0
3D Detailed Mapping Area based on EHP (2012)***	0	18502	0
Survey area 2****	0	943	0
Survey area 7****	0	47	0
Survey area 8****	0	754	0
Survey area 9****	0	421	0
Survey area F****	0	40.5	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Identified threats include habitat damage by feral goats (*Capra hircus*); broad-scale vegetation clearing; grazing pressure changed hydrology increasing salinity; fragmentation; and loss of remnants (TSSC 2008l). The main potential threats to the species include habitat degradation (granite ridge and rocky slope habitat are particularly vulnerable to erosion caused by feral goats); and weed invasion (TSSC 2008l).

Project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat, such as for cypress pine logs;
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks;
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

Consequence of project related impacts (unmitigated): With consideration given to the species known threats, the species sensitivity to disturbance is considered High. This is based on its ability to die back and regrow from tubers, which may provide some resilience to minor soil surface disturbance. The limited amount of ecological knowledge for this species is also recognised. Large areas of potential habitat exists throughout the project development area (15% of the entire area based on EHP 2012a) in cypress pine dominated woodlands (RE11.5.1 and 11.5.4) and ecosystems where patches of cypress occur as sub dominant trees (e.g. RE 11.3.18 and RE11.3.2). The species is likely to be more common within the project development area than herbarium records indicate because it is a difficult plant to find during much of the year. Field surveys within the flowering season of September to November in areas of possible habitat identified for clearing are required to determine the presence and extent of populations. The magnitude of unmitigated potential impacts is considered ***High***, due to the extent of possible habitat and potential for one of the three known local populations occurs to occur within the project development area. The significance of unmitigated impacts is assessed as ***High (21).***

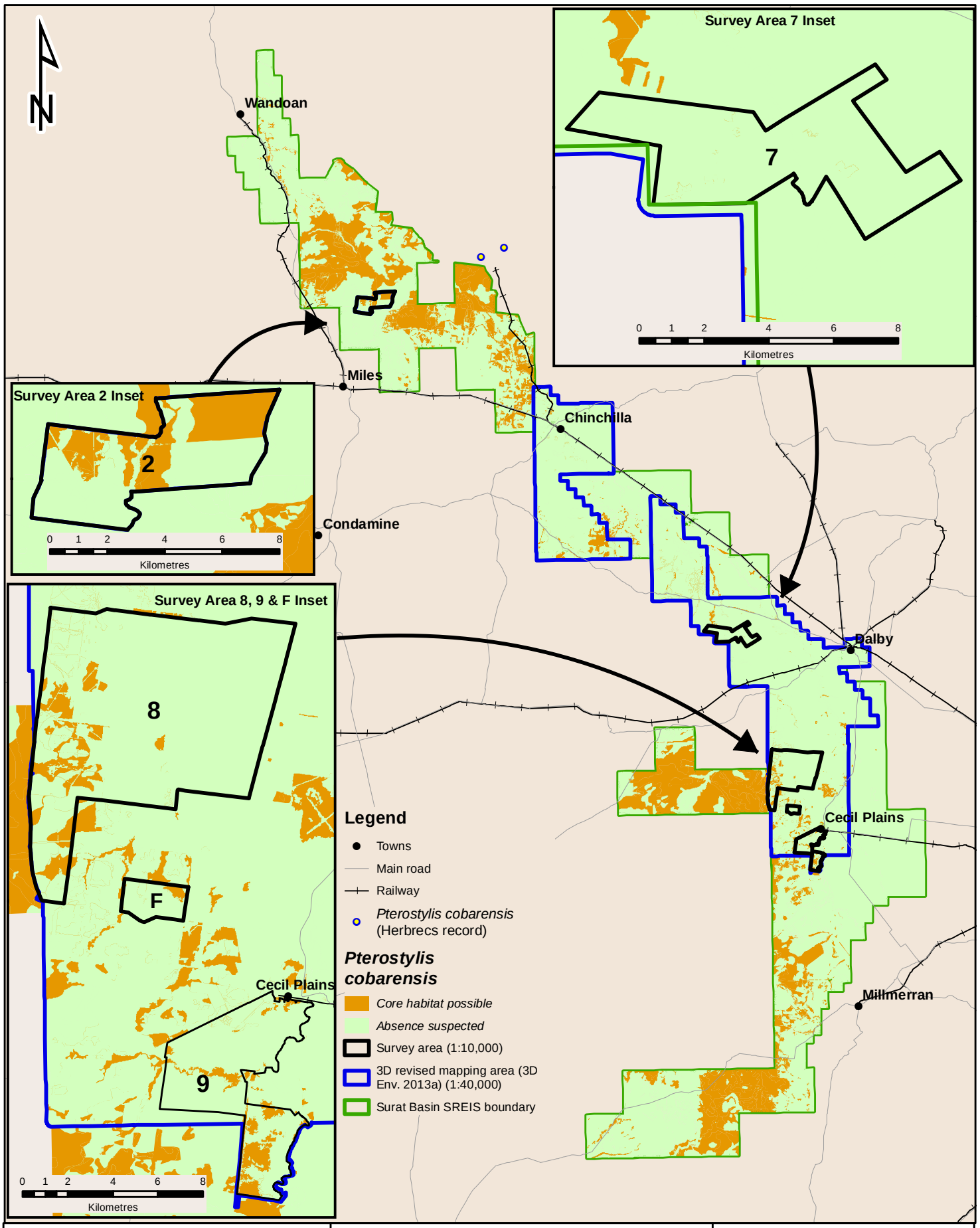
Specific management/ mitigation measures: Mitigations for management of this species are covered by committments made within **Table 1**. Infrastructure design and site selection that seeks to avoid core habitat known of Cobar greenhood orchid will be prioritised.

Summary residual impact assessment: In the absence of mitigation, impacts of ***High*** magnitude will potentially occur and the preliminary impact significance will be ***High (21)***. Areas mapped as 'core habitat possible', warrant further survey work within areas proposed for clearing in an attempt to determine the presence or absence of the species. Assuming adequate surveys are carried out in optimal seasonal conditions (i.e. flowering period) avoidance will mitigate against impacts. However, it will be difficult to gain complete confidence that this species can be completely avoided given the difficulty in detection. If surveys of impact footprints are undertaken within the optimal seasonal window, impacts to the species is not expected.

Where avoidance is not possible, translocation is considered the best risk management measure and will be mostly effective, although minor loss in a local population may still occur. Implementation of other mitigation measures such as limiting the width of disturbance corridors, establishing and maintaining buffers and rehabilitation of disturbance areas may result in a residual impact significance of ***Moderate (17)*** significance.

Residual Impact Assessment				
Avoidance*			Other mitigation measures#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Moderate	Moderate (17)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A25. Cobar greenhood orchid *(Pterostylis cobarensis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. Any confirmed species record (<500m precision) should be buffered by a 1km circumference and treated any remnant habitats contained within the buffer treated as “core habitat known” (‘high’ confidence applies).
2. Regional ecosystems coinciding with confirmed records (<500m precision) should be classed as “core habitat known” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by EHP, 2012a).
3. The following regional ecosystems in the broader region should be classed as “core habitat possible” (confidence levels as in 2 apply). This includes those REs contained within the mature regrowth dataset (EHP 2012b):
    - RE 11.3.2, 11.3.18, RE11.5.1, RE11.5.4, RE 11.5.21, RE 11.5.4, RE 11.10.9
4. All other remnant vegetation, regrowth vegetation derived from possible habitats and cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES Referral Guidelines

Table A58. Evaluation of impact significance for Cobar greenhood orchard *Pterostylis cobarensis* under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Populations of this species recorded to the north of Chinchilla represent the northern distributional limit for this species. All populations should be considered 'important populations' based on criteria provided by DEWHA (2008). Survey area 2, 7, 8, 9 and F contain 'core habitat possible' for Cobar greenhood orchid.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 2, 7, 8, 9 and F:** Intensive survey in these survey areas failed to locate this species. Survey was completed outside the optimal survey period of September - November. Based on current knowledge, the project will not lead to a long term decrease in the size of an important population. This assessment needs to be supplemented with additional survey within the optimal survey window, during pre-clearance measures when final impact footprints are identified. In accordance with **Criteria 1**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat and a suitable seasonal window prior to disturbance
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment. In accordance with **Criteria 2**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat and a suitable seasonal window prior to disturbance
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment. In accordance with **Criteria 3**, a significant impact is not expected to occur provided pre-clearance surveys are undertaken in suitable habitat and a suitable seasonal window prior to disturbance

Criteria	Evaluation
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Pre-clearance survey work is required in the optimal seasonal window to verify this assessment. In accordance with **Criteria 4**, a significant impact is not expected to occur.
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F: :** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment. In accordance with **Criteria 5**, a significant impact is not expected to occur.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. Further work on survey area 2 and survey area 8 is required in the optimal seasonal window to verify this assessment. In accordance with **Criteria 6**, a significant impact is not expected to occur.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	There is limited information on the ecology of this species although it is not known to be affected by any disease which could be potentially introduced into the project development area. In accordance with **Criteria 8**, a significant impact is not expected to occur.
Criteria 9: interfere with the recovery of the species	**Survey areas 2, 7, 8, 9 and F:** Will not interfere with the recovery of a species based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur.

Conclusions: For Cobar greenhood orchid (*Pterostylis cobarensis)* no impact is expected from development activities provided preclearance surveys are undertaken utilising appropriate survey methods and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: The species is likely to be detectable only during flowering periods from September to November which presents the most suitable window for pre-clearance surveys.

Austral cornflower (*Rhaponticum australe*)
Previously known as *Stemmacantha australis*)

Family: Asteraceae

Status: EPBC Act: Vulnerable; **NC Act:** Vulnerable; **BoT:** High

Sensitivity: Moderate

Recovery plan: A national species recovery plan has not been developed for Austral cornflower.

Overview of Austral cornflower

Description (based on Harden 1993; TSSC 2008m): Austral Cornflower is an erect, perennial herb growing to 60 cm tall. The stems and branches are woolly hairy. The leaves are deeply lobed, up to 18 cm long and 6 cm wide on the lower leaves. Leaf size declines with height on stem.

Flower heads, pink to purplish, are 3 to 6 cm diameter, and are produced at the top of the stem and branches. The individual seeds (i.e. “achenes”) are striate, 7 or 8 mm long with a feathery top approximately 2 cm long.

Plate 30. Austral cornflower habitat (Copyright © Boobook).

Ecology: Other than being a perennial, the lifespan of Austral cornflower is unknown, though as a daisy it is probably a fairly short-lived perennial (e.g. living < 5 years). The seeds are wind dispersed,

which should assist colonisation. It has the ability to survive along disturbed roadsides and blocks of land (Goodland 2000; Gardner 2008). Austral cornflower can occur in large populations. Notes from collections indicate one particularly large population (i.e. > 1000 plants) was recorded in a partially cleared paddock with a few scattered ironbarks, south-west of Biggenden (AVH 2013f). Some other abundance records are of 100 to 300 plants, but others are from much smaller populations.

Habitat: Austral cornflower grows in eucalypt open forest with grassy understory, paddocks and along roadsides, on basalt soils and alluvial flats. Goodland (2000) reports that Austral cornflower appears to have no habitat preference or soil preference, being located in mountain coolibah (*Eucalyptus orgadophila*) grassy open woodlands, on stony red soil ridges and to the deep cracking black clay soils of the floodplains. Populations of the species are virtually restricted to roadsides in the Darling Downs (Goodland 2000). They have also been seen on a neglected town block in Toowoomba (Gardner 2008).

Distribution: Endemic to eastern Australia but now presumed extinct New South Wales and Victoria. In Queensland it is known from a large number of sites ranging from Cania Gorge (west of Gladstone), Mount Moffat in the north, to Gatton in the south (Goodland 2000). The most extensive occurrence is around Toowoomba with another cluster of populations south of Biloela.

Likelihood of occurrence and extent of habitat in the project development area: The species possibly occurs. There are no records from within the project development area and Austral cornflower was not recorded during the field survey. However, it has been collected between 15 and 25 km east of the of the project development area in several locations to the north-east of Dalby and near Pittsworth. Suitable habitat occurs on road reserves supporting grasslands and poplar box woodlands on alluvium as well as relatively extensive areas of derived grassland. The extent of habitat for Austral cornflower in the project development area is presented in **Table A59** and the spatial distribution of these species is provided **Figure A26.**

Table A59. Extent of habitat for Austral cornflower. within the project development area and associated areas of assessment

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	0	13750	0
3D Detailed Mapping Area**	0	1344	6415
3D Detailed Mapping Area based on EHP (2012)***	0	5355	0
Survey area 8	0	0	266
Survey area 9	0	90	36
Survey area 2, 7, F	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Mainly found on roadsides or in undisturbed reserves where the species may regenerate after moderate mechanical disturbance. However, road work operations have been known to completely destroy entire sites (EPA 2002, Goodland 2000). Austral cornflower may be outcompeted when roadsides become infested by exotics (e.g. Johnson's grass and green panic; EPA 2002). The condition of populations may be related to grazing pressure, because it is thought to have a high sensitivity to grazing (Fensham 1997).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.
- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, altered habitat structure along gathering lines, tracks and clearing zones.

Significance of project related impacts (Unmitigated): The sensitivity of Austral cornflower is considered ***Moderate***. This is based on its known ability to produce dense populations and its ability to survive in disturbed paddocks and along roadsides, both of which suggest a capacity for abundant seed germination. Its seed is also wind dispersed, and likely to colonise adjacent areas. However, following mechanical disturbance (e.g. of roadside) invasion of exotic pasture grasses and weeds has the potential to degrade habitat and limit the re-colonisation of disturbed areas.

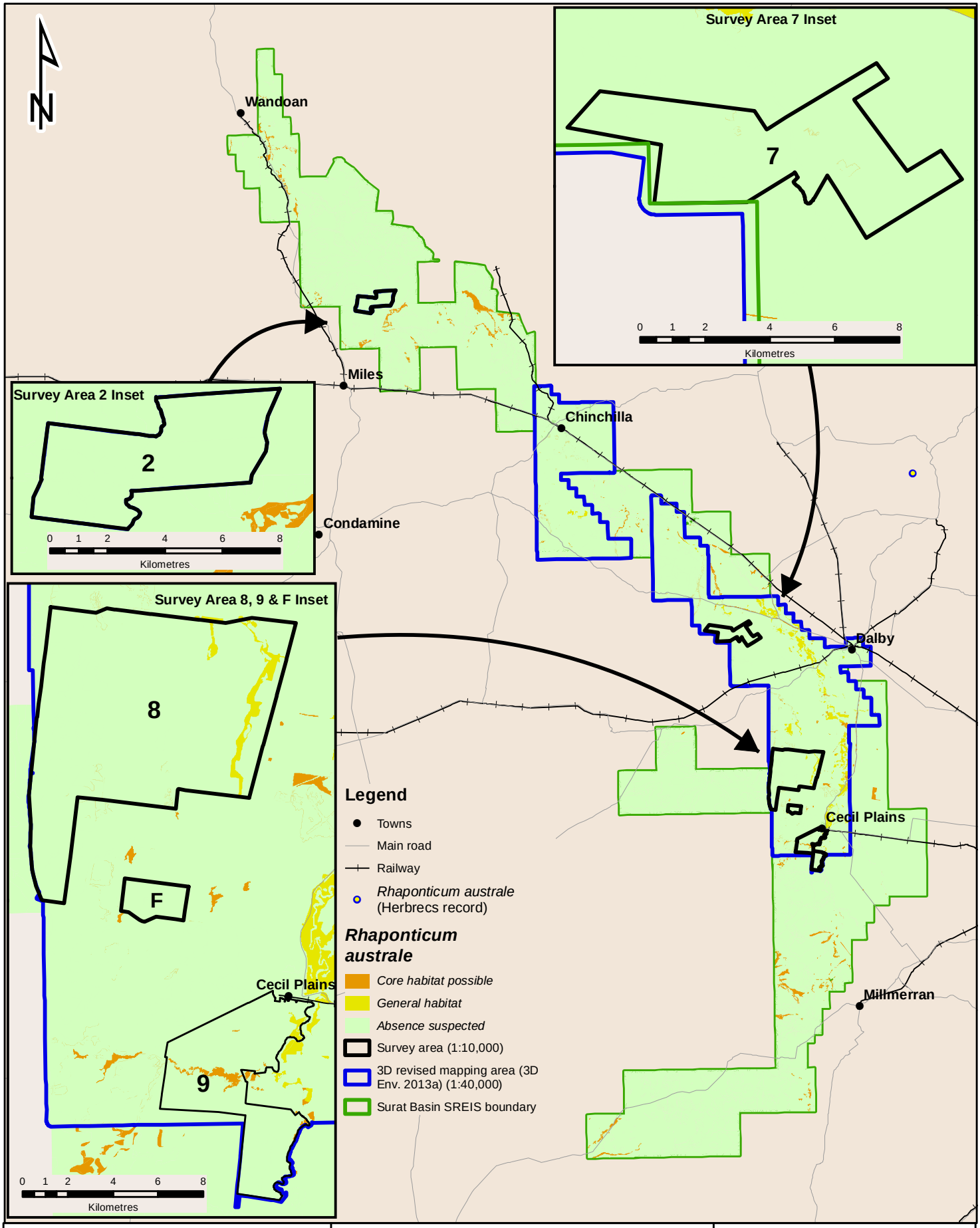
Any remnant and derived grassland and poplar box woodlands on alluvium are potential habitat and susceptible to disturbance. The species, which is not currently known from the project development area, is widely distributed in nearby pockets of habitats which are under pressure from clearing, agricultural development, weed invasion and overgrazing. Stock routes and road reserves supporting grasslands, poplar box woodlands, and derived grasslands are most susceptible to disturbance associated with linear infrastructure such as pipelines. The potential magnitude of impact is considered ***Moderate.*** Unmitigated activities in the vicinity of local populations and possible habitats are therefore likely to have an impact significance of ***Moderate*** **(13).**

Species specific management/ mitigation measures: Management of this species is covered in generic recommendations made within **Appendix A1**. Infrastructure design and site selection that seeks to avoid core habitat known of Austral cornflower will be prioritised.

Summary residual impact assessment: In the absence of avoidance of the local populations, impacts of ***Moderate (13)*** significance will potentially occur. Areas mapped as 'core habitat possible', warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding areas of potential core habitat will mitigate against impacts and residual impacts will be not be incurred***.*** Grassland and grassy woodland habitats support a number of other EVNT flora species and are particularly vulnerable to mechanical disturbance. Implementation of mitigation measures such as establishing and maintaining buffers, limiting the width of disturbance corridors, rehabilitation of disturbance areas using seeding of native grass seed of local provenance, and management of exotic grass and herb invasion will be largely effective to a degree that impact significance is ***Low* (8)**.

Residual Significance Assessment				
Avoidance*			Others#	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Low	Low (8)

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only
Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A26. Austral cornflower *(Rhaponticum australe)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. As a precautionary measure the following regional ecosystems and mature regrowth (as per EHP 2012b) should be classed as "core habitat possible" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by DEHP, 2012a and 2012b):
    - 11.3.2
    - 11.3.21 and 11.3.24
    - Non-remnant derived grasslands on land zones 3.
2. All other remnant vegetation in the project development area and cleared agricultural and grazing land should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A60. Evaluation of impact significance for Austral cornflower under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, Austral cornflower does not occur in the project development area and is restricted to non-remnant habitats within 20 km from the project development area boundary. It does however have the potential to occur throughout the entire project development area, most notably in eastern portions. The project development area would represent the western limits of the species distribution. Hence, under the guidelines of DEWHA 2008, any population that occurs within the study area would be considered an 'important population'. Habitat for the species is indicated in properties survey areas 8 and 9. Field survey within these properties did not locate the species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of Austral cornflower exists within these properties and hence no decrease in the size of an important population is likely. Survey areas 2, 7 and F do not present suitable habitat for the species. In accordance with **Criteria 1**, a significant impact is not expected to occur
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected to occur
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is

Criteria	Evaluation
	not expected to occur
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected to occur
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of exotic species within tenements are proposed (commitment C099, C179, C188, C183). In accordance with **Criteria 7**, a significant impact is not expected to occur
Criteria 8: introduce a disease	Diseases which impact Austral cornflower or other members of the Asteraceae family are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur

Conclusions: For Austral cornflower (*Rhaponticum australe)* no impact is expected from development activities Potential impacts to the species are not considered significant when assessed under MNES significant impact guidelines. This assumes provided preclearance surveys are undertaken utilising suitable methods when working within areas of possible habitat (survey area 9) and appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species..

Rule(s) for survey effort required in accordance with survey guidelines: The species, being a short lived perennial, should be detectable throughout most of the year. Limited information is available on its flowering and seeding period although like most species of the Asteraceae family, is likely to be most robust in the period from September to May.

Austral toadflax (*Thesium australe*)

Family: Santalaceae

Status: EPBC Act: Vulnerable **NC Act:** Vulnerable

Sensitivity: High

Recovery plan: A national species recovery plan has not been developed for Austral toadflax although DEH (2012c) provides 15 priority actions to aid the recovery of the species. Griffith (1992) has prepared a recovery plan for the species.

Overview of Austral Toadflax

Description (based on Stanley and Ross 1983; Harden 1993, DEH 2012c, DSE 2003): Austral toadflax is a small biennial or perennial herb or subshrub. It grows to 40 cm tall, with wiry, slender stems. Leaves are alternate, linear yellowish-green. The leaf stalks (i.e. petioles) extend down the stem a little, forming a ridge. The yellow-green flowers, < 2 mm long, occur individually in the leaf axils. The globular fruit is a nut approximately 2.5 mm diameter, with the tiny petals persisting at the apex.

Ecology: A root parasite of kangaroo grass (*Themeda triandra*) and other grasses, Austral toadflax lives for at least two years. Flowers have been recorded from spring to autumn with fruit developing in summer. Austral toadflax has been observed to germinate prolifically after fire and also after drought. The species is relatively short lived, persisting up to two years after germination (Department of Sustainability and Environment (DSE) 2003).

Habitat: Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE 11.3.2) north-west of Dalby, within the project development area. Other Herbarium collection records of Austral toadflax are from along roadsides, mountain coolibah (*Eucalyptus orgadophila*) grassy open woodlands with kangaroo grass (*Themeda triandra*) and Queensland blue grass (*Dichanthium sericeum*). Relevant regional ecosystems within the project development are:

- RE 11.3.2; *Eucalyptus populnea* woodland on alluvial plains.
- RE 11.3.21; *Dichanthium sericeum* and/or Astrebla spp. grassland on alluvial plains. Cracking clay soils.
- RE 11.3.24; *Themeda avenacea* grassland on alluvial plains. Basalt derived soils.

Distribution: Historical collections (including the late 1800's) were made from Tasmania, but it is now considered extinct in that state (DSE, 2003). Austral Toadflax occurs in eastern Victoria, NSW and southern Queensland. The majority of southern Queensland collections are from the Darling Downs and Moreton districts (Bostock and Holland 2010). The Dalby area represents the species western limits on the Darling Downs.

Likelihood of occurrence in project development area: The species is known to occur in the project development area, being recorded in non-remnant grassland approximately 4km west of Dalby and an additional record on the Warrego Highway approximately 19 km north of Dalby, and in a small remnant of *Eucalyptus populnea* on alluvium (11.3.2) approximately 25km NW of Dalby on the Warrego Highway (EHP 2013). There is a high potential for the species to occur in grassland and poplar box woodlands on alluvium as well as intact vegetation contained within stock routes and road reserves. The species was not recorded during field surveys. **Table A61** provides an indication of the extent of Austral toadflax habitats within the project development area with broad distribution indicated in **Figure A27.**

Table A61. Extent of habitat for Austral toadflax grass within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	77	13550	0
3D Detailed Mapping Area**	0	3832	7633
3D Detailed Mapping Area based on EHP (2012)***	0	5399	0
Survey area 7	0	0.85	5
Survey area 8	0	0	369
Survey area 9	0	90	70
Survey area F	0	0	4.08
Survey area 2	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: Populations in road reserves are threatened by roadwork and maintenance activities such as spraying, grading, slashing, by inappropriate grazing and burning regimes, and weed infestation (Goodland 2000). The species is known to be susceptible to rabbit, horse and cattle grazing but able to tolerate light, non-continuous cattle grazing. Populations of the species are thought to be declining (EPA 2002). Austral toadflax cannot survive beneath a dense shaded canopy (Griffith, 1992), nor is it likely to be capable of surviving dense infestations of exotic grass.

Potential project-related Impacts: Impacts associated with the proposed project related activities could include:

- Direct loss of individuals during clearing of habitat.

- Direct loss and degradation of habitat for construction of facilities and development and maintenance of access tracks.
- Habitat edge effects such as weed infestation, changed fire regimes, altered habitat structure along gathering lines, tracks and clearing zones.

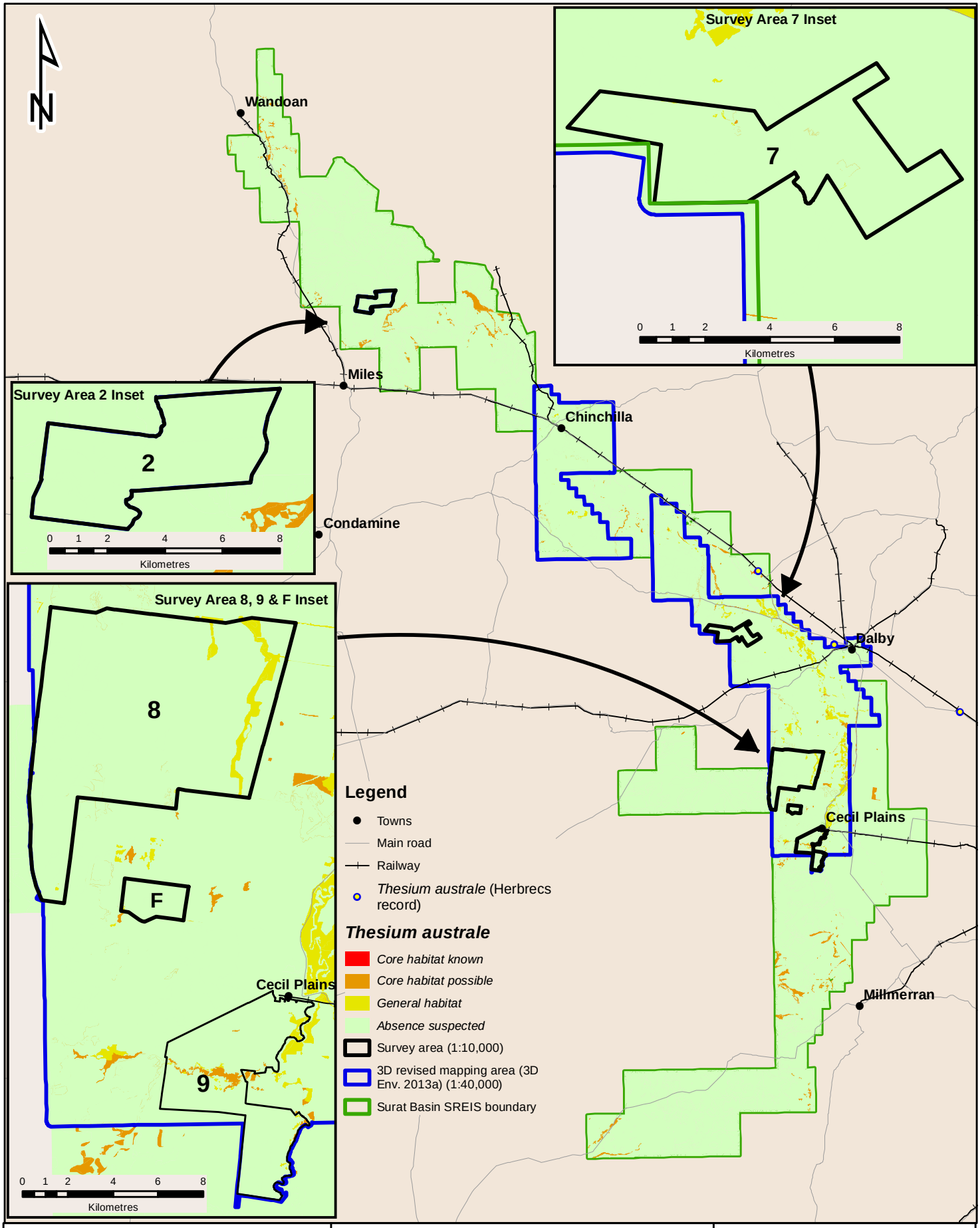
Significance of project related impacts (unmitigated): Austral toadflax is known to persist in moderately disturbed areas, such as roadsides. However, it is known to be threatened from smothering by some weeds and there is little information on its ecology or ability to regenerate. It is considered to have a ***High*** sensitivity ranking. The species occurs in roadside grassland and poplar box remnants on alluvium within the project development area. Potential habitat occupies approximately 1% of the project development area, although, stock routes and road reserves supporting habitat are most susceptible to disturbance incurred through construction of linear infrastructure such as pipelines. Two of the three populations contained within the study area are found within the project development area itself, though it is widespread beyond the study area towards the east. The potential magnitude of impact is considered ***Moderate***. Further survey is required to determine the extent of populations in tracts of suitable habitat. The likely significance of unmitigated impact is ***Moderate* (17).**

Species specific management/ mitigation measures: Commitments made by Arrow documented within **Table 1** are considered sufficient to mitigate impacts to the species. Detailed search methods as applicable to herbs and graminoids should be applied to survey effort. Infrastructure design and site selection that seeks to avoid core habitat known of Austral toadflax will be prioritised.

Summary Residual Impact Assessment: In the absence of mitigation, the resultant impact significance will be ***Moderate* (17).** Areas mapped as 'core habitat possible', warrant further survey work prior to clearing in an attempt to determine the presence or absence of the species. Avoiding areas of potential habitat will totally mitigate against impacts and no impact will be incurred. Adjacent habitat remains vulnerable to edge effects (invasion of exotic pasture grasses). Where avoidance is not possible, the identified impact management measures are considered to be mostly effective and may mitigate against an impact to a large degree, although the effectiveness of translocation is not known to have been demonstrated. The resulting residual impact following employment of a full range of mitigation measures is considered to be ***Moderate* (12)**.

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

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



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A27. Toadflax *(Thesium australe)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. The confirmed species records (<500m precision) should be buffered by a 1km circumference and any remnant RE (including mature regrowth in EHP 2012b) treated as "core habitat known" (high confidence levels apply).
2. RE polygons with confirmed records (<500m precision) should be treated as "core habitat known" ('high' confidence when applied to property specific mapping, 'moderate' when applied to 1: 40 000 scale mapping and 'low' when applied to mapping produced by EHP, 2012a).
3. The following regional ecosystems should be classed as "core habitat possible" (confidence levels as in 2 apply:
   - RE 11.3.2, RE 11.3.21, RE 11.3.24
4. Any non-remnant (regrowth) habitats derived from possible habitats (REs 11.3.21, 11.3.24, 11.3.2) and derived grassland should be treated as "general habitat" (high confidence levels apply when applied to refined mapping. Low confidence levels apply when based on RE mapping provided by EHP 2012a).
5. All other remnant vegetation and cleared agricultural land in the project development area should be treated as "absence suspected".

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A62. Evaluation of impact significance for Austral cornflower under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, Austral toadflax occurs within 2 locations in the project development area with an additional collection within the broader study area. It does have the potential to occur throughout the entire project development area, most notably grassy woodlands and grasslands in eastern locations. The project development area would represent the western limits of the species distribution in the Darling Downs with only a few scattered collection to the northwest near Carnarvon. Hence, under the guidelines of DEWHA 2008, any population that occurs within the study area would be considered an 'important population'. Populations would also provide genetic diversity and contribute to dispersal of seed within a fragmented landscape. Habitat for the species is indicated in survey areas 7, 8, 9. Field survey within these properties did not locate the species. Other properties are not considered to host suitable habitat.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey areas 7, 8 and 9:** Intensive field survey within these properties did not locate the species. It is considered unlikely that an important population of Austral toadflax exists within these properties and hence no decrease in the size of an important population is likely. Pre-clearance survey once discrete development footprints are known will be required to verify this assessment and mitigate impacts to undiscovered populations. Survey areas 2 and F do not present suitable habitat for the species. In accordance with **Criteria 1**, a significant impact is not expected to occur.
Criteria 2: reduce the area of occupancy of an important population	**Survey areas 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur.
Criteria 3: fragment an existing important population	**Survey areas 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey areas 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected to occur.

Criteria	Evaluation
Criteria 5: disrupt the breeding cycle of an important population	**Survey areas 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur.
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey areas 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected to occur.
Criteria 7: result in the establishment of an invasive species	**Survey areas 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of exotic species within tenements are proposed (commitment C099, C179, C188, C183). In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	Diseases which impact Austral toadflax are not known to occur. In accordance with **Criteria 8**, a significant impact is not expected to occur.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur.

Conclusions: For Austral toadflax (*Thesium australe)* no impact is expected from development activities provided preclearance surveys employ methods appropriate to detection of the species within areas mapped as potential habitat (survey areas 7. 8 and 9). This assessment assumes that appropriate mitigation is applied to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

Rule(s) for survey effort required in accordance with survey guidelines: Austral toadflax, being a short lived perennial, should be detectable throughout most of the year although will be most visible during its flowering period which occurs from September to May (Spring to Autumn). The use of 1 x 1 m quadrats as recommended for assessment of herbaceous groudcovers. Methods are broadly described inNeldner et al (2012).

Xerothamnella (*Xerothamnella herbacea)*

Family: Acanthaceae

Status: EPBC Act: Endangered, **NC Act:** Endangered **BoT:** Not Listed

Sensitivity: High

Recovery plan: A national species recovery plan has not been developed for *Xerothamnella herbacea*.

Overview of Xerothamnella

Description: A perennial herb to 30 cm tall. sparse, sprawling, perennial herb growing to a height of 30 cm. Leaves are soft, opposite, linear to narrowly ovate, dark green above paler beneath. The flowers are two lipped, pink to mauve to 6.5 mm long, arising from the upper leaf axils (Barker 1986 cited in TSSC 2008n).

Plate 31. *Xerothamnella herbacea.* Photograph Copyright © Boobook

Ecology: Little is known in regard to the ecology of *Xerothamnella herbacea* although it can live for a few years and establish vegetatively by rooting from nodes along stems.

Habitat: Occurs in remnant and disturbed brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) dominated communities in shaded situations, often in leaf litter (TSSC 2008n). The species is associated with brigalow (*Acacia harpophylla*) dominated communities, preferring shady locations where it grows in leaf litter (TSSC 2008n). The plant often occurs in gilgais in vertic clay soils

(vertosols) and is known to occur in non-remnant and highly disturbed habitats. Regional ecosystems associated with this species are:

- RE 11.3.1; Acacia harpophylla and/or Casuarina cristata open forest on alluvial plains.
- RE 11.4.3; Acacia harpophylla and/or Casuarina cristata shrubby open forest on Cainozoic clay plains.
- RE 11.9.5; Acacia harpophylla and/or Casuarina cristata open forest on fine-grained sedimentary rocks.

Distribution: *Xerothamnella herbacea* is known from seven locations between Goondiwindi and Theodore. Scattered populations occur to the north-east of Chinchilla (between Chinchilla and Boondooma Lake), within Palmgrove and Expedition National Parks to the southwest of Moura. Two isolated population occur between Goondiwindi and Millmerran.

Likelihood of occurrence and extent of habitat in the project development area: There are two previous Herbrecs collection sites within the project development area (EHP 2013). These are from a narrow patch of roadside Brigalow remnant on the Millmerran-Goondiwindi road, and a low precision (± 16000 m) collection approximately 30 km east of Chinchilla from 1980. A record 32km north east of Chinchilla (EHP 2013, Chinchilla Field Naturalist Club n.d) is located approximately 8 km east of the project development area boundary. There is potential for *Xerothamnella herbacea* to occur within any brigalow/belah habitat consistent with 11.3.1 11.4.3 and 11.9.5, as well as brigalow regrowth on roadsides. **Table A63** provides an indication of the extent of *Xerothamnella herbacea* habitats within the project development area with broad distribution indicated in **Figure A28.**

Table A63. Extent of habitat for *Xerothamnella herbacea* within the project development area and associated areas of assessment.

	Core Habitat Known (Ha)	**Core Habitat Possible (Ha)**	**General Habitat (Ha)**
Project development area*	55	8059	0
3D Detailed Mapping Area**	0	1307	353
3D Detailed Mapping Area based on EHP (2012)***	0	1477	0
Survey area 7	0	0.9	3
Survey area 8	0	2	0
Survey area 9	0	5	0
Survey area F	0	1	0
Survey area 2	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The species is threatened by competition from invasive grasses such as green panic (*Megathyrsus maximus* var. *pubiglumis*) and to a lesser extent buffel grass (*Cenchrus ciliaris*) either by direct competition or by increasing the fuel load and altering fire regimes. Potential threats include road widening and maintenance activities, surface erosion, and grazing and trampling by cattle and native macropods (TSSC 2008n).

Significance of project related impacts (unmitigated): *Xerothamnella herbacea* can spread vegetatively, which provides some resilience to minor disturbances and potential for rehabilitation. However, very little is known of the ecology of this small herb, other than it can persist in areas with some disturbance. The sensitivity of the species is considered ***High***. Potential habitat for *Xerothamnella herbacea* covers approximately 1% of the project development area based on mapping provided by EHP (2012a). However considerable habitat is contained within non-remnant vegetation which is not comprehensively mapped throughout the project development area. The potential magnitude of unmitigated impacts is considered ***High***. The potential significance of unmitigated impacts is therefore considered ***High* (21).**

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of *Xerothamnella herbacea* will be prioritised.

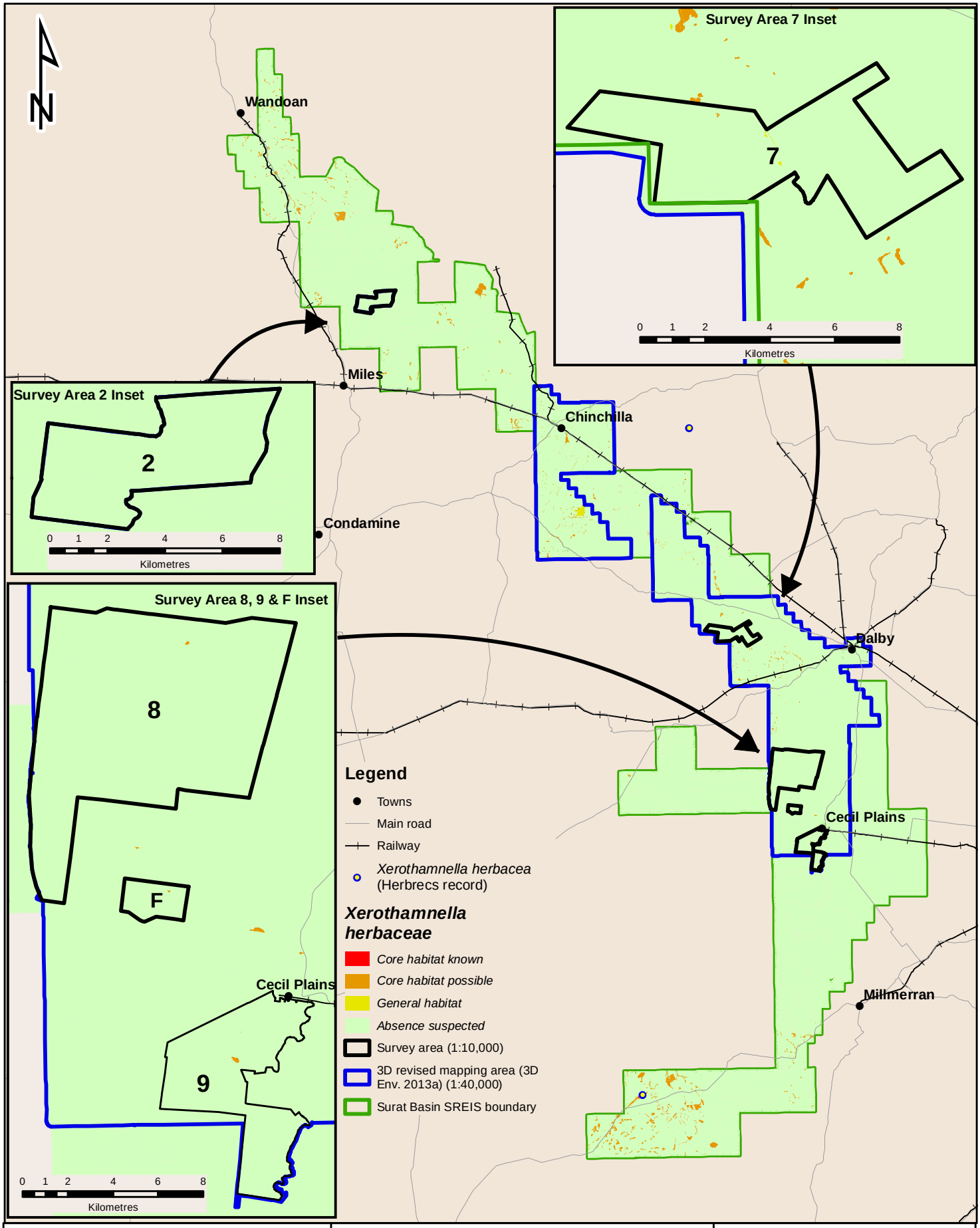
Summary residual impact assessment: In the absence of mitigation, impacts of ***High (21)*** significance are possible**.** Brigalow associations on Land zones 3, 4 and 9 constitute the optimal habitat for *Xerothamnella herbacea*. These areas are classed as Category B Environmentally Sensitive Areas and are subject to management buffers as part of project conditioning. Avoiding areas of potential habitat will completely mitigate against impact and no residual impact will be incurred**.** Where brigalow vegetation cannot be avoided, generic mitigation measures may reduce impact to some degree. Although the effectiveness of translocation has not been tested, the plants ability to reproduce vegetatively means that it may be amenable to translocation techniques. The resulting residual impact through alternative mitigation measures would be ***Moderate (17)*.**

Residual Significance Assessment					
Avoidance*			Other mitigation measures[#]		
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Sensitivity Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	High	Moderate	Moderate (17)

*Includes appropriate application of management buffers

[#] Clearing of core habitat known and possible is unavoidable.

NA - Not applicable as the area will not be subject to impacts.



NOTES:

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

Notes: Core Habitat Known applies to species records <500m precision only

Data Sources:
3d Environmental Field Survey Records, 2011.
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Herbrecs (EHP 2013

Figure A28. *(Xerothamnella herbaceae)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rule(s) for habitat mapping:

1. All confirmed species records (<500m precision) should be buffered by a 1km circumference and all remnant REs including mature regrowth (as per EHP 2012b) treated as “core habitat known” (high level of confidence).
2. RE polygons (and mature regrowth) coinciding with the confirmed record (<500m precision) should be treated as “core habitat known” (high level of confidence).
3. The following regional ecosystems should be classed as “core habitat possible” (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by EHP, 2012a):
    - RE11.3.1, RE11.4.3, RE11.9.5, RE11.9.6
4. Advanced brigalow/belah regrowth on gilgai soils of land zones 3 and 4 and 9 should be classed as “general habitat” (confidence levels as in 3 apply) (3D Environmental, 2013 dataset only.
5. All other remnant vegetation in the project development area should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Evaluation under MNES referral guidelines

Table A64. Evaluation of impact significance for *Xerothamnella herbacea* under MNES Guidelines.

Criteria	Evaluation
'Important populations' and 'distribution of the species in the project development area.	Based on current knowledge, *Xerothamnella herbacea* is scattered throughout remnant and non - remnant brigalow habitats within the study area with two prior records occurring within the project development area. The species has potential to occur throughout the entire project development area. Any localised populations are considered important for persistence of the species in a highly fragmented landscape and should be considered to form part of an 'important population'. Isolated populations within degraded habitats, whilst not likely to be viable in the long term, may represent significant genetic variation across the range of the species. Therefore, all populations should be considered important.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 7, 8, 9 and F:** Minor representations of potential habitat for xerothamnella occur within small representations of remnant and regrowth brigalow contained within. Due to the confined and isolated nature of these habitats, when considered in the context of intensive search effort, it is unlikely that an important population of *Xerothamnella herbacea* exists within these properties. Hence no decrease in the size of an important population is likely. Survey area 2 is not considered to provide suitable habitat for the species. In accordance with **Criteria 1**, a significant impact is not expected to occur.
Criteria 2: reduce the area of occupancy of an important population	**Survey area 2, 7, 8, 9 and F:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1. In accordance with **Criteria 2**, a significant impact is not expected to occur.
Criteria 3: fragment an existing important population	**Survey area 2, 7, 8, 9 and F:** Development Will not fragment an existing important population based on detail provided in Criteria 1. In accordance with **Criteria 3**, a significant impact is not expected to occur.
Criteria 4: adversely affect habitat critical to the survival of the species	**Survey area 2, 7, 8, 9 and F:** Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1. In accordance with **Criteria 4**, a significant impact is not expected to occur.
Criteria 5: disrupt the breeding cycle of an important population	**Survey area 2, 7, 8, 9 and F:** The project will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1. In accordance with **Criteria 5**, a significant impact is not expected to occur.

Criteria	Evaluation
Criteria 6: modify, destroy, remove or isolate or decrease habitat leading to the decline of the species	**Survey area 2, 7, 8, 9 and F:** Will not modify, destroy, remove, isolate decrease habitat leading to decline of the species based on detail provided in Criteria 1. In accordance with **Criteria 6**, a significant impact is not expected to occur.
Criteria 7: result in the establishment of an invasive species	**Survey area 2, 7, 8, 9 and F:** Will not result in establishment of an invasive species based on detail provided in Criteria 1. In accordance with **Criteria 7**, a significant impact is not expected to occur.
Criteria 8: introduce a disease	Diseases which impact *Xerothamnella herbacea* or its brigalow habitat are not known. In accordance with **Criteria 8**, a significant impact is not expected to occur.
Criteria 9: interfere with the recovery of the species	The recovery of the species will not be impacted based on detail provided in Criteria 1. In accordance with **Criteria 9**, a significant impact is not expected to occur.

Conclusions: For *Xerothamnella herbacea,* no impact is expected from development activities provided preclearance surveys are applied to proposed areas of impact where potential habitat is indicated (survey areas 7, 8, 9 and F). Appropriate mitigation must also be employed to any populations identified. Impact is considered known and predictable (no impact) and reversible as translocation and rehabilitation is likely to be viable. Project related activities will not contribute to the cumulative impact incurred to populations of this species.

.Rule(s) for survey effort required in accordance with survey guidelines: *Xerothamnella herbacea*, being a short lived perennial, should be detectable throughout most of the year. It will be most visible and readily identified during its flowering period although there is limited information on species lifecycle. Optimal survey period is not known.

References – Threatened Ecological Communities and Flora Species

Accad, A; Neldner, V.J; Wilson, B. A; and Niehus, R.E. (2012). Remnant Vegetation in Queensland. Analysis of remnant vegetation 1997-2009, including regional ecosystem information. (*Queensland Department of Science, Information Technology, Innovation and the Arts*: Brisbane).

Australia's Virtual Herbarium (2013a). http://avh.ala.org.au/occurrences/search?taxa=Acacia+handonis#mapView

Australia's Virtual Herbarium (2013b).

http://avh.ala.org.au/occurrences/search?taxa=Acacia+wardellii#mapView).

Australia's Virtual Herbarium (2013c).

http://avh.ala.org.au/occurrences/search?taxa=Calytrix%20gurulmundensis&sort=occurrence_date&start=40&title=#list).

Australia's Virtual Herbarium (2013D).

http://avh.ala.org.au/occurrences/search?sort=occurrence_date&taxa=Denhamia+parvifolia#recordsView).

Australia's Virtual Herbarium (2013e).

http://avh.ala.org.au/occurrences/search?taxa=Pterostylis+cobarensis#mapView

Australia's Virtual Herbarium (2013f) http://avh.ala.org.au/occurrences/search?taxa=Rhaponticum%20australe&sort=occurrence_date&start=20&title=#list

Australia's Virtual Herbarium (2013g) http://avh.ala.org.au/occurrences/search?taxa=Acacia+lauta#mapView

Australian Broadcasting Commission (2012). http://www.abc.net.au/local/stories/2012/11/21/3637695.htm

Barker, RM (1986). 'A taxonomic revision of Australian Acanthaceae', *Journal of the Adelaide Botanic Gardens*, vol. 9, pp. 91–286.

Bayly, M. (1994). Variation within *Eriostemon angustifolius* (Rutaceae) and the recognition of a new species *E. sporadicus*. *Australian Systematic Botany*. 7:275-280.

Bean, JM 1999, '*Bothriochloa biloba* (Poaceae) in natural grasslands on slopes of the Liverpool Plains, New South Wales', *Cunninghamia,* vol. 6, pp. 383-387.

Bean, A.R. (1997). *Microcarpaea agonis (*Scrophulariaceae), a new species from south-eastern Queensland. *Austrobaileya* 5, 149-51.

Benson, D. & L. McDougall. 1993. Ecology of Sydney plant species - Part 4. *Cunninghamia* **4**: 690.

Boland , D. J., Brooker M. I. H., Chippendale H. G. M., Hall, N., Hyland, B. P., Johnston, R. D., D.A. Kleinig, D. A, Turner, J. D. (2006). Forest Trees of Australia. *CSIRO Publishing.* Melbourne.

Bostock, P.D. and Holland, A.E. (Eds.) (2010). Census of the Queensland Flora. *Queensland Herbarium, Environment Protection Agency*, Brisbane.

Botanic Gardens Trust (2009). PlantNET - The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia (version [number]). Viewed 26 May 2009. Online at http://plantnet.rbgsyd.nsw.gov.au. Accessed 15/12/09.

Brooker M. I. H. and Kleinig D. A. (2004) *Field guide to the eucalypts. Volume 3 Northern Australia*. Bloomings Books Melbourne.

Butler DW (2007). Draft recovery plan for the 'Bluegrass (Dichanthium spp.) dominant grassland of the Brigalow Belt Bioregions (north and south)' endangered ecological community, 2007–2011. Report to *Department of the Environment and Heritage, Canberra.* Queensland Parks and Wildlife Service, Brisbane.

Chinchilla Field Naturalists Club (Undated), Charlies Creek Catchment Plant List. Published by the *Chinchilla Field Naturalist Club*.

Collard, S. J. (2007). Agricultural Intensification and Ecosystem function in a Brigalow Landscape; Implications for Ecosystem Services. Unpublished Phd Thesis.

Conn, J.S. (1995) The vegetation of Nombinnie and Round Hill Nature Reserves, central-western New South Wales. *Cunninghamia* 4(1): 81-101.

Curran, TJ & Curran, SR (2005), 'Rediscovery of Ooline, *Cadellia pentastylis*, near Gunnedah: notes on the habitat and ecology of this dry rainforest tree', *Cunninghamia*, vol. 9, no. 2, pp. 311–316

Department of Agriculture, Forestry and Fisheries (DAFF). Myrtle Rust Facts, Photos and Maps. Available online at: http://www.daff.qld.gov.au/4790_20269.htm

Department of Environment & Climate Change New South Wales (DECC) (2005a). Curly-bark Wattle – Profile, viewed 14 Oct 2009, Online at <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10012>.

Department of Environment & Climate Change New South Wales, formerly Department of Environment & Conservation New South Wales (DECC) (2005b), Ooline – Profile, viewed 12 March 2013, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10118>.

Department of Environment & Climate Change (DECC) NSW (2005c), 'Hawkweed – Priority actions (New South Wales Threatened Species Priority Action Statement)' http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_profile.aspx?id=10627>.

Department of Environment and Heritage (DEH) (NSW) (2012a). Threatened Species – Field Survey Methods: available online: http://www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm

Department of Environment and Heritage (DEH) (NSW) (2012b). Greenhood Orchid Profile: viewed online: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10698

Department of Environment and Heritage (DEH) (NSW) (2012c). Austral Toadflax Profile: viewed online: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10802

Department of Environment and Heritage Protection (DEHP) (2013). Herbrecs Database extract – January 2013. Queensland Herbarium, Queensland Government, Brisbane.

Department of Environment and Heritage Protection (DEHP) (2012a). Regional Ecosystem Digital Data Version 7.0. *Queensland Government*, Brisbane.

Department of Environment and Heritage Protection (DEHP) (2012b). Mature Regrowth Digital Data. *Queensland Government*, Brisbane.

Department of Environment and Heritage Protection (DEHP) (2012c). Wetland Info. http://wetlandinfo.derm.qld.gov.au/wetlands/factsfigures/FloraAndFauna/Species/macrozamia-machinii.html

Department of Environment and Resource Management (DEHP) (2012d). Wetland Info. http://wetlandinfo.derm.qld.gov.au/wetlands/factsfigures/FloraAndFauna/Species/eucalyptus-argophloia.html

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009). Weeping Myall Woodlands - EPBC Act policy statement 3.17 - Nationally threatened species and ecological communities.

Department of Environment, Water, Heritage and Arts (DEWHA) (2008). Matters of National Environmental Significance: Significant impact guidelines 1.1. *Australian Government.* Canberra.

DEWHA (2006). White Box – Yellow Box – Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands. EPBC Act Policy Statement. Online at http://www.environment.gov.au/epbc/publications/pubs/box-gum.pdf

Department of Agriculture, Forestry and Fisheries (DAFF) (2013) (Queensland Department of). Myrtle Rust Distribution Mapping. Queensland Government. Online at: http://www.daff.qld.gov.au/4790_19788.htm

Department of Sustainability, Environment, Water, Population and Communities (SEWPAC)(2013a). *Acacia curranii* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 13 Feb 2013.

Department of Sustainability, Environment, Water, Population and Communities (2013b). *Acacia handonis* in Species Profile and Threats Database, Department of the Environment, Water, Heritage and the Arts, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 13 Feb 2013.

Department of Sustainability, Environment, Water, Population and Communities (2013c). *Acacia wardellii* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 13 Feb 2013.

Department of Sustainability, Environment, Water, Population and Communities (2012a). Nationally Threatened Ecological Communities: Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and Southern Queensland, and Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin. Available online http://www.environment.gov.au/biodiversity/threatened/publications/pubs/bio237-0512-natural-grasslands-guide.pdf

Department of Sustainability, Environment, Water, Population and Communities (2012b). EPBC Act Environmental Offsets Policy . *Australian Government,* Canberra.

Department of the Environment, Water, Heritage and the Arts (2009). *Homopholis belsonii* in Species Profile and Threats Database*, Department of the Environment, Water, Heritage and the Arts*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed 2009-12-21T09:23:16.

Department of Natural Resources (Qld DNR) (2000). Species Management Manual. *Queensland Department of Natural Resouces.* Forest & Fauna Conservation and Ecology Section.

Department of Sustainability and Environment (DSE) (Victorian Government) (2003). Flora and Fauna Guarantee Action Statement – Austral Toadflax. Available online at: http://www.dse.vic.gov.au/__data/assets/pdf_file/0011/103241/056_Austral_Toad-flax_1994.pdf

Eddie, C (2007). Field Guide to Trees and Shrubs of Eastern Queensland Oil and Gas Fields. *Santos Ltd.*, Adelaide.

Environment Australia (2001b). Brigalow Regrowth and the Environment Protection and Biodiversity Conservation Act 1999. [Online]. *Environment Australia*, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/brigalow-regrowth.html.

Environment and Heritage Protection (Queensland Department of) (EHP) (2012a). Regional Ecosystem Digital Database. Version 7.0. August 2012.

Environmental and Heritage Protection (Queensland Department of) (EHP) (2012g). Regional Ecosystem Description Database (REDD). Version 7.0. August 2012.

Environment and Heritage Protection (Queensland Department of) (EHP) (2013). HERBRECS data Extract January, 2013.

Environment Protection Agency (2002). Biodiversity Planning Assessment Brigalow Belt South Flora Expert Panel Report. *Environmental Protection Agency,* Environmental Planning, South West District, October 2002.

Fensham, RJ 1998, 'The grassy vegetation of the Darling Downs, south-eastern Queensland, Australia: Floristics and grazing effects', Biological Conservation, vol. 84, pp. 301-310

Fensham, RJ 1999, 'Native grasslands of the central highlands, Queensland, Australia: Floristics, regional context and conservation', Rangelands Journal, vol. 21, pp. 82-103.

Fensham, R.J. and Fairfax, R.J. (1997) The use of the land survey record to reconstruct pre-European vegetation patterns in the Darling Downs, Queensland, Australia. *Journal of Biogeography* 24: 827-836.

Fletcher, R 2002, 'Ooline *Cadellia pentastylis* F.Muell.: a Survivor', *The Victorian Naturalist*, vol. 119, no. 5, pp. 235–236.

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

Forster, P (2004). 'The Cycads of Queensland – diversity and conservation', *Palms and Cycads*, no. 82, pp. 4–28.

Gardner P (2008) Austral Cornflower. Toowoomba Plants. Natives of the Region suitable for gardens. http://toowoombaplants2008.blogspot.com.au/2008/11/austral-cornflower.html

Goodland, A. (2000). Grassy ecosystem significant sites of the Darling Downs, Queensland. Locations and management recommendations. *WWF Australia*, Spring Hill.

Griffith, S.J. (1992). Recovery Plan: *Thesium australe*. Report submitted to the Australian Nature Conservation Agency, Endangered Species Program Project No. 196.

Halford, DA 1998, 'Eucalyptus virens, Species Management Profile', Species Management Manual, *Department of Natural Resources*, Brisbane.

Halford, D (1997a), '*Macrozamia machinii* Species Management Profile', Species Management Manual,*Department of Natural Resources*, Brisbane.

Halford, D (1997b), 'Eucalyptus argophloia Species Management Profile', Species Management Manual, *Department of Natural Resources*, Brisbane.

Halford, D (1995b). *Acacia handonis* Pedley (Mimosaceae) A Conservation Statement. *Australian Nature Conservation Agency* Program No. 482.

Halford, D (1995c), *Eriostemon sporadicus* Bayly (Rutaceae) A Conservation Statement, A report submitted to the *Australian Nature Conservation Agency* Endangered Species Program Project No. 482, by *Queensland Herbarium, Australian Nature Conservation Agency,* Canberra.

Halford D. (1996) Species Profile for *Calytrix gurulmundensis*. *Queensland Herbarium*, Brisbane

Halford D. (1995a) Species Profile for *Digitaria porrecta*. *Queensland Herbarium*, Brisbane

Halford, D (1995b). '*Digitaria porrecta* S.T.Blake (Poaceae) – Draft Recovery Plan', *Queensland Herbarium*, Brisbane.

Hando, V 2007, 'One of Australia's rarest wattles – *Acacia handonis'*, *Association of Australian Plant Growers.* Acacia Study Group Newsletter, no 99 (December), pp. 9-1

Harden, G.J. (Ed.) (1991). Flora of New South Wales, Volume Two, *University of NSW Press,* Kensington NSW.

Harden, G.J. (Ed.) (1993). *Flora of New South Wales, Volume Four*, University of NSW Press, Kensington, NSW.

Harden, G.J., McDonald, W.J.F. & Williams, J.B. (2006), Rainforest trees and shrubs: a field guide to their identification in Victoria, New South Wales and subtropical Queensland using vegetative features, *Gwen Harden Publishing*, Nambucca Heads, NSW.

House, A. (1995). Fire Ecology in Queensland Native Forests - cuirrent status and new direction. *6th Queensland Fire Research Workshop*. Page(s) 86-96. Darling Downs Inst. Advanced Education, Toowoomba.

Jessup, LW 1984, 'Denhamia' in Flora of Australia, vol. 22*, Australian Government Publishing* Service, Canberra.

Jones, D.L. (1993). '*Pterostylis*', In Harden, G.J. (Ed.) Flora of New South Wales, Vol. 4, *University of New South Wales Press*: Sydney.

Jones, D.L. & Forster, P.I. (1994). 'Seven new species of *Macrozamia* from Queensland', *Austrobaileya*, vol. 4, no. 2, pp. 269–288.

Kahn, T.P. and Lawrie, B.C. (1987). Vine thickets of the inland Townsville region. In: *The rainforest legacy, Australian national rainforests study, volume 1,* Special Australian Heritage Publication Series No 7(1): 159-99.

Kanowski, D. (2005). *Philotheca sporadica* - A Conservation Project. *Urimbirra*. 10:4-5.

Keith, D. (2006).

Lester N. C. (2008). Woodland to Weeds. Southern Queensland Brigalow Belt. *CopyRight Publishing*, Brisbane.

Lithgow G. (1997). 60 Wattles of the Chinchilla and Murilla Shires. Cranbrook Press, Toowoomba.

Martin J. (2011) A trip to northern NSW. Acacia Study Group Newsletter (Association for the Society of Growing Australian Plants) 113: 8

Maslin B. R. (2001) *Acacia curranii,* Flora of Australia 11B:pp 287-288. ABRS/CSIRO Publishing, Melbourne.

Maslin B. R. (2005). *Acacia lauta* - World Wide Wattle, viewed 26 May 2008, <http://www.worldwidewattle.com/ speciesgallery/lauta.php?id=23707>.

McDonald, W.J.F. (2010). National recovery plan for the "Semi-evergreen vine thickets of the

Brigalow Belt (North and South) and Nandewar Bioregions" ecological community. Report to Department of the Environment, Water, Heritage and the Arts, Canberra. *Queensland Department of Environment and Resource Management*, Brisbane.

Menkins, I. (1998). Draft Report for survey of *Homopholis belsonii* C.E. Hubb on the Darling Downs. Toowoomba and Region Environment Council Inc.

NSW Scientific Committee (2004). *Bothriochloa biloba* (a grass) - removal of vulnerable species listing, online at http://www.environment.nsw.gov.au/determinations/BothriochloaBilobaListingRemoval.htm>.

Norstog, K.J. and Nicholls, T.J. 1997. The Biology of the Cycads. *Cornell University Press*, Ithaca and London.

Orchard, A.E. & A.J.G. Wilson (eds) (2001). *Mimosaceae,* Acacia Part 1, vol. 11A, *Flora of Australia,* ABRS/CSIRO Publishing, Melbourne.

Pedley, L. (1978). A Revision of Acacia Mill. in Queensland. *Austrobaileya*. 1(2):75-234.

Pedley, L 1979, 'A revision of Acacia Mill in Queensland - Part 2', *Austrobaileya*, vol. 1, no. 3, pp. 235–337.

Pedley, L (1981). Further notes on Acacia in Queensland. *Austrobaileya*. 1(4):339-345.

Pedley, L. (1987). Acacias in Queensland. *Dept. of Primary Industries*, Brisbane.

Pi ckard, J. (1995a). *Acacia curranii* Maiden (Curly Bark Wattle) Recovery Plan. *Australian Nature Conservation Agency.*

Pickard, J. (1995b). Acacia curranii *Maiden (Curly Bark Wattle)* Research Plan. *Australian Nature Conservation Agency.*

Pickard, J. (1995c). *Acacia curranii* Maiden (Curly Bark Wattle) Conservation Research Statement. *Australian Nature Conservation Agency*.

Pollock A. B. (1997a). Species Profile for *Cadellia pentastylis*. *Queensland Herbarium*, Brisbane.

Pollock, A.B. (1997b). *Denhamia parvifolia*. Species Management Profile, June 1997 Flora and Fauna Information System. 2. *Qld Department of Natural Resources*, Brisbane.

QGC (2009). Environmental Impact Statement – Queensland Curtis LNG Project. Volume 3- Impacts of Gas Fields. *QGC Ltd, Brisbane*.

Queensland Herbarium. (2007). National Multi-species Recovery Plan for the cycads, *Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandroides, Macrozamia pauli-guilielmi* and *Macrozamia platyrhachis* Report to *Department of the Environment and Water Resources, Canberra. Queensland Parks and Wildlife Service*, Brisbane.

Quinn, F, Williams, JB, Gross, CL & Bruhl, J 1995, Report on rare and threatened plants of north-eastern New South Wales, *University of New England*, Armidale.

Sharp, D. & Simon, B.K. (2002), AusGrass: Grasses of Australia. CD-ROM, Version 1.0 (Australian Biological Resources Study, Canberra, and Environmental Protection Agency, Queensland).

Silcock, R.G. and Scattini, W.J. (2007) The original native pasture ecosystems of the eastern and western Darling Downs - Can they be restored? Tropical Grasslands, 41 (3). pp. 154-163.

Stanley, T.D. & E.M. Ross (1983). Flora of south-eastern Queensland. Volume One, Two and Three. *Qld Dept of Primary Industries,* Brisbane.

Stanley, T.D. & E.M.Ross (1989). *Flora of south-eastern Queensland. Volume Three*. Brisbane: Qld Department of Primary Industries.

Taylor, M.T. (1989). Fire in subtropical forest management. B.R Roberts and G.L. Unwin, eds. *4th Queensland Fire Research Workshop*. Page(s) 56-68. Darling Downs Inst. of Advanced Ed., Toowoomba.

Threatened Species Scientific Committee (2013a). Approved Conservation Advice for *Dicanthium queenslandicum* (king blue grass). [Online]. *Department of the Environment, Water, Heritage and the Arts.* Viewed 20/02/20213, Online at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=5481

Threatened Species Scientific Committee (2013b). Listing Advice for *Dicanthium queenslandicum* (king blue grass). [Online]. *Department of the Environment, Water, Heritage and the Arts.* Viewed 20/02/20213, Online at: http://www.environment.gov.au/cgi-in/sprat/public/publicspecies.pl?taxon_id=5481

Threatened Species Scientific Committee (2011a). *Approved Conservation Advice for Coolibah / Black Box Woodland of the Darling Riverine Plains and Brigalow Belt South Bioregion.* Online at http://www.environment.gov.au/biodiversity/threatened/communities/pubs/66-conservation-advice.pdf

Threatened Species Scientific Committee (2011b). *Commonwealth Listing Advice on Coolibah-Black Box Woodland of Darling Riverine Plains and Brigalow Belt South Bioregion.* Online at http://www.environment.gov.au/biodiversity/threatened/communities/pubs/66-listing-advice.pdf. Accessed 14/2/11.

Threatened Species Scientific Committee (2008a). Approved Conservation Advice for *Acacia curranii* (Curly-Bark Wattle). [Online]. *Department of the Environment, Water, Heritage and the Arts.* Viewed 20/02/20213, Online at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/24241-conservation-advice.pdf.

Threatened Species Scientific Committee (2008b). Approved Conservation Advice for *Acacia handonis* (Hando's Wattle). [Online]. *Department of the Environment, Water, Heritage and the Arts*. Viewed 20/02/2013, Online at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/24241-conservation-advice.pdf

Threatened Species Scientific Committee (2008c). Approved Conservation Advice for *Acacia wardellii*. [Online]. *Department of the Environment, Water, Heritage and the Arts*. Viewed 20/02/2013, Online at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/24241-conservation-advice.pdf.

Threatened Species Scientific Committee (2008d). Approved Conservation Advice for *Bothriochloa biloba* (Lobed Blue-grass). [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/24241-conservation-advice.pdf.

Threatened Species Scientific Committee (2008e). Approved Conservation Advice for *Cadellia pentastylis* (Ooline). [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/9828-conservation-advice.pdf.

Threatened Species Scientific Committee (2008f). Approved Conservation Advice for *Digitaria porrecta* (Finger Panic Grass). [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/9828-conservation-advice.pdf.

Threatened Species Scientific Committee (2008g). Approved Conservation Advice for *Homopholis belsonii*. [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/9828-conservation-advice.pdf.

Threatened Species Scientific Committee (2008h). Approved Conservation Advice for *Macrozamia plurinervia* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/9828-conservation-advice.pdf.

Threatened Species Scientific Committee (2008i). Approved Conservation Advice for *Microcarpaea agonis* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/64933-conservation-advice.pdf.

Threatened Species Scientific Committee (2008j). Approved Conservation Advice for *Philotheca sporadica* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/64944-conservation-advice.pdf.

Threatened Species Scientific Committee (2008k). Approved Conservation Advice for *Prostanthera sp. (*(Dunmore D. M. Gordon 8A) [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/56748-conservation-advice.pdf.

Threatened Species Scientific Committee (2008l). Approved Conservation Advice for *Pterostylis cobarensis sp.* (Cobar Green Orchid) [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/12993-conservation-advice.pdf.

Threatened Species Scientific Committee (2008m). Approved Conservation Advice for *Stemmacantha australis* (Austral Cornflower) [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/23949-conservation-advice.pdf.

Threatened Species Scientific Committee (2008n). Approved Conservation Advice for *Xerothamnella herbacea* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/4146-conservation-advice.pdf.

Threatened Species Scientific Committee (2008o). Approved Conservation Advice for *Acacia lauta* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/4165 -conservation-advice.pdf.

Threatened Species Scientific Committee (2008p). Approved Conservation Advice for *Eucalyptus argophloia* (Queensland White Gum) [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/19748 -conservation-advice.pdf.

Threatened Species Scientific Committee (2008q). Approved Conservation Advice for *Eucalyptus virens* [Online]. Department of the Environment, Water, Heritage and the Arts. Viewed Online at; http://www.environment.gov.au/biodiversity/threatened/species/pubs/10181 -conservation-advice.pdf.

Threatened Species Scientific Committee (2008r). Commonwealth Listing Advice on Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern *Queensland*. [Online]. Department of the Environment, Water, Heritage and the Arts. http://www.environment.gov.au/biodiversity/threatened/communities/pubs/88-conservation-advice.pdf

Threatened Species Scientific Committee (2008t). *Commonwealth Listing Advice on Weeping Myall Woodlands*. [Online]. Department of the Environment, Water, Heritage and the Arts. Online http://www.environment.gov.au/biodiversity/threatened/communities/pubs/98-listing-advice.pdf

Threatened Species Scientific Committee (2008u). *Commonwealth Conservation Advice on Weeping Myall Woodlands*. [Online] http://www.environment.gov.au/biodiversity/threatened/communities/pubs/98-conservation-advice.pdf

Threatened Species Scientific Committee (2008v). Conservation and Listing Advice - Yellow Box – Red Gum Grassy Woodland. [Online] http://www.environment.gov.au/biodiversity/threatened/communities/pubs/98-conservation-advice.pdf

Threatened Species Scientific Committee (TSSC) (2001a). Commonwealth Listing Advice on Brigalow (Acacia harpophylla dominant and co-dominant). [Online]. http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=28

Threatened Species Scientific Committee (2001b). Commonwealth Listing Advice on Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions. [Online]. http://www.environment.gov.au/biodiversity/threatened/communities/sevt.html

Trémont, RM & Whalley, DB, 1993, Final Report for Survey for *Homopholis belsonii*, *Toowoomba and Region Environment Council Inc*, Toowoomba.

Tindale, M.D. & Kodela, P.G. (2001), *'Acacia curranii',* In: Orchard, AE & Wilson, AJG (Eds.), *Flora of Australia, vol. 11B*, ABRS/CSIRO Publishing, Melbourne, pp. 287–288.

Vallee, L., Hogbin, T., Monks, L., Makinson, B., Matthes, M. and Rossetto, M. (2004). Guidelines for the Translocation of Threatened Plants in Australia. 2nd edition. *Australian Network for Plant Conservation,* Canberra.

Vogler, W., Navie, S. Adkins, S., Setter, C. (2006). Use of fire to control parthenium weed. *Rural Industries Research and Development Corporation, Australian Government.* Canberra.

Wang, J 1996, '*Prostanthera* sp. (Dunmore D.M.Gordon 84), Species Management Profile', Species Management Manual, *Department of Natural Resources,* Brisbane.

Whelan, R.J. (2012). Whelan, R.J., Rodgerson, L., Dickman, C.R. & Sutherland, E.F. (in press) Critical life cycles of plants and animals: developing a process-based understanding of population changes in fire-prone landscapes. In: Bradstock, R.A., Williams, J. and Gill, A.M. (eds) *Flammable Australia: The Fire Regimes and Biodiversity of a Continent.* Cambridge University Press, Cambridge.

Williams K.A.W. (1979). Native Plants of Queensland. Volume 1.

Williams P., Collins E., Mason D., Prince J. and Anchen G. (2006) Variation in age at first flowering for seedlings of 15 fire-killed shrubs and trees on sandstone outcrops and sand plains in central and north-western Queensland. *Ecological Management & Restoration 7,* 61–63.

Yu, P., Prakash, N. & Whalley, R.D.B. (2003) Sexual and apomictic seed development in the vulnerable grass *Bothriochloa biloba*. *Australian Journal of Botany* **51**:75-84

APPENDIX D. MNES Assessments - Significant Fauna Species

Collared delma (*Delma torquata*)

Status: EPBC Act: Vulnerable; **NC Act**: Vulnerable; **BoT:** High

Sensitivity: Extremely High

Recovery plan: Recovery plan for the collared legless lizard (*Delma torquata*) (Davidson 1993). The species is also included in the Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012 (Richardson 2006).

Plate 32. Collared delma (Delma torquata) (Mark Sanders Photograph)

Overview of Collared Delma

Ecology: Poorly known. Predominantly diurnal, the collared delma (*Delma torquata*) feeds on small arthropods and in captivity favours small cockroaches (S. Peck pers. comm.). It is also possible that subterranean termites will be part of the species' diet (Peck 2003). Movements are not well documented, but limited recapture data suggest that the species is highly sedentary, often repeatedly using the same rock shelter, but will abandon these shelter sites if they are disturbed (Porter 1998). It may therefore be possible for populations to be restricted to very small areas and be highly vulnerable to disturbance.

Habitat: The collared delma (*Delma torquata*) is typically associated with west-facing ridgelines with dry open sclerophyll and acacia woodlands with an open midstorey and a ground cover of native grasses, thick leaf litter and abundant loose rocks (Peck 2012b). It has also been recorded from semi-evergreen vine thickets (Ryan 2006) and from *Eucalyptus tereticornis* woodland and brigalow (*Acacia harpophylla*) without abundant rock (Wilson 2005; Peck 2012b). RE 11.3.2 could also be an important habitat for the species (Steve Wilson pers. comm). Individuals typically shelter under fallen debris (e.g., rocks, fallen timber, and leaf litter) but may be found below the ground surface or in soil cracks (Cogger 2000; Richardson 2006; Wilson and Swan 2008). Surface rocks are a significant habitat feature (Peck 2012b).

Distribution: The majority of records are from the western suburbs of Brisbane and the Toowoomba ranges in south-east Queensland. The species does also occur north to Blackdown Tablelands National Park and west to the Roma area in Brigalow Belt South (Peck 2012b).

Likelihood of occurrence and extent of habitat in the project development area: There are two known records of collared delma (*Delma torquata*) in the project development area[3], both approximately 43 km south-west of Millmerran State Forest 189 (12 km west of Wondul Range National Park). At least one of these specimens was from grey cracking clay with brigalow woodland (T. Reis pers. obs.). Other bioregional records from the Roma area have been from *Eucalyptus tereticornis* woodlands. Both these habitat associations appear atypical based on other records.

Figure A29 indicates the location of confirmed records of the species (derived from database records) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur 'absence suspected'. The extent of habitat within specific areas of the project development area is summarised within **Table A65**.

Table A65. Extent of habitat for collared delma (*Delma torquata*) within the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	456	4761	68640
3D Detailed Mapping Area**	0	1269	7200
3D Detailed Mapping Area based on EHP (2012)***	0	917	7330
Survey area 2****	0	0	347
Survey area 7 ****.	0	1	100
Survey area 8****.	0	2	813
Survey area 9****.	0	5	90
Survey area F****.	0	1	58

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The collared delma (*Delma torquata*) has apparently always been uncommon and there has not been a documented dramatic decline in numbers or substantial reduction in its distribution that can be attributed to a single threatening process (Peck 2012b). The main threats to the local populations of collared delma (*Delma torquata*) are likely to be:

[3] Wildnet (EHP's Wildlife Online database) records are not provided with location details and are not included for this or any other species. Such records may, however, be replicated through other sources such as the Queensland Museum and Birds Australia (Birdlife Australia) New Atlas databases.

- Inappropriate roadside management (Richardson 2006).
- Inappropriate fire regimes.
- Modification of habitat by invasion of exotic weed species, particularly *Lantana montevidensis* (BCC 2006; Peck 2012b).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Loss of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Collared delma (*Delma torquata*) populations can be restricted to very small areas, smaller than the minimum width required for gas gathering lines and access tracks. It is possible, therefore, that clearing activities could cause the local extinction of populations.
- The species appears to move only small distances, being largely sedentary. There is no known evidence of the species crossing artificial or disturbed surfaces and therefore gas gathering lines are likely to present a considerable barrier for collared delma (*Delma torquata*) movements.
- It is possible, although unlikely (see above), that some individuals could become trapped in open trenches, resulting in mortality.
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for this species. Considering the small extent of some populations, even small weed infestations could cause local extinctions.
- Human induced (deliberate or accidental) impacts could modify fire regimes, leading to changes in habitat structure and suitability.

Significance of project related impacts (unmitigated):.

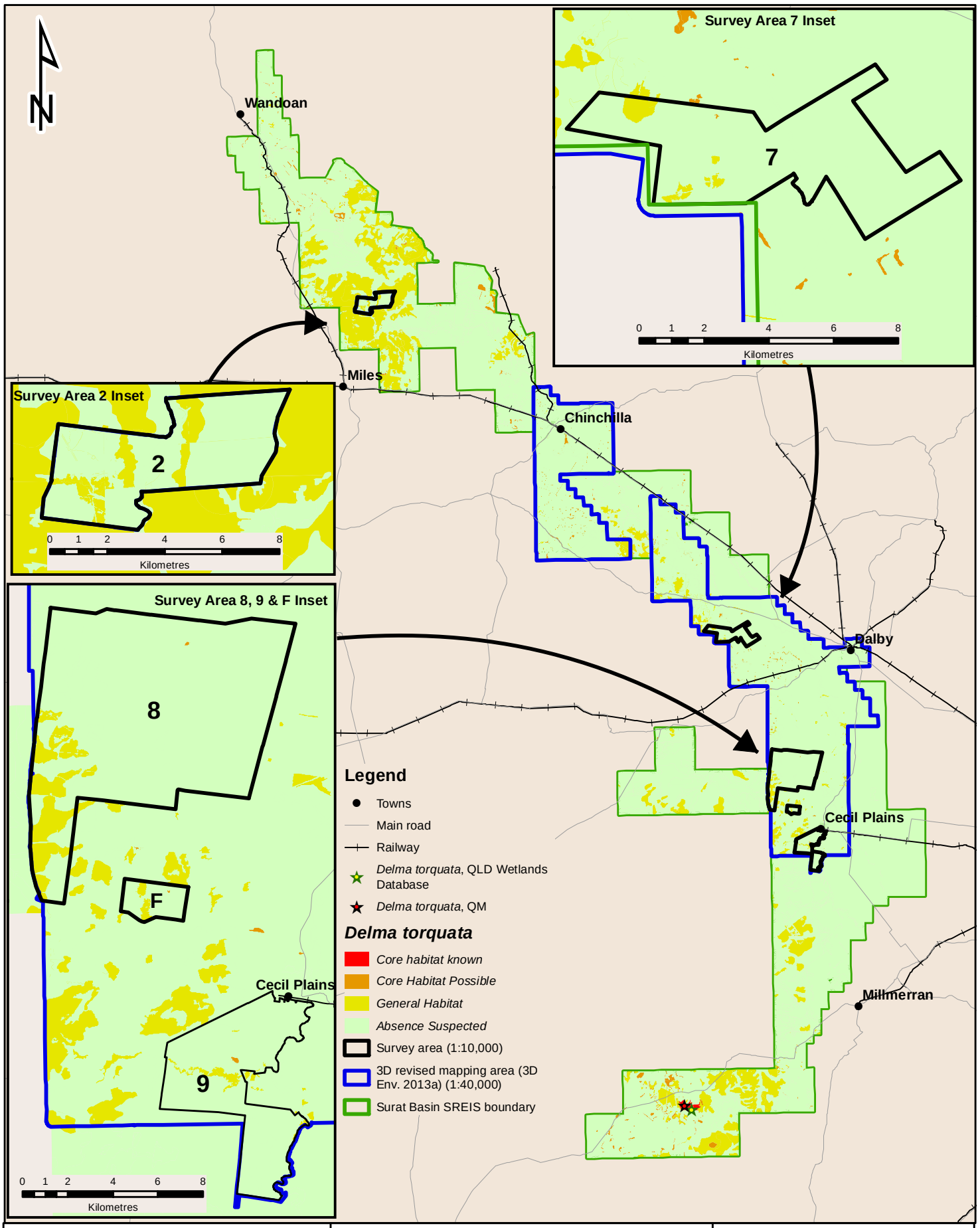
The species often occurs occurring in very small, restricted populations. Even minor disturbance such as road widening can have serious effects and therefore any clearing activity may cause extinction of a local population. The sensitivity of populations of collared delma *(Delma torquata)* is therefore considered ***Extremely High*** Records indicate that the species is much more common in the South-east Queensland bioregion and therefore project-related impacts are not expected to cause the widespread loss of this species. All known populations in the brigalow belt occur in habitats not typical to the species making predictions regarding its distribution difficult. Further, the collared delma (*Delma torquata*) is a small, secretive species that is easily over-looked. It is therefore feasible that unknown populations could be severely and unknowingly impacted and the magnitude of potential of unmitigated impact is considered ***Major***.

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A1**.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Major (25)*** significance to collared delma *(Delma torquata)* populations within the project development area. The avoidance of these populations will result in no residual impact being incurred. Mitigation measures such as trench clearing, rehabilitation and minimising clearing are likely to have only limited success in reducing possible impacts. Avoid areas of ´core habitat known‘and undertaking further survey work within areas of ‘core habitat possible’ that may require clearing to determine the presence of the species.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	High	Ext high (23)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

Figure A29. Collared delma *(Delma torquata)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for habitat mapping:

1. The entire regional ecosystem (RE) polygon of the two known records in the project development area is classed as ‘core habitat known.’
2. All remnant vegetation within a one km buffer of the two known records in the project development area is classed as ‘core habitat known’, regardless of RE type.
3. Within the Surat Gas Project area, REs on dark cracking clays with brigalow are classed as ‘core habitat possible’ (REs 11.3.1, 11.4.3, 11.9.5). This represents the species’ habitat based on records in the project development area. mature regrowth as per EHP 2012b is not included in the assessment.
4. Within the Surat Gas Project area, REs typically occurring on stony and rocky substrates (i.e., REs 11.7.2, 11.7.4, 11.7.7, 11.8.2, 11.8.3, 11.10.1, 11.10.1a, 11.10.1d, 11.3.2) are classed as ‘general habitat.’ This represents the species’ typical habitat preferences within south-east Queensland and includes REs identified by the Brigalow Belt Reptiles Workshop (2010).
5. Remaining REs should be classed as ‘absence suspected.’
6. Cleared agricultural and grazing land is classed as ‘absence suspected.’

For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
For both homogeneous and heterogeneous polygons with stony and rocky substrates, the habitat value refers only to those parts of the polygon that contain surface rocks.

Mapping confidence: Records from within the project development area occur well outside the species’ normal distribution. However, the species is known to occur in isolated populations, often hundreds of kilometres from its core distribution. Furthermore, these isolated populations often occur in atypical habitats. This makes predicting the species’ distribution and habitat *extremely* difficult. The map is considered to have a ***Low*** predictive accuracy.

Evaluation under MNES Referral Guidelines

Table A66. Evaluation of impact significance for collared delma (*Delma torquata*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	Significant populations, as defined by Peck (2003), are at sites where specimens have been recorded on two consecutive surveys, or multiple specimens were recorded on one survey. Minor populations are those at sites where only a single specimen or slough (shed skin) has been recorded and no further specimens are recorded on subsequent surveys. Many of the minor populations have only been surveyed once and may represent significant populations (Peck 2003). There are two known records of this species from the project development area, approximately 1.7 km apart, south-west of Millmerran. Based on current knowledge, the species appears to have a very marginal distribution in the project development area. In natural areas where there appears to be extensive habitat, the species appears to be restricted to small areas of habitat in the order of 100 m x 100 m (Peck 2003). Based on Peck (2003), the records within the project development area do not represent significant populations, though that may be due to a lack of survey effort or insufficient documentation of the number of individuals present. **Survey area 2**: Intensive field survey failed to locate this species. Some 'general habitat', regional ecosystems (REs) 11.7.4 and 11.7.7, is present. Generally, it is considered that survey area 2 is unlikely to support the species. **Survey area 7**: Some 'General Habitat', REs 11.3.2 and 11.10.1d, is present while RE 11.10.1 is mapped (DEHP mapping) for the property but not observed. Generally, this area is considered unsuitable for the species. **Survey area 8**: Some 'general habitat', REs 11.3.2 and 11.10.1d, is present. Areas within survey area 8 have similarities with the species typical habitat. **Survey area 9:** Some 'core habitat possible', RE 11.3.1, is present although it is fragmented, isolated and disturbed by grazing (sheep). Some 'general habitat', RE 11.3.2, is present. Habitats on survey area 9 do not appear likely to support the species. **Survey area F**: Some 'core habitat possible', RE 11.9.5, is present, although this is extremely limited in extent. Some 'general habitat', REs 11.7.4 and 11.10.1d, is present.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F**: All five properties have some REs classed as 'general habitat' for collared delma (*Delma torquata*). Survey area 9 and Survey area F also have some REs classed as 'core habitat possible.' There is no known population on these properties. It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance surveys will be required if development footprints include areas of mapped habitat. Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: Based on the assumption that this species is not present on the subject properties (Survey area 2, 7, 8, 9, F), impact of development is of extremely low magnitude and no significant impact under MNES criteria will be incurred. This assumption has not been tested by targeted survey work on survey area 7, 8, 9 or F. Works should be conducted prior to any clearing on survey area 7 and survey area 9 where habitats appear most suitable. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided and suitable surveys are undertaken in 'core habitat possible' followed by appropriate mitigation (if populations are found to be present), there is little potential for Arrow to contribute to the cumulative impacts associated with the activities of other proponents. Further, appropriate survey and mitigation should ensure that impacts are not unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed as 'core habitat known' or 'core habitat possible' should be avoided but if clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Initial visual assessment to determine if the appropriate habitat features are present, including:

- Abundant loose rocks (most important feature);
- Native grasses;
- Thick leaf litter;
- Open midstorey;
- West-facing ridgelines (non-essential).

- If suitable habitat is present, a combination of hand-searching under rocks and pitfall trapping should be undertaken.

The survey should be conducted between October and February and two surveys should be planned where practical. It is recognised that such surveys will be impractical for all activites, such those where a large number of well sites are proposed. In such cases, habitats representative of those to be impacted should be sampled rather than individual locations.

A lack of records from a single survey will not adequately demonstrate that the species is absent as the species typically has a very low capture rate even in areas that support large populations. For example, Porter (1998) found approximately one lizard per 150–200 rocks turned (or one lizard per 1.75 hours of searching). Significant populations, as defined by Peck (2003), are at sites where specimens have been recorded on two consecutive surveys, or multiple specimens were recorded on one survey. If more than one individual is recorded in a survey a follow up survey is not required. The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

However, even a single individual is sufficient for the location to be classed as 'core habitat known' and, should avoidance and a buffer then be implemented, a second survey is not required.
Despite its comparatively low success rate, hand-searching under rocks has been found to be more successful that pitfall trapping (e.g., Porter 1998; SEWPAC 2011) and should be the primary focus of the surveys. Details of pitfall trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

Brigalow scaly-foot (*Paradelma orientalis*)

Status: **EPBC Act**: Vulnerable (delisted April 29 2013); **NC Act**: Vulnerable; **BoT**: Medium

Sensitivity: Moderate

Recovery Plan: This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

Plate 33. Brigalow scaly-foot (Parade*lma orientalis*) (Photograph Angus McNab)

Overview of brigalow scaly-foot

Ecology: The brigalow scaly-foot (*Paradelma orientalis*) is known to shelter under logs, fallen bark and rocks and in leaf litter and grass tussocks (Ehmann 1992; Schulz and Eyre 1997; Peck 2012a). The species eats invertebrates such as crickets and spiders and plant material has been located in the scats of at least one individual. In addition, sap, particularly from *Acacia* species, constitutes a significant proportion of this species' diet in at least one population. Breeding occurs in spring/summer when two eggs are laid (Tremul 2000).

Habitat: The species occurs in land zones 3, 4, 5, 7, 8, 9 and 10 (SEWPAC 2013g) and in a correspondingly wide variety of habitats including woodlands dominated by brigalow (*Acacia harpophylla*) and other *Acacia* spp., spotted gum (*Corymbia citriodora*), poplar box (*Eucalyptus populnea*) and narrow-leaved ironbark (*Eucalytpus crebra*) forests and woodlands, dry sclerophyll forests on sandstone rises and areas of sparse tussock grass and spinifex (*Triodia mitchellii*) (Shea 1987; Schulz and Eyre 1997; Kutt *et al*. 2003). A dense mid-storey layer, such as of cypress pine (*Callitris* spp.), bulloak (*Allocasuarina luehmannii*) or *Acacia* spp., is often present (Kutt *et al*. 2003; Peck 2012a).

Being fossorial in habit, the brigalow scaly-foot (*Paradelma orientalis*) seems to be more prevalent in habitats that have few weeds and that consists of undisturbed ground surfaces with ground cracks and/or fallen debris and/or native tussock grasses. Most records occur in remnant habitats, but occasionally the species is recorded in young regrowth (two to three years old) (Kutt *et al*. 2003; M. Sanders pers. obs.) and weed infested habitats such as those dominated by buffel grass (*Cenchrus ciliaris*) (M. Sanders pers. obs.).

Distribution: The brigalow scaly-foot (*Paradelma orientalis*) is largely confined to the Brigalow Belt bioregion and, until recently, was thought to be endemic to Queensland (e.g., Tremul 2000; Richardson 2006). The species has now also been found in central inland New South Wales (Peck 2012a). In Queensland, it has been recorded from Ulcanbah Station 200 km southwest of Charters Towers in the north, near Goondiwindi in the south and Idalia National Park in the Mulga Lands bioregion to the west. It also occurs in the Southeast Queensland bioregion at Boyne Island near Gladstone (Schulz and Eyre 1997; Tremul 2000; Kutt et al. 2003; TSN 2008).

Likelihood of occurrence and extent of habitat in the project development area: There are eight known records of brigalow scaly-foot (*Paradelma orientalis*) known for the project development area. One record is from Chinchilla. The other seven records are all from south-west of Millmerran. There are also two recent survey records from north of Miles.

Figure A30 indicates the location of records of the species (derived from survey and database records) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A67**.

Table A67. Extent of habitat for brigalow scaly-foot (*Paradelma orientalis*) in the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	13703	162740	43359
3D Detailed Mapping Area**	444	21893	20820
3D Detailed Mapping Area based on EHP (2012)***	3458	40082	17309
Survey area 2****	444	806	914
Survey area 7 ****.	0	151	130
Survey area 8****.	0	2350	1240
Survey area 9****.	0	462	332
Survey area F****.	0	99	116

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The main threats to the local populations of brigalow scaly-foot (*Paradelma orientalis*) are:

- Habitat loss due to land clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Degradation of habitat through grazing of livestock (Cogger et al. 1993; Richardson 2006; EHP 2013).
- Predation by foxes (*Vulpes vulpes*), cats (*Felis catus*) and feral pigs (*Sus scrofa*) (Richardson 2006; TSN 2008; EHP 2013)
- Pasture improvement activities (Cogger et al. 1993).
- Inappropriate fire regimes (TSN 2008).
- Inappropriate roadside management (Richardson 2006; TSN 2008; EHP 2013).
- Death by humans due to misidentification with snakes and by being struck by vehicles (EHP 2013).

Project-related Impacts: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during vegetation clearing.
- Although the species is known to cross roadways and tracks, gas gathering and access tracks are likely to be less frequently crossed than areas with cover, reducing dispersal and movement.
- As the species is known to move across modified areas, it is highly probable that individuals could become trapped and perish in open trenches.
- Edge effects, particularly weed invasion (including buffel grass (Cenchrus ciliaris)), could significantly modify existing habitats and render them unsuitable for the species. As weed invasion resulting from clearing can extend some distance into previously unmodified habitats, this threat has the potential to alter large areas of potential or known habitat, reducing the abundance or extent of the species.
- Modified fire regimes resulting from increased human activity could affect habitat structure and therefore suitability for the species.
- Drowning or other mortality in steep-sided, plastic-lined dams.

Significance of project related impacts (unmitigated): The sensitivity of populations of brigalow scaly-foot (*Paradelma orientalis*) to unmitigated impacts within the project development area is considered ***Moderate***. The brigalow scaly-foot (*Paradelma orientalis*) may be found in a variety of habitats. Although it may be found in small fragments and areas with heavy weed infestation, it is typically located in larger remnant patches with an intact ground surface structure. Clearing within large tracts of habitat will result in the loss of some habitat, but is unlikely to significantly affect the long-term survival of populations in these areas.

The brigalow scaly-foot (*Paradelma orientalis*) is a mobile species and has been recorded crossing open roads, suggesting that, while movement may be reduced, some movements are likely to occur

across clearings < 60m in width. Gas acquisition pipelines and associated roadways may therefore have a moderate effect on movements. As the species may cross open gas acquisition pipelines, they are susceptible to trench death. This short-term impact may result in the capture of a number of individuals but is likely to be restricted in extent.

While clearing may be minor in the context of available habitat, weed invasion associated with disturbance has the potential to alter much larger tracts of vegetation. Weed invasion and other edge effects reducing the integrity of existing habitats do pose a threat to populations.

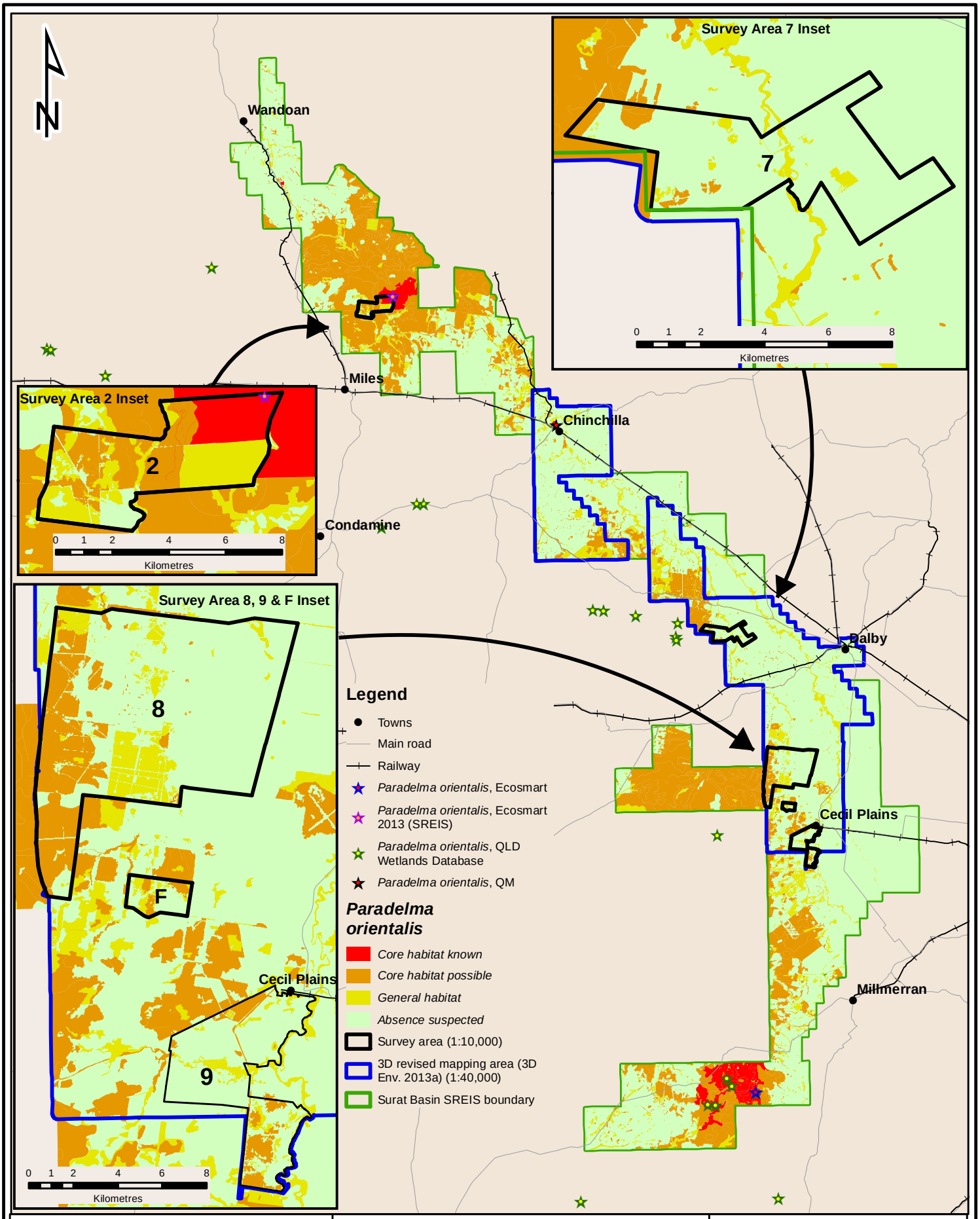
The magnitude of potential of unmitigated impact is considered ***Moderate***. The overall impact significance is ***Moderate* (13).**

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A1**. Infrastructure design and site selection that seeks to avoid core habitat known of brigalow scaly-foot will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Moderate (13)*** significance to brigalow scaly-foot (*Paradelma orientalis*) populations within the project development area. This species has broad habitat preferences and is widespread. Populations will therefore have some resilience to habitat disturbance. It is not anticipated that complete avoidance of suitable habitat will be possible, although minimising clearing should be a priority. Controlling impacts through rehabilitation and trench clearing will be beneficial and substantially reduce short-term and long-term impacts with residual impact of ***low (8).***

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Low (8)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Ecosmart 2013 (SREIS)
Ecosmart

Figure A30. Brigalow scaly-foot *(Paradelma orientalis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The known distribution of this species encompasses the entire project development area.
2. Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (confirmed locations) record in the area is classed as 'core habitat known.'
3. All contiguous remnant vegetation within a one km buffer of recent (1980+), accurate (with confirmed locations) records in the area is classed as 'core habitat known', regardless of RE type.
4. Within the Surat Gas Project area, the REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a and 11.10.1d are classed as 'core habitat possible' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
5. Patches of the REs listed above that are less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation are classed as 'general habitat.'
6. Within the Surat Gas Project area, REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'general habitat' unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
7. REs 11.3.4, 11.3.14, 11.3.25, 11.3.26, 11.3.27b, 11.3.27d and 11.4.3a are classed as 'absence suspected' if less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation.
8. Regrowth vegetation (3+ years) within 200 m of remnant vegetation classed as 'core habitat possible' is considered to be 'general habitat.'
9. All mapped 'mature regrowth (EHP 2012b)' that includes RE attributed polygons is classed 'general habitat' for REs 11.3.1, 11.3.17, 11.3.18, 11.3.19, 11.4.3, 11.4.3b, 11.4.10, 11.4.12, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.5, 11.7.6, 11.7.7, 11.9.1, 11.9.4a, 11.9.4b, 11.9.5, 11.9.6, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1 11.10.1a and 11.10.1d unless less than 10 ha in extent and greater than 200 m from a larger area of remnant vegetation. Ground-truthing of mature regrowth may result in it being elevated to 'core habitat possible.'
10. Cleared agricultural and grazing land is classed as 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present. For rules 4 to 9, these are applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

Mapping Confidence: This species has very broad habitat requirements and may be found in a large number of regional ecosystems. As the species' distribution is more easily predicted based on *ground*

strata condition, prediction based only on aerial mapping is difficult. Unless evidence suggests otherwise, most areas of remnant vegetation should be considered as possible habitat.
The map is considered to have a ***Moderate*** predictive accuracy.

Evaluation under MNES Referral Guidelines

Table A68. Evaluation of impact significance for brigalow scaly-foot (*Paradelma orientalis*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	Important populations of brigalow scaly-foot (*Paradelma orientalis*) occur in large contiguous areas of suitable remnant vegetation, such as the Central Queensland sandstone rises, the Blackwater/Blackdown Tablelands, the Moura/Theodore region and Boyne Island. Such areas of remnant vegetation are considered important strongholds for the species. Any populations found in such habitats are, therefore, important (Brigalow Belt Reptiles Workshop 2010). There are eight known records of brigalow scaly-foot (*Paradelma orientalis*) known for the project development area. One record is from Chinchilla and the other seven records are all from south-west of Millmerran. There are also two recent survey records from north of Miles. **Survey area 2**: Field surveys trapped two individuals of this species. The species could occur in all remnant and regrowth (3+ years old) vegetation on the property. This vegetation is part of a large contiguous area of suitable remnant vegetation and, as such, these records indicate that all remnant and regrowth vegetation on the property should be considered to support an 'important population' of brigalow scaly-foot (*Paradelma orientalis*) based on the above definition. **Survey area 7**: Some 'core habitat possible, regional ecosystems (REs) 11.9.7, 11.9.9 and 11.10.1d, is present. In particular, areas of these habitats in the west of the property are connected too much larger tracks of vegetation in the adjacent State Forest, and therefore have greater potential to provide habitat for this species. **Survey area 8**: Some 'core habitat possible, REs 11.5.1, 11.5.1a, 11.5.20 and 11.7.4, is present. Habitat structure and conditions in many areas of remnant vegetation on survey area 8 look highly suitable for this species, and is connected too much larger tracks of vegetation in the adjacent State Forest. **Survey area 9**: Some 'core habitat possible', REs 11.3.1, 11.3.18, 11.5.1, 11.5.1a and 11.9.9, is present. Areas of these REs with a dense ground-cover of grass and fallen debris is not consistent with ideal habitat while locations such as RE 11.5.1 in the very north (adjacent Cecil Plains-Tara Rd) and south (adjacent Millmerran-Cecil Plains Rd) have microhabitats consistent with good habitat. **Survey area F**: Some 'core habitat possible', REs 11.3.18, 11.7.4, 11.9.5, 11.9.9 and 11.10.1d, is present. Generally, these habitats appear less suitable for the species.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2**: Survey records indicate that all remnant and regrowth vegetation on the property should be considered to support an important population of brigalow scaly-foot (*Paradelma orientalis*). Clearing of these areas will lead to a decrease in the size of an important population, although these impacts are expected to be localised and not lead to a significant long-term decrease of the broader population. Under Criteria 1, a significant impact to brigalow scaly-foot is expected based on an assumption that core habitat known or core habitat possible will be impacted. **Survey area 7, 8, 9, F**: All four properties have some REs classed as 'core habitat possible' for brigalow scaly-foot (*Paradelma orientalis*). There is no known population for these properties. Should a population be present on survey area 9 and F, the small size and isolation of the suitable habitat would, in most cases (i.e., not including the northern patch of 11.5.1 on survey area 9, which is near contiguous with habitat to the north of the Cecil Plains-Tara Rd), preclude it being considered an 'important population' based on the Brigalow Belt Reptiles Workshop (2010). It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance surveys will be required if project footprints impact on remnant vegetation. Based on current knowledge of habitat and distribution, an 'important population'

Criteria	Evaluation
	is not present on the properties, hence no long term decrease in population size will occur due to project activities. For Survey areas 7, 8, 9 and F, significant impacts are not expected assuming that pre-clearance survey is undertaken and potential habitats are avoided during development.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2**: The project could reduce the area of occupancy of an important population. The impact will however be discrete and not affect habitat in the broader area. Under Criteria 2, a significant impact to brigalow scaly-foot is expected based on an assumption that core habitat known or core habitat possible will be impacted. **Survey area 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2:** Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. The project will not fragment an existing important population if the species occurs in the contiguous habitat beyond the boundaries of survey area 2. Under Criteria 3, a significant impact is not expected in survey area 2. **Survey area 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2:** The project will result in the loss of habitat. However, these impacts will be discrete and localised; other habitats in the surrounding area will not be affected. It is therefore unlikely that activities on survey area 2 will affect habitat critical to the survival of the species in the broader area. Under Criteria 4, a significant impact is not expected in survey area 2. **Survey area 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2:** While the project will affect breeding within survey area 2, it is unlikely to affect breeding within the broader population. Under Criteria 5, a significant impact is not expected in survey area 2. **Survey area 7, 8, 9, F:** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2:** While the project could modify, destroy, remove, or decrease habitat for this species within survey area 2, these impacts are likely to be restricted to survey area 2 and at most the immediate area. It is unlikely that development on survey area 2 will lead to a decline of the species across its broader distribution. Under Criteria 6, a significant impact is not expected in survey area 2. **Survey area 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F** Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2:** Based on Criteria 1, broadscale clearing of survey area 2 does not comply with Recovery Objective 1 of the *Draft Queensland Brigalow Belt Reptile Recovery Plan* (Richardson 2006) and could interfere with the recovery of the species. Under Criteria 9, a significant impact to brigalow scaly-foot is expected due to actions which are contrary to the species recovery plan, assuming areas of core habitat known or core habitat possible is to be impacted.

Criteria	Evaluation
	Survey area 7, 8, 9, F: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions:

***Survey area 2*:** Based on current population knowledge, impacts are significant under MNES guidelines for actions on survey area 2. Clearing of remnant and regrowth vegetation on survey area 2 will lead to a decrease in the size and extent of an important population and hence significant impact to brigalow scaly-foot (*Paradelma orientalis)* is expected under Criteria 1 and 2. This assumes that development activities will impact on areas of core habitat known or core habitat possible. The proposed actions are also contrary to objectives of the reptile recovery plans for the Brigalow belt bioregion (Richardson 2006) and hence significant impacts could potentially occur under Criteria 9. Significant impacts are not expected under other criteria.

Survey areas 7, 8, 9 and F: Based on the assumption that this species is not present on the subject properties (survey area 7, 8, 9 and F), impact of development is of extremely low magnitude and impacts under MNES criteria area not considered significant This assumption has not been tested by targeted survey work and pre-clearance works should be conducted prior to any clearing on these survey survey areas. The potential for significant impacts under MNES criteria should be reconsidered once detailed survey works have been completed.

Arrow impacts in survey area 2 will be localised in extent and not likely to lead to the long-term decline, or reduce viability, of the broader population. Provided appropriate rehabilitation works are undertaken following decomission, habitat areas have the potential for re-establishment and impacts are not therefore irreversible. Impacts on these descrete properties are not unknown or unpredictable, although the extent of cumulative impacts remain unclear.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed ‘core habitat possible’ should be avoided but, given the wide habitat use of the species, this is unlikely. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover dominated by native species, particularly tussock grasses;

- Fallen debris, i.e., timber, bark;
- Rocks (non-essential);
- Dense leaf litter (non-essential);
- Soil cracks (non-essential).

- Landscape interpretation, including:
  - Is the habitat part of contiguous remnant or mature regrowth at least 10 ha in size;
  - If less than 10 ha, is the habitat within 200 m of a large area of contiguous remnant vegetation of suitable regional ecosystems for the species;
  - If less than 10 ha, is the habitat part of a EHP mapped discontinuous wildlife corridor of State or regional significance.

If suitable habitat and landscape features are present, the following survey methods should be deployed:

- Actively search suitable microhabitat.
- Pitfall traps.
- Funnel traps.
- Spotlight on warm nights (Brigalow Belt Reptiles Workshop 2010).
- Spotlight sap-exuding Acacia species (SEWPAC 2011).

Details of pitfall and funnel trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Trapping should be supplemented with active searching and spotlighting. A single survey conducted over four trap nights during October to February should be sufficient, provided ground temperatures are generally above 19^{o}C and preferably above 24^{o}C (SEWPAC 2011). Multiple surveys with good spatial and habitat representation may be required in very large habitat patches. It is recognised that such surveys will be impractical for all activites, such those where a large number of well sites are proposed in close proximity. In such cases, habitats representative of those to be impacted should be sampled rather than individual locations.

Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

Important populations of brigalow scaly-foot (*Paradelma orientalis*) occur in large contiguous areas of suitable remnant vegetation. Such areas of remnant vegetation are considered important strongholds for the species. Any populations found in such habitats are, therefore, important (Brigalow Belt Reptiles Workshop 2010).

If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

Five clawed worm-skink (*Anomalopus mackayi*)

Status: **EPBC Act**: Vulnerable; **NC Act**: Endangered; **BoT:** H

Sensitivity: Extremely High

Recovery plan: This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

Anomalopus mackayi is known as both the five clawed worm-skink (*Anomalopus mackayi*) and the long-legged worm-skink.

Plate 34. Five clawed worm-skink (*Anomalopus mackayi*) (Photograph Scott Eipper)

Overview of five clawed worm-skink

Ecology: Little is known of this species' biology, but it is adapted to burrowing and can be found under logs, rocks and in loose soil (Hobson 2012b), under clumps of slashed grass (T. Reis pers. obs.) and presumably in soil cracks (Ehmann 1992). Nothing is known of its breeding biology, except that it is an egg-laying species. Its diet is assumed to consist of small arthropods (e.g., insects, spiders). Captive animals remained beneath the upper surfaces of soil during the day, emerging only to capture mealworms from the surface.

No movement data has been recorded. The species has not been recorded crossing roadways or tracks; however, related species are known to occasionally cross open artificial surfaces. This suggests that the species, while very reluctant, may cross open ground for short distances.

Habitat: The five clawed worm-skink (*Anomalopus mackayi*) is found in open grasslands on heavy cracking soil (Wilson 2005) in areas with closely spaced tussock grass that may be prone to inundation (Ehmann 1992). Scattered eucalypts may be present or adjacent (Ehmann 1992; Cogger *et al*. 1993). It also occurs in open eucalypt woodland, cypress pine (*Callitris* spp.) woodland with a grassy groundcover and in grassland on loam or sandy soils (Hobson 2012b). Suitable habitats on the

Darling Downs remain a stronghold (Fitzgerald 1996; Hobson 2002; EPA 2003), particularly low (typically <40 cm) native grasslands with or without sparse trees and also derived native grasslands created by land clearing. In Queensland the species is now largely confined to relict roadside verges (Wilson 2005).

Distribution: The five clawed worm-skink (*Anomalopus mackayi*) has a small distribution, being confined to the eastern Darling Downs region of the southern Brigalow Belt in Queensland and the western slopes of the Great Dividing Range in north-east New South Wales (Richardson 2006; Hobson 2012b). Its range appears to have contracted eastwards (Cogger *et al*. 1993). Records in the past 20 years have come only from Oakey and the Dalby regions of Queensland, and from the Wallangra, Mungindi and Wee Waa regions of New South Wales. The Wallangra specimens link what were previously thought to be disjunct Queensland and New South Wales populations. Localities for museum specimens collected prior to 1970 include a number on the plains south and west of Moree, and as far west as Goodooga, New South Wales (SEWPAC 2013a).

Likelihood of occurrence and extent of habitat in the project development area: There are three known records of five clawed worm-skink (*Anomalopus mackayi*) known for the project development area. Two records from Dalby (to which the record may have been attributed based on it being the nearest town) and one from approximately 19 km east of Cecil Plains.

Figure A31 indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A 69**.

Table A69. Extent of habitat for five clawed worm-skink (*Anomalopus mackayi*) in the project development area and associated areas of assessment.

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	0	12703	0
3D Detailed Mapping Area**	0	7776	0
3D Detailed Mapping Area based on EHP (2012)***	0	7215	0
Survey area 7 ****.	0	16	0
Survey area 8****.	0	292	0
Survey area 9****.	0	125	0
Survey area 2, F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General threats to the species: The main threats to the local populations of five clawed worm-skink (*Anomalopus mackayi*) are:

- Habitat loss due to land clearing.
- Degradation of habitat through grazing of livestock, soil compaction and erosion due to grazing and/or ploughing.
- Loss of ground litter and other cover such as fallen timber, modification of habitat through agriculture and irrigation (Cogger et al. 1993; Richardson 2006; Hobson 2012b).
- Inappropriate fire regimes.
- Inappropriate roadside management.
- Weed invasion (Richardson 2006).
- Feral predators (SEWPAC 2013a).

Very little pristine native grassland now remains within its known range, and much of the area is heavily modified and regularly cropped (Fitzgerald 1996). A threatening process of ploughing bluegrass has also been noted (EPA 2003).

Project-related impacts: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Loss of suitable habitat, reducing the extent of populations. In cases where disturbance is extensive, local extinctions may occur.
- Fragmentation and isolation of previous contiguous or connected populations by gas gathering lines and access tracks.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Increased surface water leaking from gas bores may alter the soil structure, closing ground cracks and facilitating weed or exotic grass growth.
- Edge effects, particularly weed invasion, pose a significant threat to grasslands dominated by native species. Exotic species alter habitat structure, potentially rendering large areas unsuitable.

Significance of project related impacts (unmitigated): The sensitivity of populations of five clawed worm-skink (*Anomalopus mackayi*) to unmitigated impacts within the project development area is considered ***Extremely High***. Darling Downs grasslands remain the stronghold for this species in

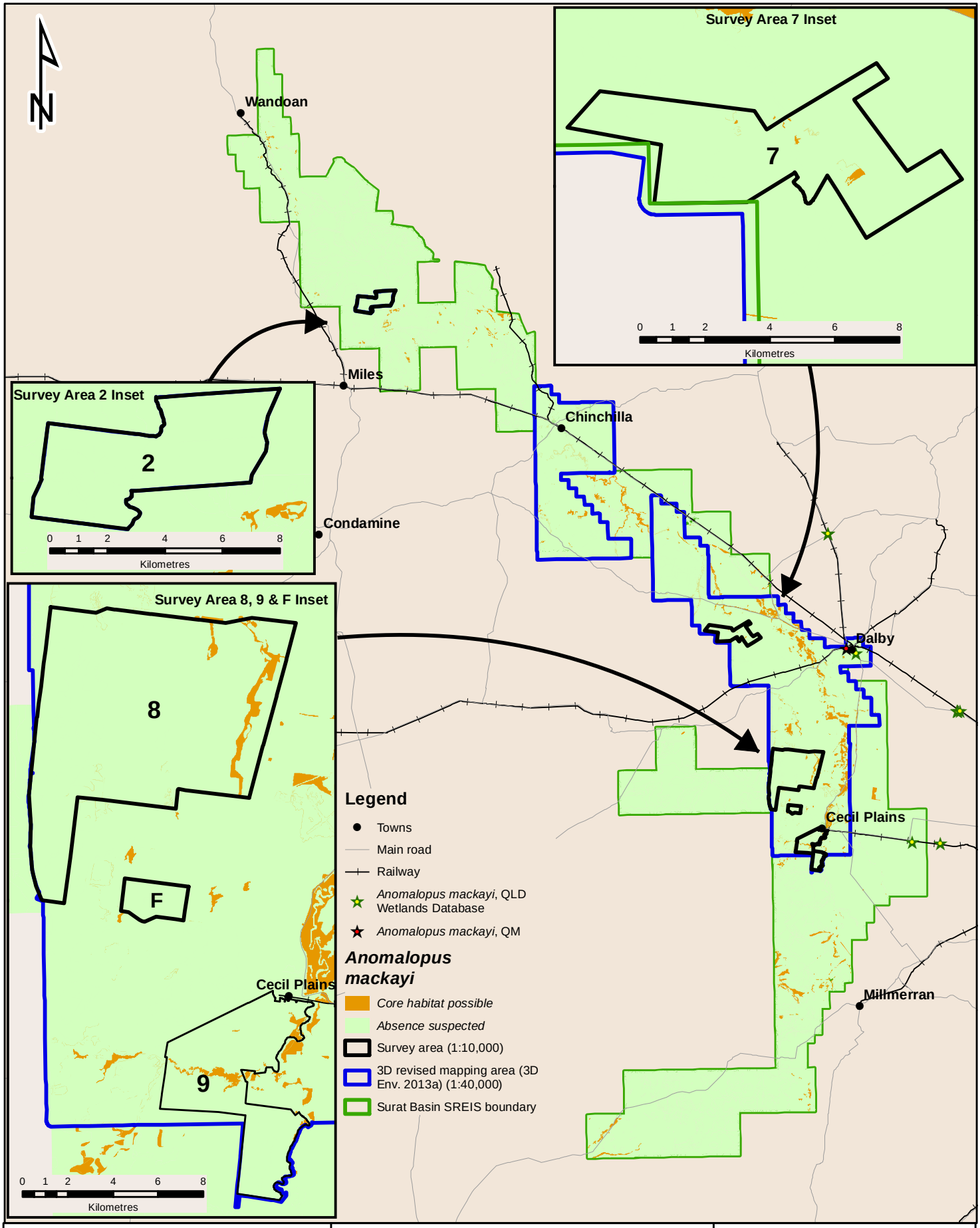
Queensland. However, remaining populations are restricted to minor fragments such as roadside reserves. Due to the minor extent and linear nature of these areas, even small clearing actions can have serious impacts. Remaining populations are highly important. Remnant grasslands are fragile communities and highly susceptible to disturbance and modification. Clearing, fragmentation, increased mortality due to trench deaths and weed invasion pose significant threats to the species and impact magnitudes could be ***Major***. In the absence of appropriate mitigation, the the impact significance to this species is ***Major* (25)** as populations may be lost and populations are unlikely to recover through remedial actions.

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of five clawed worm skink will be prioritised.

Summary Residual Impact Assessment: Unmitigated project related activities may result in impacts of ***Major (25)*** significance to five clawed worm-skink (*Anomalopus mackayi*) populations within the project development area. This species has a narrow distribution in Queensland and remaining stronghold populations within the Brigalow Belt are centred on grasslands in the Darling Downs. If potential habitats are avoided, no residual impact will be incurred. Other measures such as minimising disturbance, trench checking and weed control may achieve only limited success.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	High	Major (23)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

Figure A31. Long legged worm skink *(Anomalopus mackayi)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The species will not occur in the very northern portions of the project development area. It is therefore restricted to habitats south of 260 40' (26.6660).
2. Remnant grasslands and woodlands with native ground cover on dark cracking clays (regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.21, 11.3.24), and derived non-remnant native grasslands (veg code ARG) are classed as 'core habitat possible.' This includes attribution of mature regrowth datasets (EHP 2012b).
3. Any polygon of 'core habitat possible' containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known.'
4. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
5. Remaining regional ecosystems are considered to be 'absence suspected.'

Mapping confidence: This species' habitat requirements are relatively well understood and form a discrete set of regional ecosystems. Additional areas of 'core habitat known' are likely to be located with increased survey effort and regional understanding. The habitat map for this species is considered to be ***Highly*** accurate.

Evaluation under MNES Referral Guidelines

Table A70. Evaluation of impact significance for five clawed worm-skink (*Anomalopus mackayi*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	Important populations in Queensland occur where habitat remains throughout the species' known distribution on the Condamine River Floodplain: the region (including agricultural farming land) between Bowenville/Oakey, Pittsworth and Jimbour (Richardson 2006; Brigalow Belt Reptiles Workshop 2010). There are three known records of this species for the project development area, two from Dalby and one from approximately 19 km east of Cecil Plains. However, the records attributed to Dalby may be based on it being the nearest town, rather than the specimens actually being collected at Dalby. **Survey area 2**: Intensive field survey failed to locate this species. No 'core habitat possible' is present. Survey area 2 is north of the known distribution of the species. **Survey area 7**: Some 'core habitat possible', regional ecosystem (RE) 11.3.2 and derived non-remnant native grassland, is present. **Survey area 8**: Some 'core habitatp, REs 11.3.2 and 11.3.21 and derived non-remnant native grassland, is present. **Survey area 9**: Some 'core habitat possible', RE 11.3.2 and derived non-remnant native grassland, is present. **Survey area F**: No 'core habitat possible' is present.

Criteria	Evaluation
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F**: Survey area 2 has no habitat classed as 'core habitat possible' and is outside the known distribution of the species. Survey area F has no 'core habitat possible.' The species is not expected to occur on survey area 2 or survey area F based on a combination of known distribution and habitat requirements. Survey area 7, 8 and 9 have some REs and some derived grasslands classed as 'core habitat possible' for long-legged worm-skink. There is no known population for these properties, however further survey in these habitats is required. As such, it is not possible to totally discount occurrence of the species on the survey area 7, 8 and 9. Further survey on these properties will be required if suitable habitats are within proposed clearance zones. Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations on any of the five survey areas. Some small areas of suitable habitat (derived grasslands) are known from survey area 8 and 9, which should be the subject of survey if disturbance to these areas is expected. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' and 'core habitat possible' is not disturbed and appropriate pre-construction survey efforts are undertaken, broader project scale activities are unlikely to result in a significant impact and Arrow will not contribute to cumulative impacts associated with other proponents. Further, appropriate survey and mitigation should ensure that impacts are not unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed as 'core habitat known' are to be avoided and do not require survey work on this basis. Areas mapped as 'core habitat possible' should be avoided where possible. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation that the location is south of 260 40' (26.6660) and part of the Condamine River Floodplain.
- Confirmation that the location is remnant grassland or woodland with native ground cover on dark cracking clays (REs 11.3.2, 11.3.3, 11.3.21, 11.3.24), and derived non-remnant native grasslands (veg code ARG).
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Presence of native grasses;
    - Closely spaced grass tussocks;
    - Woody debris (non-essential);
    - Rocks (non-essential);
    - Clumps of slashed grass (non-essential).

If suitable habitat and landscape features are present, at least three of the following survey methods should be deployed:

- Actively search suitable microhabitat. Searching may not be possible where movable sheltering sites are not present.
- Establishment and monitoring of artificial shelter sites, such as hay bales, canite, particle boards and old carpet (Brigalow Belt Reptiles Workshop).
- Pitfall traps.

During dry periods, the five clawed worm-skink (*Anomalopus mackayi*) may be in deep soil cracks, which makes them difficult to find through active searching. The deployment and regular monitoring of artificial shelter sites is likely to be the most effective method of detecting the species as it is likely to shelter at or near the soil surface in such locations (Spark 2010, DEWSPaC 2011).
The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. The survey should be a minimum of three days and nights and should be replicated if unsuccessful (Brigalow Belt Reptiles Workshop 2010). If the patch of suitable

habitat is sufficiently large, a different location should be surveyed to achieve greater spatial representation. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations

Details of pitfall trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.
Important populations in Queensland occur where habitat remains throughout the species' known distribution on the Condamine River Floodplain: the region (including agricultural farming land) between Bowenville/Oakey, Pittsworth and Jimbour (Richardson 2006; Brigalow Belt Reptiles Workshop 2010). If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a significant population and work should not proceed without evaluation under MNES guidelines.

Yakka skink (*Egernia rugosa*)

Status: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable; **BoT:** Medium

Sensitivity: High

Recovery Plan: This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

Plate 35. Yakka skink (*Egernia rugosa*) (Photograph Mark Sanders).

Overview of yakka skink

Ecology: Yakka skinks (*Egernia rugosa*) live in communal burrow systems, often under timber and in deep rock crevices. The species also uses abandoned rabbit (*Oryctolagus cuniculus*) warrens and shelters in hollow logs. Burrows may be under buildings and other solid structures, such as concrete slabs and piles of felled timber (Ehmann 1992; Wilson 2005). Yakka skinks (*Egernia rugosa*) can occur in highly degraded sites especially where there are heaps of dead timber and rabbit warrens. The species may be more common than previously thought (EPA 2003). Yakka skinks (*Egernia rugosa*) eat soft plant material, invertebrates and small vertebrates and foraging occurs by day and on warm nights (Ehmann 1992). However, no detailed study on the distribution and ecology of this species has been published. They are secretive animals, retreating to their burrows when disturbed. Their presence is often indicated by their defecation sites (Eddie 2012).

Habitat: The species occurs in land zones 3, 4, 5, 7, 9 and 10, and possibly in land zone 8, though the latter is not considered to be representative of core habitat. Within these land zones it occurs in a wide variety of habitat types, particularly woodland and open forest dominated by brigalow (*Acacia harpophylla*), mulga (*A. aneura*), bendee (*A. catenulata*), lancewood (*A. shirleyi*), belah (*Casuarina cristata*), poplar box (*Eucalyptus populnea*), ironbark (*Eucalyptus* spp.), and white cypress pine (*Callitris glaucophylla*). Yakka skinks (*Egernia rugosa*) usually occur on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Ehmann 1992; Cogger 2000; Wilson 2005; Richardson 2006; Brigalow Belt Reptiles Workshop 2010) but are also found on loam and clay soils (Eddie 2012). The core habitat of yakka skink (*Egernia rugosa*) is within the Mulga Lands and Brigalow Belt South bioregions (TSN 2008).

Distribution: The yakka skink (*Egernia rugosa*) is endemic to eastern Queensland and is patchily distributed in sub-humid to semi-arid dry open forest, woodland and rocky areas. Its distribution is highly fragmented due to land clearing (SEWPAC 2012c). Isolated populations occur from St George north to Coen on Cape York Peninsula. In 2002, new populations were discovered in Culgoa Floodplain and Thrushton National Parks, and the species extends further west to Chesterton Range National Park (Richardson 2006).

Occurrence in the project development area and extent of habitat: There is no known record of yakka skink (*Egernia rugosa*) in the project development area. However, there are two records within proximity to the project development area, one approximatley 30 km to the south-west of Chinchilla (no date) and one 20km west of Chinchilla (1987). **Figure A32** indicates the location of confirmed records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table 71**.

Table A71. Extent of habitat for yakka skink (*Egernia rugosa*) in the project development area and associated areas of assessment.

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	0	20654	181559
3D Detailed Mapping Area**	0	3101	24720
3D Detailed Mapping Area based on EHP (2012)***	0	3634	23891
Survey area 7 ****.	0	231	35
Survey area 8****.	0	0	2016
Survey area 9****.	0	90	647
Survey area 2, F****.	0	228	1149

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The main threats to the local populations of yakka skink (*Egernia rugosa*) are:

- Habitat loss due to land clearing.
- Predation by foxes (*Vulpes vulpes*) and cats (*Felis catus*) (Drury 2001; Richardson 2006; TSN 2008).

- Trampling of burrows by livestock.
- Pasture improvement activities such as ploughing.
- Inappropriate fire regimes (Drury 2001).
- Ripping of rabbit warrens (TSN 2008).
- Removal of fallen timber and rocks.
- Inappropriate roadside management (Richardson 2006; TSN 2008).
- Mortality by being struck by vehicles (Drury 2001).

Potential project-related impacts: Impacts associated with the proposed project related activities could include:

- Loss of individuals during vegetation clearing. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- Wide infrastructure corridors with little cover may inhibit movement, leading to increased fragmentation of existing populations.
- Individuals may become trapped in open trenches, resulting in mortality.
- Creation and maintenance of gas gathering lines and access tracks may increase access to habitats for feral predators.
- Edge effects, particularly weed invasion, could significantly modify existing habitats and render them unsuitable for this species. Considering the small extent of some populations, even small weed infestations could have significant impacts.
- Drowning or other mortality in steep-sided, plastic-lined dams.

Significance of project related impacts (unmitigated): The sensitivity of populations of yakka skink (*Egernia rugosa*) to unmitigated impacts within the project development area is considered ***High***.
All known yakka skink (*Egernia rugosa*) records occur outside the project development area, although two occur within close proximity (≤ 30 km) and the the species' persistence within the area is unclear. The species is communal, meaning that the animals in any given area are likely to be concentrated in one location. Apparently minor disturbance such as road widening can have substantial impacts on a local population. The species is tolerant of some disturbance and provided adequate alternative habitat is available, is capable of recovery. The species is considered to be highly sensitive and impact magnitudes could be ***High***. This species has an unmitigated impact significance of ***High (21).***

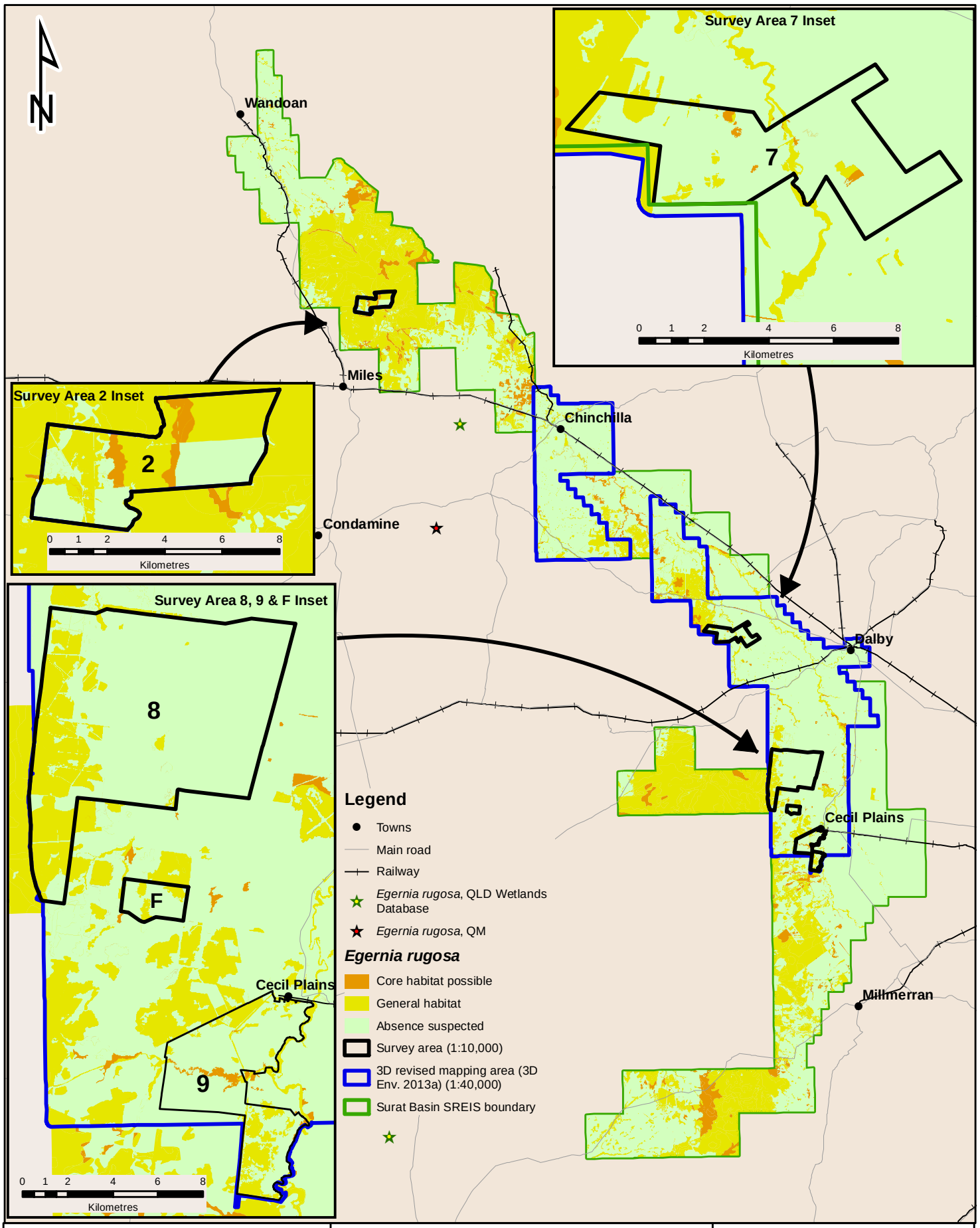
Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of yakka skink wattle will be prioritised.

Summary Residual Impact Assessment: Unmitigated project related activities may result in impacts of ***High (21)*** significance to yakka skink (*Egernia rugosa*) populations within the project development area. Avoiding habitat is the most effective mitigation measure for this species and no impact will be incurred. Where core habitat cannot be avoided, further survey work should be undertaken to

ascertain their presence and/or distribution. Important habitat for the species includes REs 11.3.2, 11.3.3, 11.3.14 and 11.7.7, though other regional ecosystems should not be discounted as possible habitat. Further survey work will allow the likely level of impact to be clarified. Other mitigation measures such as rehabilitation, translocation may have some success and resulting residual impact significance will be ***Moderate (12)***.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Low	Moderate (12)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

Figure A32. Yakka skink *(Egernia rugosa)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. Map regional ecosystems 11.3.2, 11.3.3, 11.3.14 and 11.7.7 as ‘core habitat possible.’
2. Map all other remnant vegetation on land zones 3, 4, 5, 7, 9 and 10 as ‘general habitat.’

Mapping Confidence: This species is poorly represented within the project development area. It is unlikely that the species will occur with any regularity and the map is considered to be of ***Low*** accuracy.

Evaluation under MNES Referral Guidelines

Table A72. Evaluation of impact significance for yakka skink (*Egernia rugosa*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	Important populations of yakka skink (*Egernia rugosa*) occur where colonies are identified or within five km of known records of the species. Any contiguous patch of vegetation suitable for the long-term persistence of a population, or for maintaining genetic diversity across the landscape, is important habitat for the species (Brigalow Belt Reptiles Workshop 2010). There is a no known record of this species from the project development area. **Survey area 2**: Intensive field survey failed to locate this species. Some 'core habitat possible', regional ecosystem (RE) 11.7.7, is present. **Survey area 7**: Some 'core habitat possible', REs 11.3.2 and 11.3.14, is present. However this property is well east of any known record and it seems unlikely the species will occur. **Survey area 8**: Some 'core habitat possible', RE 11.3.2, is present. However this property is well east of any known record and it seems unlikely the species will occur. **Survey area 9**: Some 'core habitat possible', RE 11.3.2, is present. However this property is well east of any known record and it seems unlikely the species will occur. **Survey area F**: No 'core habitat possible' is present. However this property is well east of any known record and it seems unlikely the species will occur.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F**: Survey area 2, 7, 8 and 9 all have some remnant vegetation classed as 'core habitat possible' for yakka skink (*Egernia rugosa*). There is no known record within five km of any of the five properties that would identify an 'important population.' It is not possible to totally discount occurrence of the species on the properties, although their occurrence on all but survey area 2 seems quite unlikely. Pre-clearance surveys on survey area 2 should be undertaken once project footprints have been identified. Based on current knowledge of habitat and distribution, an 'important population' is not present on the properties, hence no long term decrease in population size will occur due to project activities.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of yakka skink (*Egernia rugosa*) on any of the subject five properties. It also seems unlikely that the species could occur in most properties as all those except survey area 2 are well east of its known range. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and there is little potential for cumulative impacts to be reinforced by Arrow related activities. Further, appropriate survey and mitigation should ensure that impacts across survey areas and the broader SREIS assessment area are not unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Where areas classed 'core habitat possible' cannot feasibly be avoided, if clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. Yakka skinks (*Egernia rugosa*) usually occur on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Ehmann 1992; Wilson 2005; Richardson 2006) but are also found on loam and clay soils (Eddie 2012). Important habitat for the species includes regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.14 and 11.7.7, though other REs should not be discounted as possible habitat.

Survey work should include:

- Initial visual assessment to determine if several of the below habitat features are present:
    - Animal burrows, including rabbit (*Oryctolagus cuniculus*) burrows.
    - Hollow logs.
    - Cavities under or between rocks, logs, tree stumps and tree roots.
    - Log piles.
    - Deep gullies.

If suitable habitat features are present, the following survey methods should be deployed:

- Actively search for communal defecation sites (surveyors must be familiar with latrine sites as they may not be immediately obvious).
- Actively search for burrow systems.
- Elliott style box traps set close to burrow entrances or other suspected shelter sites such as hollow logs.
- Observation of potential shelter sites at a distance with binoculars.

The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. Optimal survey times for active searching are early morning (two hours either side of dawn) and during the evening on warm nights (Brigalow Belt Reptiles Workshop 2010). Minimum survey effort should be three survey days and nights. If the presence of the species is suspected but not confirmed, a second survey should be conducted. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations.

Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval. Important populations of yakka skink (*Egernia rugosa*) occur where colonies are identified or within five km of known records of the species. Any contiguous patch of vegetation suitable for the long-term persistence of a population is important habitat for the species (Brigalow Belt Reptiles Workshop 2010). If yakka skink (*Egernia rugosa*) is located then work should cease in all parts of any contiguous habitat. Evaluation under MNES guidelines will be required.

Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*)

Status: **EPBC Act**: Endangered; **NC Act**: Endangered; **BoT:** High
Sensitivity: Extremely High
Recovery Plans: *The Recovery Plan for the Grassland Earless Dragon* Tympanocryptis lineata pinguicolla *2000–2004* (Robertson and Cooper 2000). *National Recovery Plan for the Grassland Earless Dragon Tympanocryptis pinguicolla* (Robertson and Evans 2009). This species is also included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006) (as *T. pinguicolla*).

Plate 36 . Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) (Photograph Mark Sanders).

Alternative Nomenclature: EHP's Wildnet database refers to the species as Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). SEWPAC's Species Profile and Threats (SPRAT) Database refers to the species as grassland earless dragon (*Tympanocryptis pinguicolla*) but acknowledges that the Queensland (Darling Downs) population is more closely related to *Tympanocryptis tetraporophora* (SEWPAC 2013i) as per Melville *et al*. (2007). Melville *et al.* (2007) found that the Darling Downs population is not closely related to *Tympanocryptis pinguicolla*, but were unable to establish whether they are an undescribed species of *Tympanocryptis* or a population of *Tympanocryptis tetraporophora*. Given this taxonomic uncertainty this report will refer to the species as the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). Where the literature does not clearly differentiate between populations, reference will be made to grassland earless dragon.

Overview of Darling Downs earless dragon

Ecology: The few ecological studies undertaken of Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) in Queensland suggest that they are more prevalent in sorghum crops (average of 8.686 individuals per 100 trap-days) than grass verges (0.725/100 trap-days) or native grasslands (0.572/100 trap-days). Individuals predominantly shelter beneath sorghum litter (85.7%), but soil cracks are also used (9.5%) (Starr and Leung 2006).

Habitat: Unlike the southern grassland earless dragon (*Tympanocryptis pinguicolla*), the Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) is regularly recorded in sorghum crops, usually adjacent to native grassland verges that may be only minor in extent (Starr and Leung 2006).

These minor grassland areas may act as vital refugia when active farming of sorghum prevents inhabitation. Despite the use of crops, native grasslands (regional ecosystems 11.3.2 and 11.3.21) are listed as Essential Habitat for the Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) (EPA 2003). Native grasslands within the Darling Downs have been reduced to 1.34% of their original extent by 1993 (Fensham 1997). Remaining areas are typically located in stock routes and road reserves.

Distribution: Until 2001, the grassland earless dragon (*Tympanocryptis pinguicolla*) was known only from native grasslands around Cooma and Canberra. Historically, the species was also known from grasslands on the Darling Downs, Queensland. Undetected for more than 30 years despite survey efforts (Covacevich *et al.* 1998), the Darling Downs population was rediscovered in 2001 (Melville *et al.* 2007). It is now known from a handful of locations on the Darling Downs, all between Dalby, Toowoomba, Millmerran and Cecil Plains (Hobson 2002).

Likelihood of occurrence and extent of habitat in the project development area There is one known record of Darling Downs earless dragon (*Tympanocryptis cf. Tetraporophora*) in the project development Area, approximately 20 km east south-east of Cecil Plains. **Figure A33** indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A73**.

Table A73. Extent of habitat for Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) in the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	0	7727	0
3D Detailed Mapping Area**	0	7230	0
3D Detailed Mapping Area based on EHP (2012)***	0	3463	0
Survey area 7 ****.	0	1	0
Survey area 8****.	0	293	
Survey area 9****.	0	126	0
Survey area 2, F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a and 2012b) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General Threats to the Species: The main threats to the local populations of Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) are:

- Habitat loss caused by agricultural and urban development.
- Processes that modify and degrade remaining habitat including:
- Irrigation.
- Changed fire regimes.
- Changed grazing regimes.
- Invasion of weeds.
- Introduced animals (Cogger et al. 1993; Brereton and Backhouse 2003; Robertson and Evans 2006).

Darling Downs earless dragons (*Tympanocryptis cf. tetraporophora*) occur in crop paddocks on private property. In the absence of further information, existing cropping practices should be continued.

Project-related Impacts: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during construction. Depending on the extent of clearing, displaced animals are unlikely to persist due to increased competition with existing resident animals.
- Loss of habitat reducing the extent of populations, or in the cases where disturbance is extensive, causing local extinctions.
- Fragmentation and isolation of previous contiguous or connected populations by gas gathering lines and access tracks.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Increased surface water leaking from gas bores may alter the soil structure, closing ground cracks and facilitating weed or exotic grass growth.
- Edge effects, particularly weed invasion, pose a significant threat to grasslands dominated by native species. Exotic species alter habitat structure, potentially rendering large areas unsuitable.
- Drowning or other mortality in steep-sided, plastic-lined dams.

Significance of Project Related Impacts (Unmitigated): The sensitivity of populations of Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) to unmitigated impacts within the project development area is considered ***Extremely High***. This species possibly only occurs within the Darling Downs in Queensland (see Alternative Nomenclature above). The project development area includes a large portion of the western Darling Downs and the loss of populations in the area could have

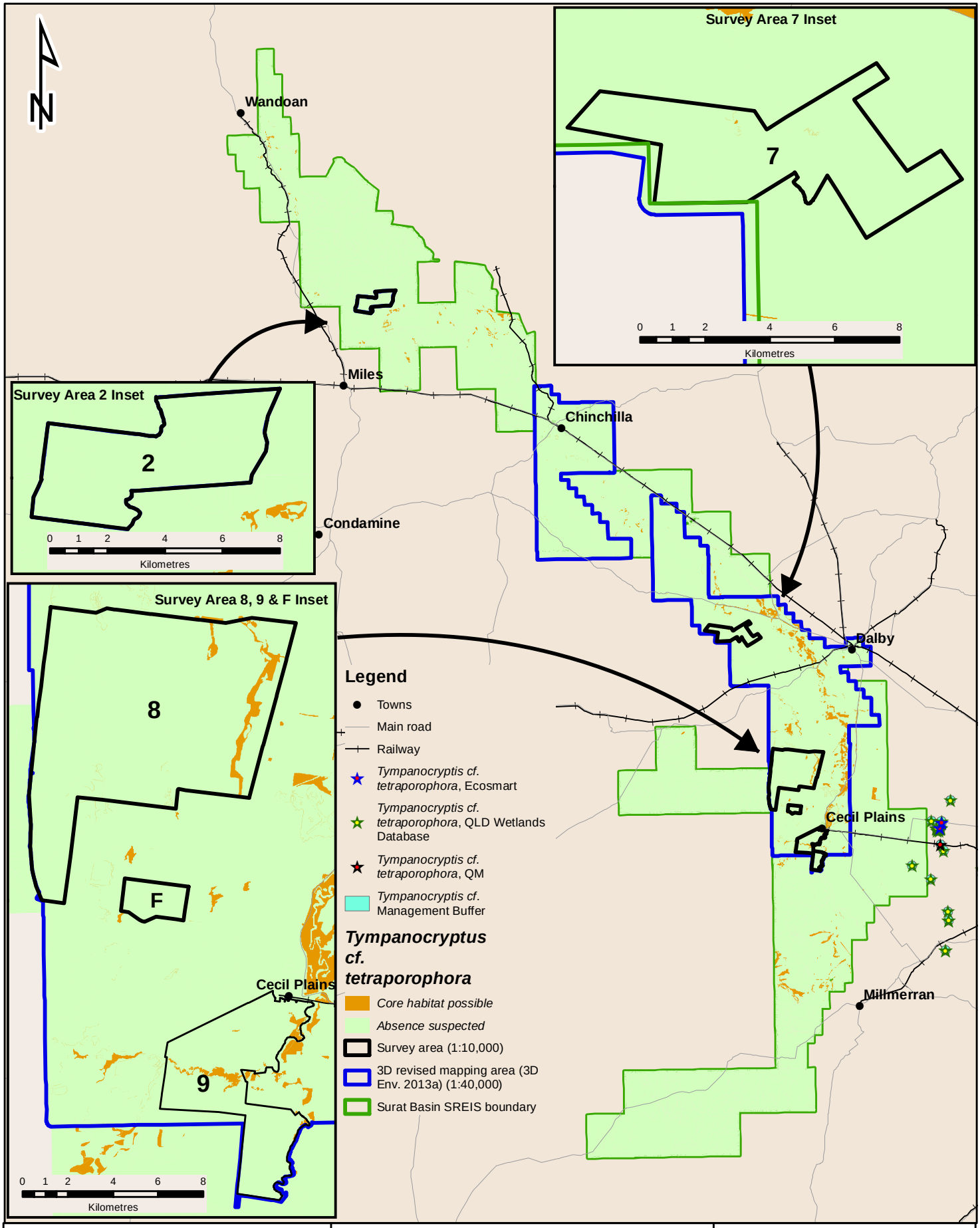
significant deleterious impacts on the overall survival of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*). The species occurs in small isolated populations making them susceptible to clearing. Movement of the species over artificial surfaces is not documented. However, the species inhabits modified sorghum fields suggesting that narrow gas gathering lines or access tracks are unlikely to create significant movement barriers. Any such willingness to move over disturbed ground places them at risk of becoming captured in trenches. Given the small extent of some populations, open trenches adjacent or through communities may affect a significant number of individuals. Native grasslands are particularly prone to weed infestation. Weed infestations can alter habitat structure, rendering previously suitable areas unsuitable. These factors indicate that impacts could have a ***High*** magnitude and the species has an impact significance of ***Major (23).***

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of Darling Downs earless dragon will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Major (23)*** significance to Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) populations in the project development area. Aoidance of 'core habitat known' or 'core habitat possible' is the most effective and efficient impact mitigation measure and if undertaken, no impact will be incurred. Other measures such as minimising disturbance, trench checking and weed control may achieve limited success.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Extremely High	NA	NA	High	Major (23)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Ecosmart

Figure A33. Darling Downs earless dragon *(Tympanocryptis cf. tetraporophora)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The species will only occur within the Darling Downs regions associated with the Condamine Floodplain (-27.00˚ to -28.00˚; 151.18˚ to 151.90˚).
2. All remnant grasslands and woodlands with native ground cover (regional ecosystems (REs) 11.3.2, 11.3.21, 11.3.24), and derived non-remnant grasslands dominated by native grasses are classed as 'core habitat possible.' A 100 m buffer around these communities regardless of land-use should be included as 'core habitat possible' for management purposes to account for the species ability to occur in tilled crops (e.g., sorghum).
3. All land, irrespective of land-use, within one km of a recent (1980+), accurate (± 500 m) record is treated as 'core habitat known.' This is represented and a 1 km management buffer as habitats such as cultivated paddocks are not likely to be subject to offset requirements.
4. All remaining areas are considered to be 'absence suspected.'

Mapping Confidence: The species is known to inhabit artificial land causing difficulties in using REs to predict its occurrence. Remaining populations are isolated and fragmented, further compounding predictions. However, survey work to identify remaining populations of this species has been undertaken by EHP on the Darling Downs. These surveys have added to the overall knowledge of the species' distribution. The habitat map for this species is considered to be of ***Moderate*** accuracy.

Evaluation under MNES Referral Guidelines

Table A74. Evaluation of impact significance for Darling Downs earless dragon (*Tympanocryptis cf. tetraporphora*) under MNES Guidelines.

Criteria	Evaluation
Populations of the species in the project development area.	All extant populations are extremely important for the survival of the species. All currently known and subsequently discovered populations should be considered in conservation strategies for this species (Robertson and Evans 2006). There is a single known record of this species from the project development area, approximately 20 km east south-east of Cecil Plains. The majority of known records lie further to the east. **Survey area 2**: Intensive field survey failed to locate this species. No 'core habitat possible' is present. Survey area 2 is north and west of the known distribution of the species. **Survey area 7**: Some 'core habitat possible', regional ecosystem (RE) 11.3.2 and derived non-remnant native grassland, is present. Survey area 7 is west of the known distribution of the species. **Survey area 8**: Some 'core habitat possible', REs 11.3.2 and 11.3.21 and derived non-remnant native grassland, is present. Survey area 8 is west of the known distribution of the species. **Survey area 9**: Some 'core habitat possible', RE 11.3.2 and derived non-remnant native grassland, is present. **Survey area F**: No 'core habitat possible' is present. Survey area F is west of the known distribution of the species.

Criteria	Evaluation
Criteria 1: lead to a long-term decrease in the size of a population.	**Survey area 2, 7, 8, 9, F**: Survey areas 2 and F have no habitat classed as 'core habitat possible' and are outside the known distribution of the species. Survey areas 7 and 8 have some 'core habitat possible' but are outside the known distribution for the species. Survey area 9 has some 'core habitat possible' and is on the western edge of the known distribution of the species. There is no known population on these properties. The species is not expected to occur on survey area 2 and F based on a combination of known distribution and habitat requirements. It is not possible to totally discount occurrence of the species on the survey area 7, 8 and 9. Pre-clearance survey will be required once project footprints have been identified. Based on current knowledge of habitat and distribution, a population is not present on the properties, hence no long term decrease in population size will occur due to project activities.
Criteria 2: reduce the area of occupancy of a population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of a population based on detail provided in Criteria 1.
Criteria 3: fragment an existing population into two or more populations.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of a population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease the availability of quality of habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) on any of the subject five survey areas. Some small areas of suitable habitat (derived grasslands) are known from survey area 8 and 9, although all properties are west of the species known range, and as such it seems unlikely that the species could occur. Targeted survey works focused on derived grasslands on survey area 8 and 9 should occur if disturbance of these areas is expected.

Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided, and adequate survey of 'core habitat possible' is undertaken prior to disturbance to evaluate the species presence (and subsequent

impacts), there is little potential for the cumulative impacts associated with Arrow activities to be reinforced. Further, appropriate survey and mitigation should ensure that impacts across survey areas and the broader SREIS project development area are not unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Core habitat possible should be avoided, these areas including critcally endangered native grasslands. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken.

Darling Downs earless dragons (*Tympanocryptis cf. tetraporophora*) are only found on the Condamine flood plain (-27.00° to -28.00°; 151.18° to 151.90°) in, or within proximity to (including on tilled land), remnant grasslands (REs 11.3.2, 11.3.21, 11.3.24) and derived non-remnant native grasslands (veg code ARG). Works outside this area, or not within 100 m of a remnant grassland, need not consider this species.

If works are to coincide with the above parameters, the following survey methods should be deployed:

- Pitfall trapping using several arrays of 10L buckets.
- Actively search using an endoscope of spider burrows for sheltering individuals.
- The creation and monitoring of artificial burrows using:
- PVC tubing inserted near vertically into the ground with the opening level the ground surface. An inner tube is placed into this to allow the removal of sheltering individuals.
- A metal roof is placed over each trap to shelter animals from sun and rain, increasing the value of these as sheltering opportunities for the species.
- Ground cover vegetation is slashed within one meter of the artificial burrow to improve visibility of the burrow for dragons.
- Active searching using binoculars of habitats in a systematic grid during the morning period (7am-9am).

The species is more likely to be detected when conditions are warm, not too dry and maximum temperatures are greater than 25°C. Optimal survey times for active searching are early morning. Minimum trap effort should include four days and nights trapping. If the presence of the species is suspected but not confirmed, a second survey should be conducted. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

All extant populations of the Darling Downs earless dragon (*Tympanocryptis cf. tetraporophora*) are significant populations. If the dragon is located, work should seas and evaulation under MNES guidelines will be required.

Dunmall's snake (*Furina dunmalli*)

Status: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable **BoT:** Medium

Sensitivity: Moderate

Recovery Plan: This species is included in the *Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012* (Richardson 2006).

Plate 36. Dunmall's snake (*Furina dunmalli*) (Photograph Mark Sanders)

Overview of Dunmall's snake

Ecology: Dunmall's snake (*Furina dunmalli*) is a nocturnal, cryptic, secretive species that is possibly genuinely scarce and very rarely encountered (Wilson 2005; Hobson 2012a). The species has been found sheltering under fallen timber and ground litter (Cogger *et al*. 1993; Brigalow Belt Reptiles Workshop 2010) and may use cracks in alluvial clay soils (Ehmann 1992). Little is known of its ecology, but it reportedly preys on lizards and geckos (Gow and Swanson 1977; Shine 1981). Nothing is known of its breeding biology other than that it lays eggs (Wilson and Swan 2010).

Habitat: The species has been found in a wide range of habitats, including forests and woodlands dominated by brigalow (*Acacia harpophylla*) and other acacias (*A. burowii*, *A. deanii*, *A. leioclyx*), cypress (*Callitris* spp.) or bulloak (*Allocasuarina luehmannii*) on black alluvial cracking clay and clay loams (Covacevich *et al*. 1988; Stephenson and Schmida 2008; Brigalow Belt Reptiles Workshop 2010; Hobson 2012a). It also occurs in spotted gum (*Corymbia citriodora*), ironbark (*Eucalyptus crebra* and *Eucalyptus melanophloia*), white cypress pine (*Callitris glaucophylla*) and bulloak open forest and woodland on sandstone-derived soils and there is a record from the edge of dry vine scrub (Stephenson and Schmida 2008, TSN 2008; Brigalow Belt Reptiles Workshop 2010). However, preferred habitat appears to be brigalow growing on cracking black clay and clay loams (Cogger *et al*. 1993), with the majority of records from between 200 to 500 m above sea level (Hobson 2012a).
Distribution: Dunmall's snake (*Furina dunmalli*) is confined to the Brigalow Belt bioregion of south-eastern Queensland and north-eastern New South Wales, occurring north to Clermont and near Rockhampton. Most records are from the Dalby-Tara area of the Darling Downs (Hobson 2012a).

Occurrence in the project development area and extent of habitat: There is no known record (post 1979) of Dunmall's snake (*Furina dunmalli*) in the project development area. **Figure A34.** indicates the location of records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A75**.

Table A75. Extent of habitat for Dunmall's snake (*Furina dunmalli*) in the project development area and associated areas of assessment.

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	0	7727	0
3D Detailed Mapping Area**	0	7230	0
3D Detailed Mapping Area based on EHP (2012)***	0	3463	0
Survey area 7 ****.	0	1	0
Survey area 8****.	0	293	
Survey area 9****.	0	126	0
Survey area 2, F****.	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General Threats to the Species: The rarity and secretive nature of Dunmall's snake (*Furina dunmalli*) means that it is not known if it has actually declined in numbers, though records suggest a decline in eastern parts of its range. Its distribution, however, is confined to the Brigalow Belt bioregion, an area that has been highly modified for agriculture, the timber industry, natural gas and coal extraction and urban development. Much of its habitat has been cleared or fragmented, particularly in its core area on the Darling Downs (Hobson 2012a). The main threats to the local populations of Dunmall's snake (*Furina dunmalli*) are thought to be:

- Predation by feral animals.
- Pasture improvement practices.
- Livestock grazing.

- Inappropriate roadside management, because much of its core habitat now only exists as linear fragments along roads and in stock routes (Richardson 2006; Hobson 2012a).

Other possible threats include loss of fallen timber and ground litter (e.g., fuel reduction burns, firewood collection), weed invasion and drainage of swamps (SEWPAC 2013d).

Project-related Impacts: Impacts associated with the proposed project related activities could include:

- Death or injury of individuals during construction. Those displaced by clearing may face increased competition with nearby existing resident animals.
- Loss of habitat, which may reduce population extent.
- While the species is known to cross roads and tracks, it is not known if movement frequency is reduced by these structures. The construction of gas gathering lines and access tracks could affect movement.
- Increased mortality due to captured individuals in open trenches passing through or adjacent to existing habitats.
- Modified fire regimes from increased human activity can cause mortality and lead to long-term changes in vegetation/habitat structure.
- Edge effects, particularly weed invasion, may alter the ground surface structure of existing habitats, rendering large areas unsuitable.
- Drowning or other mortality in steep-sided, plastic-lined dams.

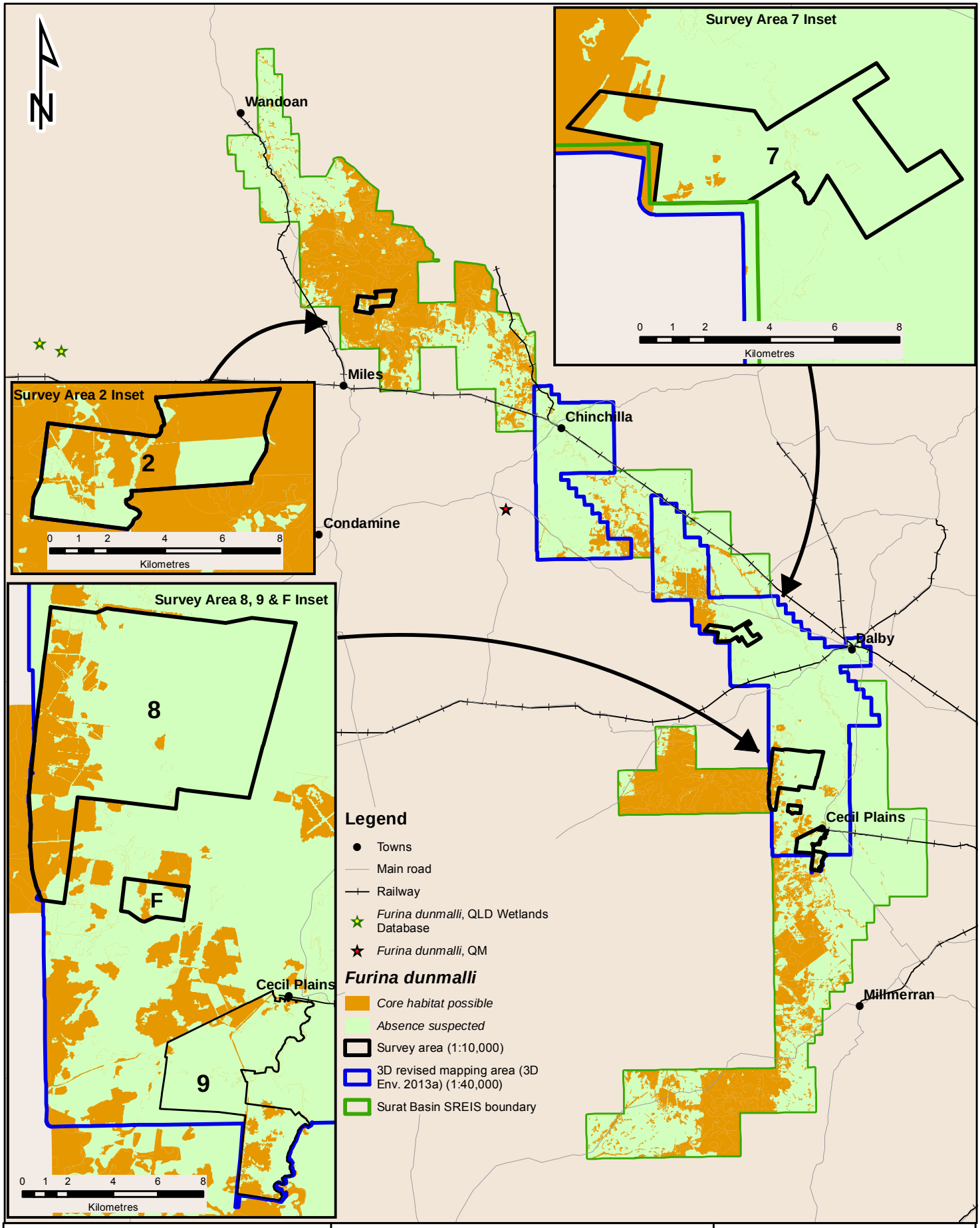
Significance of project related impacts (unmitigated): The sensitivity of populations of Dunmall's snake (*Furina dunmalli*) to unmitigated impacts within the project development area is considered ***Moderate***. This species is widely distributed and the SREIS area forms only a portion of its distribution. However, the species is very uncommon and encountered very sporadically. Consequently, the loss of individuals from populations may affect this species more than those that are locally common. Deaths resulting from clearing and trench capture will have short-term consequences, but the species' ability to recover population numbers is unknown.
Clearing native vegetation will promote edge effects, including weed invasion. The response of this species to habitat modification is unknown, but most records occur in large natural areas, or patches that have not been historically disturbed. Edge effects and subsequent weed invasion has the potential to produce long-term impacts over a large area. The sensitivity of this species this poorly known and difficult to assess, but has been estimated as ***Moderate***. The magnitude has also been estimated as ***Moderate***, giving an overall impact significance of ***Moderate (13)***.

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**.

Summary Residual Impact Assessment: Unmitigated project related activities may result in impacts of ***Moderate (13)*** significance to Dunmall's snake (*Furina dunmalli*) populations within the project development area. This species has broad habitat preferences and is widespread, though at apparently very low densities. It could occur in regional ecosystems 11.3.1, 11.3.17, 11.3.25, 11.4.3, 11.4.3a, 11.5.1, 11.5.4, 11.9.4a, 11.9.5 and 11.9.6. It is therefore anticipated that complete avoidance of suitable habitat will not be possible, although minimising clearing should be a priority. Deaths associated with vegetation clearing may be unavoidable if the animal is present, and cannot be completely mitigated. Consequences from the loss of individuals from existing populations remain unknown, but would be dependent on the number of animals removed. Controlling indirect impacts through rehabilitation, trench clearing and weed suppression will be beneficial and assist in reducing short-term and long-term impacts. Application of a full range of mitigation committments will result in residual impact that is ***Low (8)***.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Low	Low (8)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database

Figure A34. Dunmall's snake *(Furina dunmalli)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The known distribution of this species encompasses the entire project development area.
2. All remnant vegetation >100 ha in extent or within 500 m of a remnant vegetation patch >100 ha should be classed as 'core habitat possible.'
3. Any regional ecosystem (RE) polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known' except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5.
4. All contiguous remnant vegetation within a one km buffer of recent (1980+), accurate (± 500 m) records in the area is classed as 'core habitat known', except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5.
5. All mapped 'mature regrowth' that includes RE attributed polygons is classed 'general habitat' except for REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5. Ground-truthing of regrowth may result in it being elevated to 'core habitat possible.'
6. Cleared farmland or tilled crops are classed 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present (i.e., excluding REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5). For rule 1 this is applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

Mapping Confidence: This species is very poorly understood and records are scarce. Prediction of its occurrence based on habitat preferences is therefore uncertain. The habitat map for this species is considered to be of ***Low*** accuracy.

Evaluation under MNES Referral Guidelines

Table A76. Evaluation of impact significance for Dunmall's snake (*Furina dunmalli*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	*Given the rarity and difficulty in detecting this declining species, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats. Similarly, any suitable remnant vegetation or vegetation corridors within the range of Dunmall's Snake* (*Furina dunmalli*) *is considered important habitat for the species (Brigalow Belt Reptiles Workshop 2010)* (taken from the SPRAT database (SEWPAC 2013d)). No definition of an 'important population' is provided. There is no known record (post 1979) of this species from the project development area. **Survey area 2**: Intensive field survey failed to locate this species. Habitat suitable for the species is present and widespread, connecting to larger areas of intact habitat. Without further survey effort this species cannot be discounted and should be assumed present. **Survey area 7**: While most areas of vegetation on survey area 7 have marginal value for this species, areas of RE 11.9.7 and 11.9.9a along the western border (immediately adjacent Kumbarilla Ln) which are adjacent nearby State Forest are suitable. The species should be assumed as present in these areas. **Survey area 8**: Sizeable areas of remnant vegetation on survey area 8 are suitable for this species, and furthermore, connected to adjacent habitat within the nearby State Forest. The presence of this species within these areas of vegetation should be assumed. **Survey area 9** and **F**: While some suitable habitat is present, most areas are relatively minor in extent and have marginal value for Dunmall's snake (*Furina dunmalli*).
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F**: Survey areas 2, 7, and 8 all have some remnant vegetation suitable for Dunmall's snake (*Furina dunmalli*). By the definition provided above there is 'important habitat' on all these three properties. An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties. It is not possible to totally discount occurrence of the species on Survey area 2, 7 and 8. Pre-clearance survey will be required once project footprints have been identified. Based on no known population on the properties, the project will not lead to a long-term decrease in the size of an important population.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: Although trapping work has not been undertaken on survey area 7, 8, 9 or F, there are no known populations of Dunmall's snake (*Furina dunmalli*) on any of the subject five properties. However, the species is reclusive and difficult to detect and its presence cannot be discounted from Survey area 2, 7 and 8 where habitats appear suitable. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria. Provided 'core habitat known' is avoided, and adequate survey of 'core habitat possible' is undertaken prior to disturbance to evaluate the species presence (and subsequent impacts), then there little potential for cumulative impacts to be reinforced. Furthermore, application of a range of mitigation measures including pre-clearance survey will ensure that impacts are not unknown, unpredictable or irreversible and Arrow's contribution to cumulative impact will be minimal.

Rule(s) for survey effort required in accordance with survey guidelines: Surveys for this species should incorporate the following recommendations, based on SEWPAC (2011), although applied specifically to the project based on information collected during the EIS and SREIS. They provide the most suitable techniques for detecting the species in the project development area and consider application of habitat mapping developed during the SREIS study:

Areas classed 'core habitat possible' should be avoided but, given the wide habitat use of the species, this is unlikely to be practical. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover dominated by native species;
    - Fallen debris, i.e., timber, bark;
    - Rocks (non-essential);

- Dense leaf litter (non-essential);
- Soil cracks (non-essential).

- Landscape interpretation, including:
  - Is the habitat part of contiguous remnant or mature regrowth at least 10 ha in size;
  - If less than 10 ha, is the habitat within 200 m of a large area of contiguous remnant vegetation of suitable regional ecosystems for the species;
  - If less than 10 ha, is the habitat part of a EHP mapped discontinuous wildlife corridor of State or regional significance.

If suitable habitat and landscape features are present, the following survey methods should be deployed:

- Actively search suitable microhabitat.
- Pitfall traps.
- Funnel traps.
- Spotlight on warm nights (Brigalow Belt Reptiles Workshop 2010).

Details of pitfall and funnel trapping may be found in the *Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland* (Eyre *et al*. 2012). The species is extremely difficult to detect and one-off surveys are unlikely to be sufficient. Surveys should be conducted between October to February, provided ground temperatures are generally above 20^{o}C and preferably above 24^{o}C. Multiple surveys with good spatial and habitat representation may be required in very large habitat patches. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval. It should be noted that where a large number of well sites are proposed in close proximity, habitats representative of those to be impacted should be sampled rather than individual locations

If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted). The location will be considered to support a population and work should not proceed without evaluation under MNES guidelines.

Squatter pigeon – southern subspecies (*Geophaps scripta scripta*)

Status: **EPBC Act**: Vulnerable; **NC Act**: Vulnerable **BoT:** Medium

Sensitivity: High

Recovery Plan: No recovery plan is available.

Plate 37. Squatter pigeon - southern subspecies (*Geophaps scripta scripta*) (Photograph Angus McNab).

Overview of squatter pigeon

Ecology: Squatter pigeons (*Geophaps scripta scripta*) are largely terrestrial, foraging and breeding on the ground. Seeds make up the bulk of their diet and can include grass, legume, herb, tree and shrub seeds. Occasionally insects may be taken (Higgins and Davies 1996). Food is mostly picked from the ground, but may be occasionally taken directly from low seed heads (M. Sanders pers. obs.). This feeding strategy is most effective in grass areas that have a mosaic of vegetation and open areas. As a result, the species is absent from thick rank grasslands (e.g., areas dominated by exotic grasses), which also restricts movement of the ground. However, individuals and small groups are often located along roads and tracks surrounded by thick grasslands. Breeding is poorly known but does appear to be greatly influenced by rainfall. The nest is a shallow depression on the ground lined with dry grasses. Often nests are located beside or beneath a tuft of grass, log or low bush (Frith 1982; Higgins and Davies 1996; Beruldsen 2003). Movements are poorly documented, but birds appear to be locally nomadic (Frith 1982; Higgins and Davies 1996).

Habitat: The southern subspecies of the squatter pigeon (*Geophaps scripta scripta*) occurs mainly in dry grassy eucalypt woodlands and open forests and also inhabits cypress pine (*Callitris* spp.) and acacia woodlands (Frith 1982). It mostly occurs on sandy sites near permanent water (Blakers *et al*. 1984). Birds will forage along roads and railway lines and are often found around homesteads and cattle yards (Pizzey 1980; Reis 2012). Squatter Pigeons (*Geophaps scripta scripta*) dust-bathe and are frequently encountered on dirt tracks and in areas of bare soil denuded of ground cover by livestock (Crome 1976; Frith 1982; Higgins and Davies 1996).

Distribution: The squatter pigeon (*Geophaps scripta scripta*) is endemic to Australia and is now largely, if not wholly, restricted to Queensland. The species formerly occurred as far south as 34^{o}S (Blakers *et al*. 1984) but there has been no record in New South Wales since the 1970s (NSW NPWS 2003), though there was an unconfirmed sighting in 1989 (Morris 1993). In Queensland, the southern subspecies occurs north to the Burdekin River (Frith 1982) with an intergrade zone with the northern subspecies *G. s. peninsulae* around the Burdekin-Lynd Divide (Crome 1976; Ford 1986; Schodde and Mason 1997), though there is some doubt over the identification of hybrid forms (Higgins and Davies 1996). The southern subspecies extends west to Longreach, Barcaldine and Charleville and east to Townsville, Proserpine, Warwick and Esk (Storr 1973; Frith 1982; Schodde and Mason 1997). It is now very localised in southern Queensland but is still recorded in low numbers around Inglewood and Warwick (Birds Queensland 2011) and Esk (Reis 2012).

Likelihood of occurrence and extent of habitat in the project development area: There are three known records of squatter pigeon (*Geophaps scripta scripta*) from the project development area, two from north of Miles and one from Chinchilla. The latter is likely to be of low spatial accuracy, possibly being attributed to the nearest town. **Figure A35** indicates the location of known records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A77**.

Table A77. Extent of habitat for squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) in the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	17765	154992	0
3D Detailed Mapping Area**	512	19162	0
3D Detailed Mapping Area based on EHP***	12479	34559	0
Survey area 2	0	1030	324
Survey area 7 ****.	0	114	0
Survey area 8****.	0	1401	936
Survey area 9****.	0	621	3
Survey area F****.	0	41	58

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

Threats: The main threats to the local populations of squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) are:

- Habitat loss.
- Degradation of habitat by livestock and feral herbivores (Baptista et al. 1997; Reis 2012), declines occurs before the land-clearing era (Franklin 1999).
- Predation by feral predators, particularly foxes (*Vulpes vulpes*) (Garnett and Crowley 2000).
- Some pasture improvement activities, particularly the propagation of buffel grass (Cenchrus ciliaris) (Reis 2012).

Overgrazing degrades habitat, reduces food resources, limits or eliminates vegetation used as cover or for breeding, and subjects nests to trampling (Blakers *et al*. 1984; Garnett 1993; Higgins and Davies 1996). Close-grazing by sheep and rabbits (*Oryctolagus cuniculus*) in particular replaces perennial bushes, herbs and grasses with ephemeral herbs and annual grasses (Frith 1982).

Potential project-related impacts: Squatter pigeons (*Geophaps scripta scripta*) are highly mobile and able to easily cover large distances over modified land. It is unlikely that dispersal or movement patterns will be affected by gas field activities. Impacts associated with the proposed project related activities could include:

- Loss of habitat associated with the clearing of woodland vegetation for the construction of infrastructure.
- Decreased habitat quality due to invading exotic grasses associated with inappropriate revegetation or surface soil disturbance.
- Loss of breeding potential should clearing, by coincidence, impact nesting pairs.
- Modified fire regimes, affected by human activities, can affect ground strata composition (i.e., grass diversity) and structure rendering previously suitable habitats unsuitable.

Increased availability of surface water for drinking may reduce distance to permanent water from foraging habitats, thereby increasing the use of areas. However, as squatter pigeons (*Geophaps scripta scripta*) are highly mobile and able to cover large distances, this benefit is likely to be of minor or negligible consequence.

Significance of project related impacts (unmitigated): The sensitivity of populations of squatter pigeon (*Geophaps scripta scripta*) to unmitigated impacts within the project development area is considered ***High***. Historically the southern subspecies of the squatter pigeon (*Geophaps scripta scripta*) ranged south from the Burdekin River to northern central New South Wales. While encompassing only a portion of this range, the project development area is in an area of decline and any populations (if present) are of importance. However, the species is not regularly recorded in the area and the presence of permanent populations seems unlikely. Existing records probably reflect either historical observations prior to declines or transient individuals that have not taken residence. Suitable squatter pigeon (*Geophaps scripta scripta*) habitat has been substantially reduced or modified by agriculture and areas of open woodlands with native understories are restricted to minor

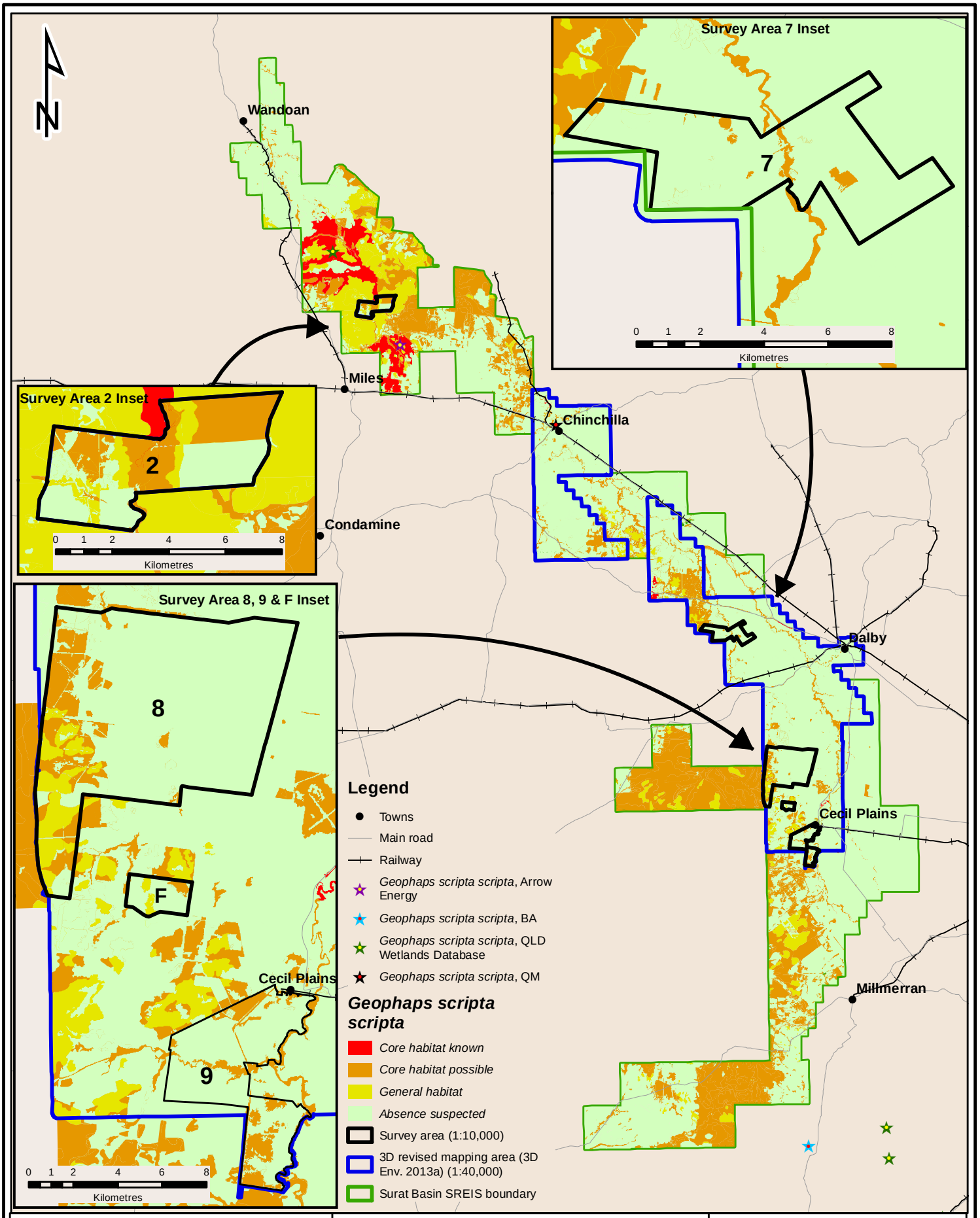
remnants. In many cases, even these minor fragments have been affected by grazing and altered fire regimes. The species has been estimated to have a ***High*** sensitivity to disturbance and magnitude of impact is ***Low*** as the species occurs in extremely low numbers, possibly extirpated from some areas. The unmitigated impact significance is therefore ***Moderate (12).***

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of squatter pigeon will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Moderate*** significance to squatter pigeon (*Geophaps scripta scripta*) populations within the project development area. Project-related impacts have the potential to affect squatter pigeon (*Geophaps scripta scripta*) habitat, particularly through weed infestations. However, when assessing the possible severity of these impacts it should be considered that squatter pigeons (*Geophaps scripta scripta*) are possibly locally extinct. Should this be the case it negates any consideration of high importance for existing habitats with regard to this species. Nonetheless, habitats should be protected where possible. Application of a range of generic mitigation measures will result in impacts that are of ***Low (8)*** significance.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	Low	Moderate (12)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database
Arrow Database

Figure A35. Squatter pigeon *(Geophaps scripta scripta)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	6/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for habitat mapping:

1. The known distribution of this species encompasses the entire project development area.
2. Woodlands, native grasslands and derived native grasslands (regional ecosystems (REs) 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.21, 11.3.25, 11.3.26, 11.4.12, 11.5.1, 11.5.4, 11.5.20, 11.7.4c, 11.8.2a, 11.9.9, 11.9.10) are considered to be 'core habitat possible.' mature regrowth (EHP 2012b) are also included in the mapping assessment.
3. 'General habitat' that might be used by this species includes REs 11.3.18, 11.7.4, 11.7.7, 11.7.9 and 11.10.1.
4. All remaining REs are 'absence suspected.'
5. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
6. All land (remnant or non-remnant), except tilled land, within one km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known' for management purposes.

Mapping confidence: This species' occurrence within the region is highly sporadic and it may not occur within all areas of designated 'core habitat possible.' Furthermore, where this species is still relatively common (e.g., Bowen Basin), it may occur in artificial habitats including areas dominated by exotic grasses. It could therefore occur in the project development area outside of mapped habitat. Consequently, the habitat map for this species is considered to be of ***Low*** accuracy.

Evaluation under MNES referral Guidelines

Table A49 Evaluation of impact significance for squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development area.	*No populations have been identified as being especially important to the long-term survival or recovery of the Squatter Pigeon (southern)* (*Geophaps scripta scripta*) SEWPAC 2013e). There are three known (post 1979) records of this species from the project development area, two from north of Miles (see below) and one from Chinchilla, which may be of low spatial accuracy. **Survey area 2**: Intensive field survey failed to locate this species. Some 'core habitat possible', regional ecosystems (RE) 11.3.4, 11.3.25, 11.5.1 and 11.5.4, is present. There are two database records of the species in the general area, approximately 9 km to the south-east and 12 km to the north-west of the property. **Survey area 7**: Some 'core habitat possible', REs 11.3.2, 11.3.4, 11.3.14, 11.3.25 and 11.9.9 is present. **Survey area 8**: Some 'core habitat possible', REs 11.3.2, 11.3.21, 11.3.26, 11.5.1 and 11.5.20, is present. **Survey area 9**: Some 'core habitat possible', REs 11.3.2, 11.3.4, 11.3.18, 11.3.25, 11.5.1 and 11.9.9, is present. **Survey area F**: Some 'core habitat possible', REs 11.3.18 and 11.9.9, is present. There is no known record of squatter pigeon (*Geophaps scripta scripta*) (post 1979) within 50 km of survey areas 7, 8, 9 and F.

Criteria	Evaluation
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F**: All five properties have some remnant vegetation classed as 'core habitat possible' for squatter pigeon (*Geophaps scripta scripta*). There is no known population on these properties. It is not possible to totally discount occurrence of the species on the properties. Pre-clearance survey may be required once project footprints have been identified. An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties. No long-term decrease in the size of an important population will occur due to project activities.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2**: Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. It will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1. **Survey area 2, 7, 8, 9, F**: will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: While there is suitable habitat on all five subject properties, squatter pigeons (*Geophaps scripta scripta*) are scarce in the region and local records probably represent transient individuals. No know or breeding populations occur, or are considered likely to occur. Therefore, based on current population knowledge, impacts are not considered significant when assessed under MNES criteria, both for survey areas and also on a broader project scale. The species is highly mobile and tolerant of some disturbance .As such, there is little potential for cumulative impacts to be reinforced through Arrow development actions and impacts are unlikely to be unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: The following recommendations for survey are made:
If suitable habitat and landscape features are present, then area searches concentrating on roadways, tracks and around waterbodies should be undertaken. DEWHA (2010b) guidelines recommended undertaking a total of 25hrs (15 hrs for area searches/transects and 10 hrs for flushing surveys) over three days for each 50 ha area. It is recognised that searches of this intensity cannot be acheived given the scale of the project. Appropriate survey requirements for this species are as follows:

Areas classed as 'core habitat known' should be avoided, with a 100 m buffer, and do not require survey work on this basis. Areas classed 'core habitat known' and 'core habitat possible' should be avoided but, given the wide habitat use of the species, this is unlikely. If clearing is planned, fauna survey work should be conducted before any gas related work is undertaken. This work should include:

- Confirmation of the regional ecosystem mapping.
- Initial visual assessment to determine if the appropriate habitat features are present, including:
    - Ground cover includes a matrix of bare ground/leaf litter and clumps of native grasses;
    - A open (at most barely overlapping) canopy;
    - Nearby water (can include ephemeral waterbodies);

Australian painted snipe (*Rostratula australis*)

Status: **EPBC Act**: Vulnerable (updated to Endangered, April 29 2013), Migratory (as *R. benghalensis* [*sensu lato*]); **NC Act**: Vulnerable; **BoT:** Medium

Sensitivity: Moderate

Recovery Plan: A brief recovery outline for the species is featured in the *Action plan for Australian birds 2000* (Garnett and Crowley 2000).

Plate 38. Australian painted snipe (*Rostratula australis*)

Alternative Nomenclature: *Rostratula australis* was considered to be a subspecies of *Rostratula bengalensis* until Baker *et al*. (2007) raised it to species level. The Australian painted snipe (*Rostratula australis*) is endemic to Australia. It is often referred to in previous literature as *Rostratula. bengalensis* (*sensu lato*).

Overview of painted snipe

Ecology: The Australian painted snipe (*Rostratula australis*) appears to be crepuscular and nocturnal, feeding on mudflats or in shallow water during the morning and evening and throughout the night (Geering *et al.* 2007). A variety of foods are eaten, including vegetation, seeds, insects, worms, molluscs, crustaceans and other invertebrates including beetles (Marchant and Higgins 1993; Johnstone and Storr 1998).

Nesting occurs in spring and summer in southern Australia and during the wet season in northern Australia (Geering *et al.* 2007). Nests consist of a simple scrap in the ground lined by dry grasses, fine twigs and other vegetation. These nests are located in specific positions such as on a small island surrounded by shallow water, or occasionally on small mounds of purpose-built vegetation surrounded by water (Berudlsen 2003; Rogers *et al.* 2005). Breeding occurs only in suitable temporary wetlands with low relief and complex shorelines after an influx of water (Rogers *et al.* 2005).

Migration patterns are poorly known for Australian painted snipe (*Rostratula australis*) (Pringle 1987). They are possibly dispersive or migratory. It is possible that such movements are due to local conditions, moving to flooded areas from drying wetlands (Marchant and Higgins 1993).

Habitat: Birds may be recorded singly or in small groups in freshwater marshes. They are extremely nomadic, coming and going in response to local rainfall and flooding. Although its occurrence in a location is often erratic, with the bird absent some years and common in others (Marchant and Higgins 1993) there is indication of some regular seasonal migration, e.g., to central and north coastal Queensland in autumn and winter (Black *et al*. 2010). Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Rogers *et al.* 2005; Geering *et al.* 2007). During non-breeding periods they may be found in a wider range of habitats including dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant and Higgins 1993).

Distribution: Most records of the Australian painted snipe (*Rostratula australis*) occur east of a line between Eyre Peninsula and the Gulf of Carpentaria, excluding Cape York Peninsula where they appear to be absent (Marchant and Higgins 1993). However, scattered individuals occur west as far as Western Australia, where they may have once been common in the Kimberley and Swan Coastal Plain (Johnstone and Storr 1998). Recent records mostly centre on the Murray-Darling basin of eastern Queensland and New South Wales (Marchant and Higgins 1993; Rogers *et al.* 2005). Lake Broadwater is considered to be important habitat for this species within Brigalow Belt South, although there is no known breeding record from this location (EPA 2003).

Occurrence in the project development area and extent of habitat: There are six known records of Australian painted snipe (*Rostratula australis*) for the project development area. Five of these are from Lake Broadwater and in immediate surrounding area. The other is from Dalby. However, the record attributed to Dalby may be based on it being the nearest town, rather than the specimen being collected, or observation being made, at Dalby. **Figure A36** indicates the location of known records of the species (derived from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A79**.

Table A79. Extent of habitat for Australian painted snipe (*Rostratula australis*) in the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	275	0	3389
3D Detailed Mapping Area**	255	230	257
3D Detailed Mapping Area based on EHP (2012)***	268	0	2870
Survey area 2****	0	0	4
Survey area 7****	0	0	0
Survey area 8****	0	0	0

	Core Habitat Known (ha)	Core Habitat Possible (ha)	General Habitat (ha)
Survey area 9****	0	0	14
Survey area F****	0	0	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General threats to the species: Estimations of Australian painted snipe (*Rostratula australis*) population trends have been confounded by its nomadic nature. The species may become absent from historical locations, only to re-appear after decades. Nevertheless, there has been a substantial reduction in the reporting rate for the species (Johnstone and Storr 1998; Lane and Rogers 2000; Rogers *et al.* 2005). The main threats to the local populations of Australian painted snipe (*Rostratula australis*) are:

- Loss or alteration of wetland habitats and their water regimes, particularly areas of breeding habitat (Rogers et al. 2005; Garnett et al. 2011).
- Degradation of existing wetlands through weed invasion.
- Trampling of habitat by cattle and feral pigs (Sus scrofa) (Rogers et al. 2005; Tzaros et al. 2012).
- Reduced water quality due to a lack of flushing, increased nutrient runoff, pesticide and herbicide runoff, saline discharge and increased erosion and turbidity due to vegetation removal (Tzaros et al. 2012).

The loss of habitat has occurred through drainage of wetlands and diversion of floodwaters for agricultural and irrigation purposes (Rogers *et al.* 2005; Garnett *et al.* 2011). The diversion of floodwaters into permanent deep-water wetlands with dense reed beds, and an absence of islands and complex shallow margins creates habitat unsuitable for the species (Tzaros *et al*. 2012). Invasion of wetlands by weed species such *Parkinsonia aculeata* (regularly associated with waterways and wetlands) may also form tall dense thickets unsuitable for Australian painted snipe (*Rostratula australis*) and a range of other wetland species (Rogers *et al*. 2005; Tzaros *et al*. 2012).

- Project-related Impacts: It is probable that any local breeding by this species will be restricted to Lake Broadwater, Long Swamp, large farm dams (>5 ha), and wetlands within the flood plains of the Condamine River. Current development plans do not include direct impacts on Lake Broadwater. Impacts are therefore likely to be restricted to impacts at Long Swamp, wetlands within the Condamine flood plain, and indirect impacts on Lake Broadwater. Impacts associated with the proposed project related activities could include:

- The temporary loss of vegetation and hence habitat within Long Swamp for the construction of gas gathering lines.
- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater and Long Swamp.
- Deterioration of water quality within Long Swamp and Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Long Swamp and Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported either directly through clearing practices (Long Swamp) or by surface water flow in Broadwater and Surveyors Gully.
- Loss or modification (including weed invasion), of wetlands or low-lying areas of pooling water within the Condamine River flood plain.

Significance of project related impacts (unmitigated): The sensitivity of populations of Australian painted snipe (*Rostratula australis*) to unmitigated impacts within the project development area is considered ***Moderate***. The use of suitable habitats by this species within the project development area is unclear. It is possible that breeding could occur during prolonged wet periods (e.g., wet seasons between and including the summers of 2009/10 and 2012/13); however, it seems more probable that records represent transient individuals taking advantage of suitable foraging habitat. Mapping and predicting suitable foraging habitat for this species on the Condamine River flood plain is almost impossible given its ability to use areas of pooling water, sometimes small in extent, in both remnant and modified landscapes. No known resident population occurs within the project development area and the importance of potential habitat for the Australian painted snipe (*Rostratula australis*) is difficult to predict. While the species can use temporary flooded areas (locations of which are difficult to predict), the best (and known) habitat is located at Lake Broadwater. Habitat might also occur along Long Swamp during periods of inundation. A 500 m exclusion zone has been established around Lake Broadwater and hence direct impacts are not expected. Unmitigated indirect impacts predominantly relate to alterations in water quality, the most severe of which could be salination due to ground water intrusion into surface waterways. Water quality could also be affected by increased sedimentation, although this is likely to be short-term as vegetation should return to stabilise disturbed surfaces.

Unlike Lake Broadwater, no exclusion zone has been established around Long Swamp. Disturbance within this area is likely to be restricted to gas gathering lines as infrastructure cannot be placed in flood prone areas. The construction of gas gathering lines through Long Swamp will result in the loss of some vegetation and increased ground disturbance. These impacts will be short term and probably minor in severity given the existing condition of the swamp and surrounding vegetation. Long-term impacts to Long Swamp might occur if weeds are brought in during construction or if saline groundwater is allowed to flow from bores into the swamp. Weed invasions can be difficult to control in low-lying areas where water collects. Given the above uncertainties, it is difficult to estimate the

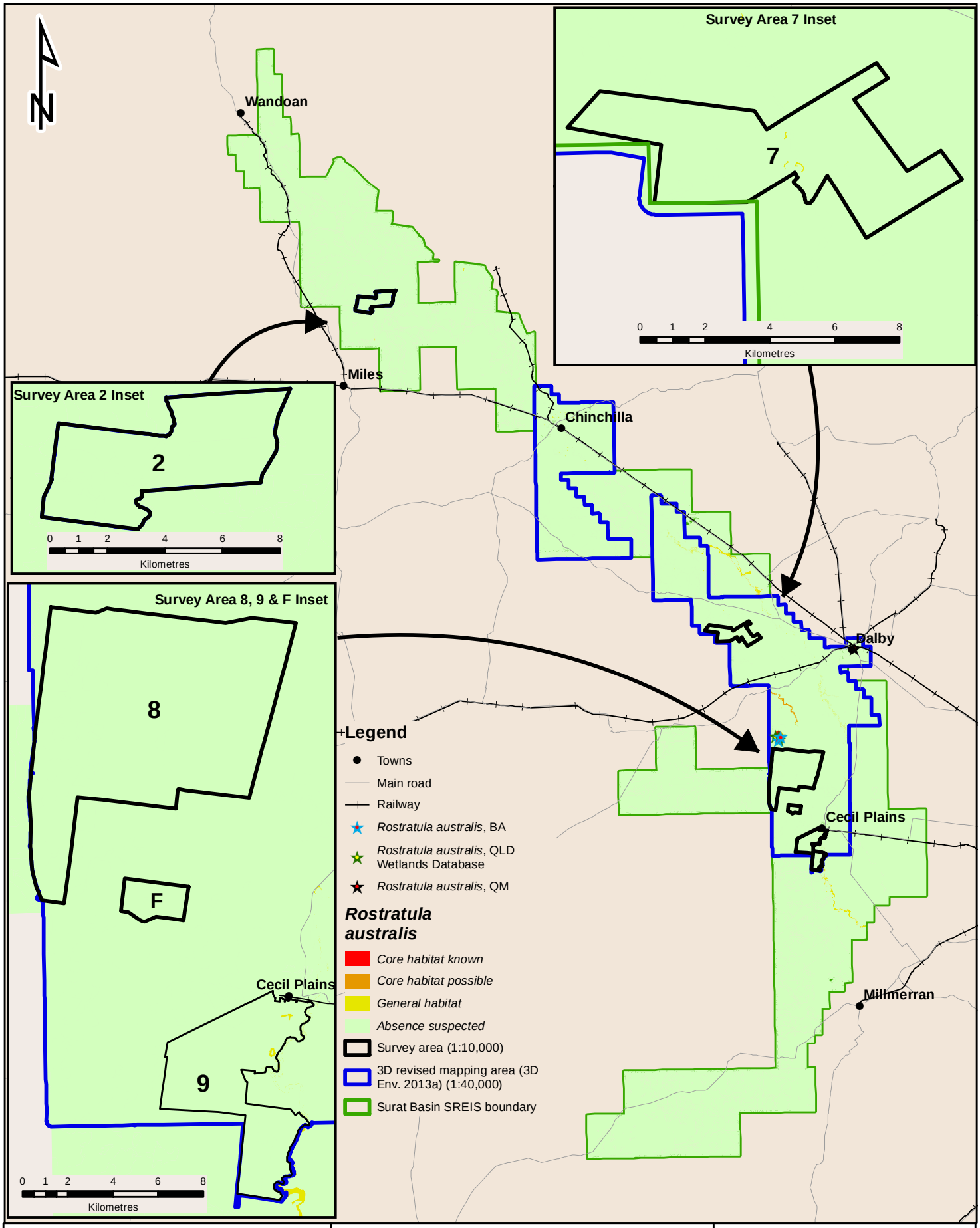
species sensitivity, or impact magnitude. Both are rated ***Moderate*** based on a conservative approach. The overall impact significance is therefore ***Moderate (13).***

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of Australian painted snipe will be prioritised.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Moderate*** significance to Australian painted snipe (*Rostratula australis*) populations within the project development area. The most suitable habitat, around Lake Broadwater, is unlikely to be affected. Impacts may occur if avoidance is not possible within less suitable habitat at Long Swamp and in this case, residual impact will remain Moderate (13).

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database

Figure A36. Australian painted snipe *(Rostratula australis)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for habitat mapping:

1. The known distribution of this species encompasses the entire project development area.
2. The water containment area of Lake Broadwater and a buffer of 100 m should be considered 'core habitat known.'
3. Areas within Long Swamp where water collection might occur following surface flow should be considered 'core habitat possible.'
4. All remnant vegetation where surface water could collect within the Condamine and Wilkie Creek Catchments (e.g., RE11.3.27d, f and vegetation communities WA, WA1 and WA2) should be classed as 'general habitat.'
5. Remaining REs or tilled crops are classed 'absence suspected.'

Mapping confidence: This species is associated with aquatic and semi-aquatic vegetation, which may be clearly indicated in vegetation maps. However, the species' occurrence is sporadic and may therefore not occur within all areas of 'core habitat possible.' The species may also occur in minor wetlands and flooded non-native grasslands, suggesting that it might occur in areas not indicated on the habitat map. However, these occurrences are likely to be very infrequent and short term. The habitat map for this species is considered to be ***Low*** in accuracy.

Evaluation under MNES referral Guidelines

Table A80. Evaluation of impact significance for Australian painted snipe (*Rostratula australis*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the Project Development Area.	*The total population size of the Australian Painted Snipe* (*Rostratula australis*) *is effectively unknown, but tentative estimates range from a few hundred individuals to 5000 breeding adults (Garnett & Crowley 2000; Lane & Rogers 2000; Oring et al. 2004; Watkins 1993). The Australian Painted Snipe* (*Rostratula australis*) *is considered to occur in a single, contiguous breeding population (Garnett & Crowley 2000)* (taken from SEWPAC 2013h). No definition of an 'important population' is provided. There are six records of this species from the project development area, five from Lake Broadwater and in immediate surrounding areas (within prescribed buffers), and one from Dalby. Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Roger *et al*. 2005; Geering *et al*. 2007). The species may be found in a wider range of habitats including dams, waterlogged grasslands and roadside drains (Marchant and Higgins 1993). **Survey area 2**: Field survey failed to locate this species. The closest known record for the species is approximately 100 km to the south-west. Habitats are unlikely to support this species. **Survey area 7**: The closest known record for the species is approximately 30 km to the east. Access to the Condamine River was restricted due to flooding, however areas of RE 11.3.4 and 11.3.25 *as well as* any non-remnant (but not tilled) land subject to inundation could be inhabited by the species. **Survey area 8**: is within two km of a record at Lake Broadwater. Long Swamp, which flows through the eastern portion of survey area 8 is considered suitable habitat for this species. **Survey area 9**: The closest known record for the species is approximately 20 km to the south. There are a number of wetlands supporting remnant habitats (including areas within RE 11.3.27 and 11.3.2) and non-remnant habitats in the northern portion of the property. Access to the Condamine River flood plain was restricted due to flooding, however it is expected that there are a number of suitable habitats along the river. **Survey area F**: The closest known record for the species is approximately 13 km to the east. It is unlikely the species will occur on this property. The closest records with regards to survey areas 7, 8 and 9 are from Lake Broadwater.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2, 7, 8, 9, F** The occasional use of dams, waterlogged grasslands and drains by Australian painted snipe (*Rostratula australis*) means that habitat suitable for sporadic, non-breeding use is present on all five properties, although the species seems unlikely on survey area 2 and F. It is not possible to totally discount occurrence of the species on survey area 7, 8 and 9 and pre-clearance survey may be required once project footprints have been identified. An 'important population' is not defined for this species. Based on current knowledge, no population, whether it could be regarded as 'important' or not, is present on the properties. No long-term decrease in the size of an important population will occur due to project activities.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 3: fragment an existing important population.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing important population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, 7, 8, 9, F** Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F**: will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: There are no known records of Australian painted snipe (*Rostratula australis*) on any of the five survey areas and, while there is some potential habitat on survey area 8 and 9, the species is unlikely to occur. Local records probably represent transient individuals.

Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and provided core habitat (Lake Broadwater and Long Swamp) are avoided, broader Arrow related activities within the project development area will not have a significant impact and there is little potential for cumulative impacts associated with the actions of other proponents. Actions on these properties are unlikely to be unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines: The following mitigation measured should be applied a based on methods of DEWHA (2010b) although adapted based on information collected during EIS and SREIS studies.

The only known habitat for the species, Lake Broadwater, is to be avoided and provided a 500 m buffer. This area does not require survey work on this basis.Areas classed 'core habitat possible' should be avoided but, if unavoidable, fauna survey work should be conducted before any gas related work is undertaken. In addition to 'core habitat possible' any areas of non-remnant wetland within the Condamine River flood plain should be surveyed. Surveys should include:

- Initial visual assessment to determine if appropriate habitat is present. The species occurs in ephemeral to semi-ephemeral wetlands with small islands of vegetation or bare ground, or on waterbodies with exposed mud areas.
- If suitable habitat is present, then the species should be targeted using (DEWHA 2010b:
    - Stationary observations for moving/foraging individuals (10hrs over five days/50ha of wetland habitat), and
    - Area or transect searches (10 hrs over three days/50ha of wetland habitat).

Spotlighting for individuals can also be successful (M. Sanders *pers obs*). The species can be extremely difficult to detect, even when present, and single surveys may not be sufficient. If the presence of the species is suspected but not confirmed, a second survey should be conducted.

Regent honeyeater (*Anthochaera phrygia*)

Status: **EPBC Act**: Endangered, Migratory (as *Xanthomyza phrygia*); **NC Act**: Endangered; **BoT**: Medium

Sensitivity: High

Recovery plan: Regent Honeyeater Recovery Plan 1994-1998 (Menkhorst 1997). Regent Honeyeater Recovery Plan - 1999-2003 (Menkhorst et al. 1999). The Action plan for Australian birds 2010 (Garnett et al. 2011) identifies types of information required and management actions for the recovery of the species. The Queensland Government (EPA 2008b) recommends actions to assist the recovery of the regent honeyeater.

Plate 39. Regent honeyeater (*Anthochaera phrygia*)

Alternative nomenclature: Changed from the genus *Xanthomyza* to *Anthochaera* (Christidis and Boles 2008).

Overview of regent honeyeater

Ecology: Regent honeyeaters (*Anthochaera phrygia*) feed predominantly on nectar and insects (including exudates such as lerp and honeydew). Nectar is taken mainly from eucalypts and often mistletoes (Higgins *et al*. 2001), which when scarce may be substituted by lerps and insects. These resources can become a major component of their diet (up to 90%) when nectar is scarce (Menkhorst 1997; Oliver 2000). Regent honeyeaters (*Anthochaera phrygia*) actively select larger trees for foraging (Oliver 2000).

Breeding typically coincides with peak flowering in local tree populations, i.e., May to March but with a peak from September to November (Franklin *et al*. 1989; Higgins *et al*. 2001). Cup-shaped nests,

constructed from strips of bark and dry grass, are usually placed towards the end of large horizontal branches in the crowns of taller trees (Geering and French 1998; Oliver *et al.* 1998; Higgins *et al.* 2001). Studies have found that nesting success is very low, typically less than 50%, but ranging from 14.3% to 73.3% (SEWPAC 2013b). Predation and adverse weather conditions (e.g., hot weather, strong winds, storms) have been suggested as the primary causes of nesting failure (Geering and French 1998; Higgins *et al.* 2001). Regent honeyeaters (*Anthochaera phrygia*) are highly mobile and may be nomadic, eruptive or show some migratory patterns. This makes their movements difficult to predict; however, the population drifts north from southern Australia to northern New South Wales and south-east Queensland during late autumn/early spring. This is followed by an influx of birds into core breeding areas on the inland slopes of the Great Dividing Range (SEWPAC 2013b).

Habitat: Although occasionally found in agricultural land with only partial tree cover or in city parks and gardens, the regent honeyeater (*Anthochaera phrygia*) occurs mainly in dry box-ironbark eucalypt woodland and dry sclerophyll forest (Higgins *et al.* 2001). They are particularly fond of vegetation associations that reliably produce nectar such as mugga ironbark (*Eucalyptus sideroxylon*), yellow box (*E. melliodora*), white box (*E. albens*) and yellow gum (*E. leucoxylon*). However, when nectar is scarce they can also be observed in association with grey box (*E. microcarpa*), red box (*E. polyanthemus*), Blakely's red gum (*E. blakelyi*), Queensland blue gum (*E. camaldulensis*), silver-leafed box (*E. melanophloia*), Caley's ironbark (*E. caleyi*) and swamp mahogany (*E. robusta*) (Franklin *et al.* 1989; Geering and French 1998). Within these vegetation associations they are most regularly recorded from the wettest, most fertile sites (Garnett and Crowley 2000).

Distribution: The regent honeyeater (*Anthochaera phrygia*) is restricted to south-eastern Australia where it is widespread but extremely patchy in occurrence (Garnett *et al*. 2011). Historically, the species was distributed from Adelaide in South Australia north to Rockhampton in Queensland. However, their range has contracted considerably (Higgins *et al*. 2001). The species have not been recorded in South Australia or western Victoria since the 1970s (Garnett *et al.* 2011). Most records now occur north of the Great Divide in Victoria and south of Pomona in Queensland. They may still be observed within their historical distribution in New South Wales, extending inland to Narrabri, Parkes and Warrumbungle National Park. However, reporting frequency and numbers have declined significantly since the 1940s (Higgins *et al.* 2001; Garnett and Crowley 2000).
Small numbers and individuals are occasionally reported in south-east Queensland from locations such as Pomona, Bribie Island, the Granite Belt, Sundown National Park and around Gore-Karara (e.g., Durikai State Forest). A small breeding population around Gore-Karara may represent the only breeding population in Queensland (Higgins *et al.* 2001; Geering 2012; SEWPAC 2013b).

Occurrence in the project development area and extent of habitat: There are five known records of regent honeyeater (*Anthochaera phrygia*) for the project development area. One record from Chinchilla and four records from Dalby. Regent honeyeater (*Anthochaera phrygia*) has been observed feeding on flowering *Eucalyptus sideroxylon* in parkland along Myall Creek in Dalby, though this is a very infrequent event. **Figure A37** indicates the location of known records of the species (derived

from databases) as well as providing representation of the distribution in the project development area of areas classified as 'core habitat known', 'core habitat possible', 'general habitat' and areas where the species is considered unlikely to occur, 'absence suspected.' The extent of habitat within specific areas of the project development area is summarised within **Table A81**.

Table A81. Extent of habitat for regent honeyeater (*Anthochaera phrygia*) in the project development area and associated areas of assessment

	Core Habitat Known (ha)	**Core Habitat Possible (ha)**	**General Habitat (ha)**
Project Development Area*	33	260	25105
3D Detailed Mapping Area**	512	3946	6520
3D Detailed Mapping Area based on EHP***	32	260	8759
Survey area 2****	0	0	0
Survey area 7 ****.	0	18	61
Survey area 8****.	0	0	409
Survey area 9****.	0	0	167
Survey area F****.	0	9	9

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General threats to the species: The main threats to the local populations of regent honeyeater (*Anthochaera phrygia*) are:

- Habitat loss fragmentation (Garnett and Crowley 2000)
- Poor habitat condition of many of the remaining habitat fragments (Garnett et al. 2011).

The decline of the regent honeyeater (*Anthochaera phrygia*) is primarily due to vegetation clearing and fragmentation (Garnett and Crowley 2000), with 75% of its habitat cleared, particularly its most preferred habitat. The poor health of many of the remaining fragments is also likely to be a contributing factor (Garnett *et al*. 2011). Birds using these fragments will be subject to nest failure due to predation and parasitism (Lindenmayer and Fischer 2006), increased adverse abiotic conditions (e.g., increased temperature and wind) (Saunders *et al*. 1991), reduced foraging resources leading to lowered reproductive success, and an influx of aggressive species (e.g., friarbirds and miners) increasing competition (Franklin *et al.* 1989; Ford *et al.* 1993). Silviculture also removes the larger trees that regent honeyeaters (*Anthochaera phrygia*) favour for foraging and nesting and may therefore reduce resource availability and breeding success.

Project-related Impacts: Regent honeyeaters (*Anthochaera phrygia*) are highly mobile and able to easily cover large distances over modified land. Project-related impacts might include loss of foraging habitat for non-breeding birds.

Significance of project related impacts (Unmitigated): The sensitivity of populations of regent honeyeater (*Anthochaera phrygia*) to unmitigated impacts within the project development area is considered ***High.*** No known breeding populations of the regent honeyeater (*Anthochaera phrygia*) occur in the project development area. However, a breeding population is approximately 35-40 km to the south-east of ATP 689. Dispersing and nomadic individuals may occasionally occur in southern portions of the project development area. Although suitable habitats in the area do not support resident populations, the areas could be important for the recovery of the species. Should a population be found to occur in the project development area, the unmitigated impact magnitude has been estimated as ***High***. This species impact significance is therefore ***High (21).***

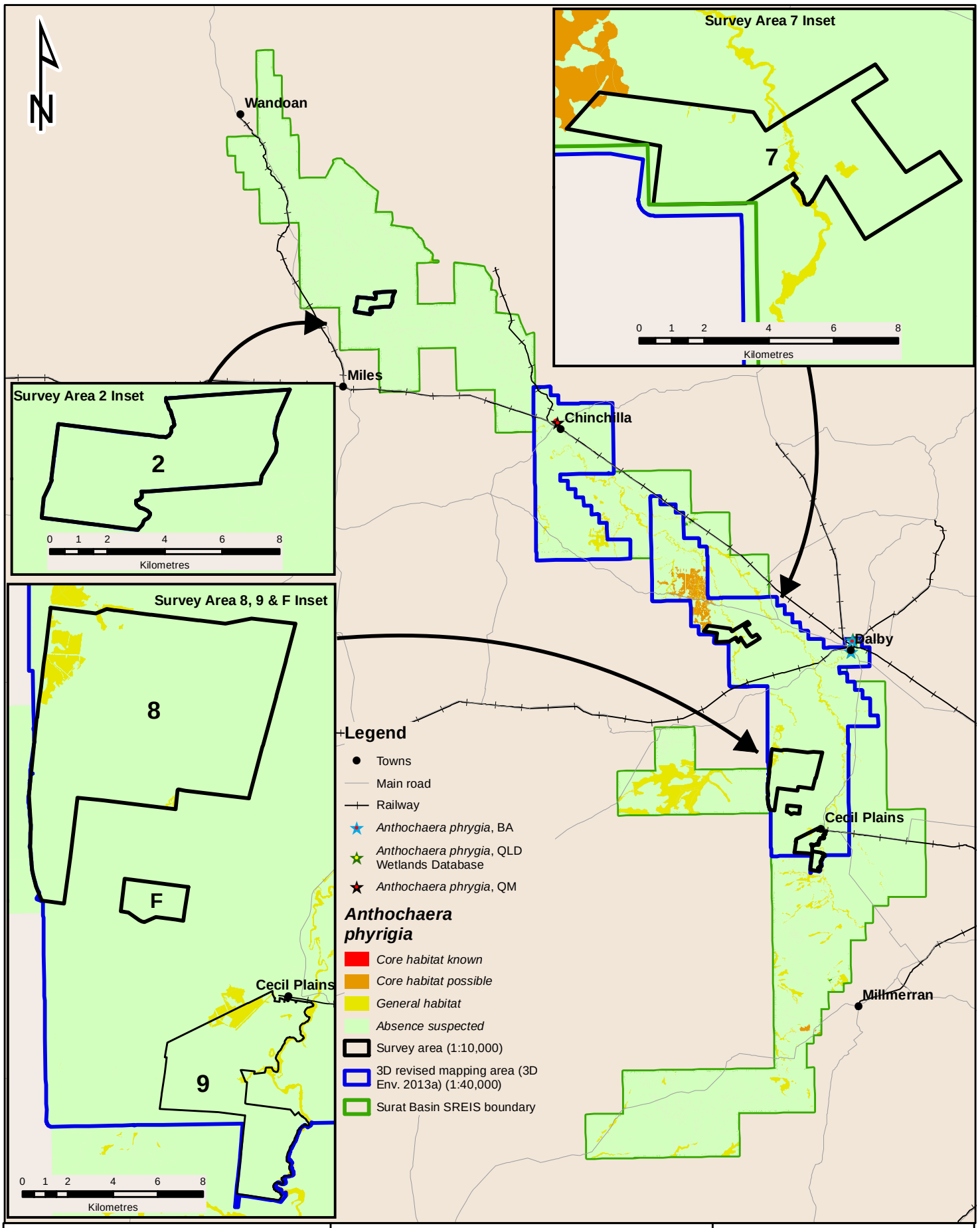
Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of regent honeyeater will be prioritised.

In addition rehabilitation of regent honeyeater (*Anthochaera phrygia*) habitat has been undertaken in other states and presents an opportunity for this project to improve regional biological values. Rehabilitation should focus on returning *Eucalyptus sideroxylon*, *Eucalyptus albens* and *Eucalyptus melliodora* communities to suitable land zones within the southern portions of the project development area.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***High*** significance to regent honeyeater (*Anthochaera phrygia*) populations that may use habitats in the project development area seasonally or sporadically. This assessment is based on the presumption that there is no known resident or seasonal population in the project development area and the species probably occurs very sporadically. Therefore, impact likelihood should not be based only on the disturbance of core habitats. Pre-clearing surveys of 'core habitat possible' are required to ensure that mapped regional ecosystems are accurate. Rehabilitation provides some opportunity for environmental value improvement although in general mitigation measures that do not involve habitat avoidance will have limited affect, therefore the residual impact remains ***High (21)***.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
High	NA	NA	High	High (21)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Queensland Museum Database
Birds Australia Database

Figure A37. Regent honeyeater *(Anthochaera phyrigia)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The species is highly unlikely to occur north of Chinchilla (approximate latitude -26.7). All vegetation north of this latitude should be classed as ‘absence suspected.’
2. The species may occur, albeit very sporadically, between Chinchilla and Millmerran (-26.7 south to -27.8). In this region, ‘core habitat possible’ should be downgraded to ‘general habitat’ and ‘general habitat ‘downgraded to ‘absence suspected.’
3. The species is most likely to occur in proximity to known populations south of Millmerran (south of -27.8).
4. Within the above areas, regional ecosystems (REs) with yellow box (*Eucalyptus* melliodora) and white box (*Eucalyptus* albens) (REs 11.8.2a, 11.9.9a) are classed ‘core habitat possible.’
5. Communities with other dominant eucalypts such as grey box (*Eucalyptus moluccana*), Queensland blue gum, (*Eucalyptus tereticornis*) (REs 11.3.4, 11.3.14), Queensland blue gum (*Eucalyptus camaldulensis*) (REs 11.3.25, 11.3.26, 11.3.27a, 11.3.27b) and western grey box (*Eucalyptus microcarpa*) (REs 11.4.10, 11.5.20) are classed ‘general habitat.’
6. All contiguous remnant vegetation classed as ‘core habitat possible’ and ‘general habitat’ within one km of a recent (1980+), accurate (± 500 m) record is classed as ‘core habitat known.’
7. Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as ‘core habitat known.’
8. For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
9. All remaining remnant communities are considered ‘absence suspected.’
10. Open pasture, crops and urban landscapes are classed as ‘absence suspected.’

Mapping Confidence

Given the uncertainty over the occurrence of the species in the project development area, the map is considered to have a *Low* predictive accuracy.

Evaluation under MNES referral Guidelines

Table A82. Evaluation of impact significance for regent honeyeater (*Anthochaera phrygia*) under MNES Guidelines.

Criteria	Evaluation
Populations of the species in the Project Development Area.	The regent honeyeater's (*Anthochaera phrygia*) population is estimated at 350-400 birds (Geering 2012). In Queensland, the species has been recorded from 15 sites, primarily south of a line from Chinchilla to the Sunshine Coast (SEWPAC 2013b). *It is suspected that in Queensland, as in NSW, declines in the area of occupancy may have been masked by occasional records of small numbers of birds. However, there is little documentation available to support this assumption (Geering 2005 pers. comm.)* (taken from SPRAT database (SEWPAC 2013b). There are five known records of regent honeyeater (*Anthochaera phrygia*) for the project development area. One record from Chinchilla and four records from Dalby. No 'core habitat possible' is present on the five properties listed below. **Survey area 2**: Some 'general habitat', regional ecosystems (REs) 11.3.4 and 11.3.25, is present. Survey area 2 is north of the known distribution of the species. **Survey area 7**: Some 'general habitat', regional ecosystems (REs) 11.3.4, 11.3.14 and 11.3.25, is present. **Survey area 8:** Some 'general habitat', REs 11.3.26 and 11.5.20, is present. **Survey area 9:** Some 'general habitat', REs 11.3.4 and 11.3.25, is present. **Survey area F:** No 'general habitat' is present.
Criteria 1: lead to a long-term decrease in the size of a population.	**Survey area 2, 7, 8, 9, F**: Survey area F has no habitat classed as 'general habitat.' Survey area 2 has 'general habitat' but is north of the known distribution. Survey areas 7, 8 and 9 have some 'general habitat.' There is no known population for these properties on these properties. It is not possible to totally discount occurrence of the species on survey areas 7, 8 and survey area 9. Pre-clearance surveys may be required once project footprints have been identified. Based on current knowledge of habitat and distribution, a population is not present on the properties, hence no long term decrease in population size will occur due to project activities.
Criteria 2: reduce the area of occupancy of a population.	**Survey area 2, 7, 8, 9, F**: Will not reduce the area of occupancy of a population based on detail provided in Criteria 1.
Criteria 3: fragment an existing population into two or more populations.	**Survey area 2, 7, 8, 9, F**: Will not fragment an existing population based on detail provided in Criteria 1.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2, 7, 8, 9, F**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of a population.	**Survey area 2, 7, 8, 9, F**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.
Criteria 6: modify, destroy, remove, isolate or decrease the availability of quality of habitat leading to the decline of the species.	**Survey area 2, 7, 8, 9, F:** Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, 7, 8, 9, F**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions: There are no known records of regent honeyeater (*Anthochaera phrygia*) on any of the survey areas and all are at the northern limit of, or outside, the species known range. Local records represent transient individuals and all known or possible populations are located well south of the five survey areas. Based on current population knowledge, impacts are not considered significant when assessed under MNES criteria and cumulative impacts are not expected to be reinforced by Arrow related activities. Actions on these properties are unlikely to be unknown, unpredictable or irreversible.

Rule(s) for survey effort required in accordance with survey guidelines:
DEWHA (2010b) guidelines suggest that area searches and targeted searches should be conducted for 20 hrs over ten and five days respectively, based on a 50 ha area. It is recognised that searches of this intensity cannot be acheived given the scale of the project. Appropriate survey requirements for this species are as follows:

Areas classed as 'core habitat known' should be avoided and do not require survey work on this basis. Areas classed 'core habitat possible' should be avoided but, if clearing is required, survey work should be conducted before any gas related work is undertaken. This work should include:

- Area searches of suitable habitat during the morning period (before 9am). Birds can be detected by call and visual observation.
- Targeted searches of flowering trees and around waterpoints such as dams and creeklines. These works are best undertaken when suitable foraging resources are in blossom.
- Call broadcast may also be useful immediately before, or during, the breeding season (May to March, mostly September to November; Higgins et al. 2001).

As surveys can require detection by call, surveys should be undertaken by personnel with previous survey experience and call identication capabilities.

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

Status: **EPBC Act**: Vulnerable (as *Nyctophilus timoriensis sensu lato*); **NC Act**: Vulnerable

BoT: Medium

Sensitivity: Moderate

Recovery Plan: Draft national recovery plan for the south-eastern long-eared bat *Nyctophilus corbeni* (Schulz and Lumsden 2010).

Photograph 40. South-eastern long-eared bat (*Nyctophilus corbeni*) (Photograph Angus McNab).

Alternative Nomenclature: Taxonomic revision of *Nyctophilus timoriensis* has revealed four geographically separated forms (Parnaby 2009). The south-eastern form has been called *Nyctophilus corbeni* (south-eastern long-eared bat) and is protected under legislation as *N. timoriensis sensu lato* (south-eastern form).

Overview of south-eastern long-eared bat

Ecology: Little is known about the ecology of this species and most of what is known comes from research outside of Queensland (Reardon 2012). Roosting has been recorded in hollows of live trees, cracks in tree limbs, occasionally under exfoliating bark and even within foliage (Churchill 2008; Turbill *et al*. 2008; Reardon 2012). With broad, short wings, the south-eastern long-eared bat is highly manoeuvrable and well-adapted to its cluttered habitat. They fly close to vegetation, often through the canopy and can drop suddenly to almost ground level after prey (Churchill 2008). Individuals are known to fly more than seven km moving between roosts and foraging areas. Roosts may be changed frequently, with an average of 1.3 days in one study (Reardon 2012).

Mating occurs in autumn and winter. Females are able to store spermatozoa until ovulation and conception in early spring. Two young are usually born in late October to November and lactation continues until January (Turbill *et al.* 2008).

Habitat: The south-eastern long-eared bat (*Nyctophilus corbeni*) is most common in box/ironbark/cypress pine woodland on sandy soils (Turbill and Ellis 2006; Churchill 2008; Turbill *et al*. 2008), though it also occurs in bulloak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities (Turbill *et al*. 2008), dry sclerophyll forests with *Corymbia citriodora*, and semi-evergreen vine thickets. The species prefers areas with a distinct canopy and a dense understorey (Churchill 2008). Most records are from large tracts of vegetation of approximately 5000+ ha (e.g., Southwood National Park) (EPA 2008a), although the species can be recorded from smaller tracks of 600 ha (e.g., Erringibba National Park; M. Sanders unpub. data).

Distribution: The species is largely restricted to the Murray-Darling Basin (Churchill 2008; Turbill *et al*. 2008), with its stronghold in the Pilliga forests of central New South Wales (Turbill and Ellis 2006). In Queensland the species is mainly recorded in Brigalow Belt South, with records from less than 30 locations (Reardon 2012). The distributional limits in Queensland are uncertain. McFarland *et al.* (1999) state that the species is found north to near Duaringa and Venz *et al*. (2002) consider that the Dawson River area is at, or close to, its northern range limit. However, Parnaby (2009), in a taxonomic review of Australian greater long-eared bats previously known as *N. timoriensis*, states that the most northerly record of the species is from 80 km west of Taroom. Forearm length is used extensively in field identifications of *Nyctophilus* species and there is broad overlap between each species for each sex of *N. corbeni* and *N. gouldi*. Larger individuals of *N. gouldi* are the same general size as *N. corbeni* (Parnaby 2009). It is unknown if possible misidentifications of the species have resulted in the uncertainty attached to its distribution.

Likelihood of occurrence in the project development area and extent of habitat: There are eight known database records for the project development area. One record is from approximately 25 km north of Miles. Six records are from an area approximately 30 km south-west of Millmerran. There are also two recent survey records one from approximately 18 km north north-east of Miles, the second on survey area F. **Figure A38** indicates the location of known records of the species (derived from databases and survey records) as well as providing representation of the distribution in the project development area of areas classified as ‘core habitat known’, ‘core habitat possible’, ‘general habitat’ and areas where the species is considered unlikely to occur, ‘absence suspected.’ The extent of habitat within specific areas of the project development area is summarised within **Table A83.**

Table A83. Extent of habitat for south-eastern long-eared bat (*Nyctophilus corbeni*) in the project development area and associated areas of assessment.

	Core Habitat Known (ha)	Core Habitat Possible (ha)	General Habitat (ha)
Project Development Area*	14716	185001	0
3D Detailed Mapping Area**	702	23792	0
3D Detailed Mapping Area based on EHP***	12947	41179	0
Survey area 2****	702	663	0
Survey area 7 ****.	0	156	0
Survey area 8****.	0	2131	0
Survey area 9****.	0	342	0
Survey area F****.	0	97	0

* Based on attribution of regional ecosystem mapping of EHP (2012a) following mapping rules detailed within this profile. Level of confidence = ***Low***

** Based on 1: 40 000 scale RE mapping undertaken within PL areas by 3D Environmental (3D Environmental 2013). Level of Confidence = ***Moderate***

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

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

General threats to the species: The main threats to the local populations of south-eastern long-eared bat (*Nyctophilus corbeni*) are:

- Major habitat loss over a large part of its distribution, mostly clearing of brigalow (Reardon 2012).
- Degradation of habitat from grazing.
- Loss of hollows and larger trees from logging and fires (Turbill et al. 2008).
- Increased competition for hollows from other species
- Increased exposure to predators (Reardon 2012).

Survey data suggest that large, intact remnants of suitable habitat are required to support populations (Turbill and Ellis 2006; Turbill *et al*. 2008). With more than 75% of habitat cleared in some parts of its range, land clearing and fragmentation continue to threaten this species (Duncan *et al.* 1999). Increased competition for hollows is an example of a flow-on impact from fragmentation (Reardon 2012).

Project-related impacts: Evidence suggests that this species is absent from small patches, occuring only in patches equal to or larger than Southwood National Park in extent (approximately 5,000 ha) (EPA 2008a). However, the effect of fragmentation and disturbance associated with the construction of tracks and linear clearing is uncertain. Possible project-related impacts include:

- Potential death or injury of roosting bats caused by diurnal clearing of roosts. Depending on the extent of clearing, displaced animals forced into nearby habitats are unlikely to persist due to increased competition with resident animals.
- The loss of foraging and roosting habitat due to the construction of infrastructure.
- Fragmentation of existing large, intact and contiguous habitats. The species does occur in large forests that are traversed by management tracks, suggesting that they could be tolerant of some disturbance.
- Increased fire frequency associated with increased human activity and machinery.
- Increased watering points by the creation of surface ponds around gas wells. Flying insect abundance may also be increased around these waterbodies.

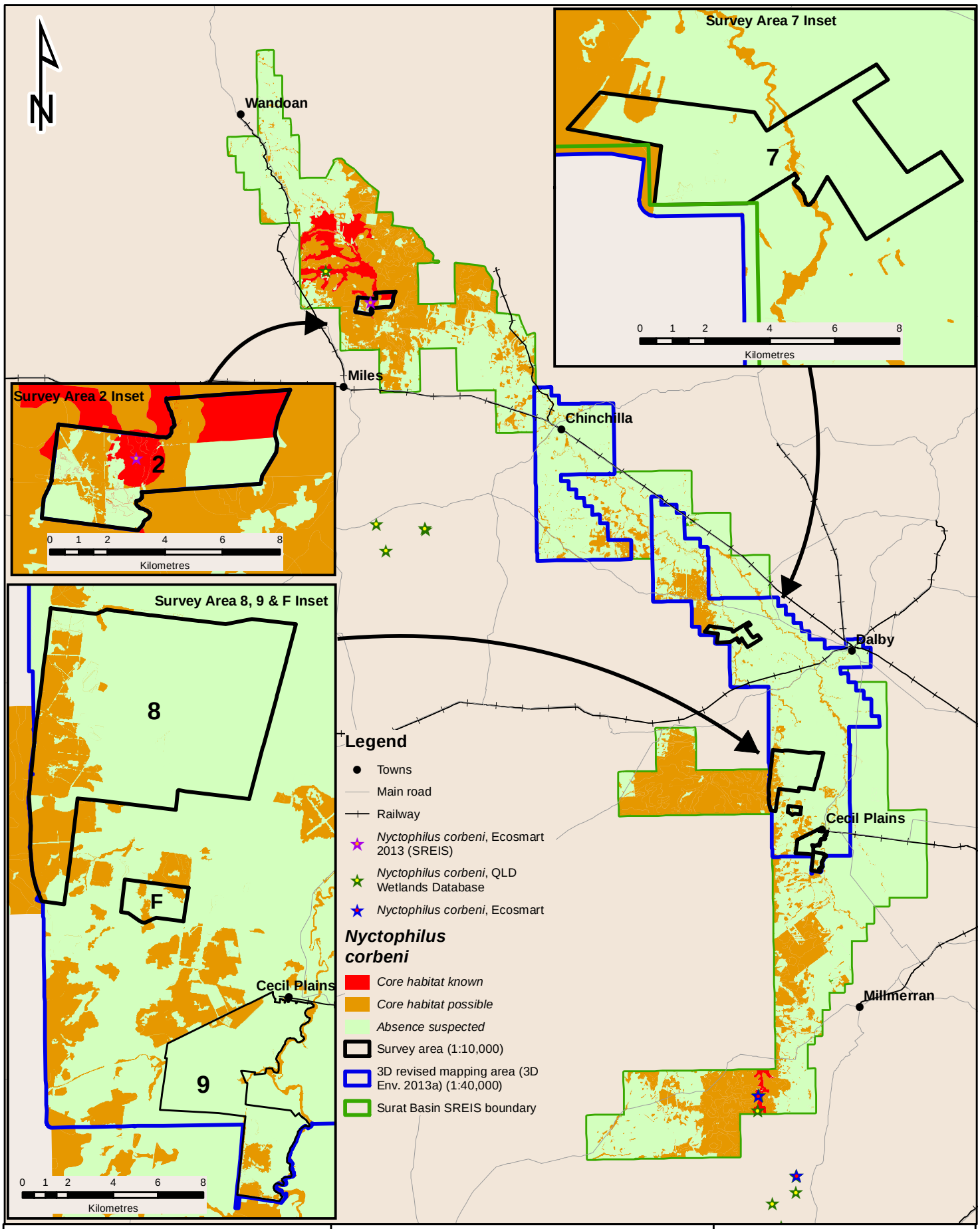
Significance of project related impacts (unmitigated): The sensitivity of populations of south-eastern long-eared bat (*Nyctophilus corbeni*) to unmitigated impacts within the project development area is considered ***Moderate***. The species is highly mobile and may be tolerant of small-scale disturbance associated with activities such as gas acquisition pipelines and bores. More substantial clearing of vegetation associated with larger infrastructure (e.g., power generation plants, groundwater dams, etc) will have greater impacts. While it seems improbable that these activities will result in the extinction of a population, it may reduce available habitat and affect roosting opportunities.
Based on these factors, both the species sensitivity and impact magnitude are evaluated as ***Moderate*** for an overall impact significance of ***Moderate*** (13).

Species specific management/ mitigation measures: Management of this species is covered in Arrow mitigation commitments provided within **Appendix A**. Infrastructure design and site selection that seeks to avoid core habitat known of south-eastern long-eared bat will be prioritised. In addition, any Habitat offsets that may be required under the Queensland Biodiversity Offset Policy (version 1). 3 October 2011 (DERM 2011) and/or the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (SEWPAC 2012b) should be connected to much larger contiguous tracks of vegetation to be successful.

Summary residual impact assessment: Unmitigated project related activities may result in impacts of ***Moderate*** significance to south-eastern long-eared bat (*Nyctophilus corbeni*) populations in the project development area. If habitat is avoided, no impact will be incurred. Mitigation measures other than habitat avoidance will not significantly reduce residual impact, remaining at ***Moderate (13)***.

Residual Impact Assessment				
Avoidance*			Other mitigation measures[#]	
Sensitivity Ranking	Magnitude Ranking	Significance Ranking	Magnitude Ranking	Significance Ranking
Moderate	NA	NA	Moderate	Moderate (13)

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



NOTES:

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

Notes: Core Habitat Known applies to species records with confirmed locations.
Data Sources:
3d Environmental (takes precedence);
EHP Regional Ecosystem Data (EHP 2012a);
EHP Mature Regrowth Dataset (EHP 2012b).
Queensland Wetlands Database
Ecosmart 2013 (SREIS)

Figure A38. South-eastern long eared bat *(Nyctophilus corbeni)* distribution in project development area.

Client Arrow

0 15 30 45 60
Kilometres

Scale	Drawn By	Checked	File Path	Date	
1:1,083,672	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd	3/05/2013	A4

3D Environmental
Vegetation Assessment & Mapping Specialists
P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 822 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Surat\3d_DEHP_A4P_3513_Defrag.mxd

Rules for Habitat Mapping:

1. The known distribution of this species encompasses the entire project development area.
2. All remaining remnant vegetation (except very open communities; regional ecosystems (REs) 11.3.2, 11.3.21) greater in extent than 5000 ha (including cumulative area where patches are separated by less than 100 m) should be considered 'core habitat possible.'
3. All 'core habitat possible' REs within one km of a recent (1980+), accurate (± 500 m) record is classed as 'core habitat known.'
4. Any RE polygon containing a recent (1980+), accurate (± 500 m) record in the area is classed as 'core habitat known' unless it is a heterogeneous polygon that includes REs 11.3.2 and 11.3.21. Such areas should be excluded.\
5. Regrowth and mature regrowth (as per EHP 2012b) Is excluded.
6. All remaining remnant vegetation is mapped as 'absence suspected.'
7. Cleared non-remnant areas are classed as 'absence suspected.'

For heterogeneous polygons, the above rules are applied where the relevant REs are found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present (i.e., excluding REs 11.3.21, 11.3.24, 11.3.27a and 11.7.5). For rule 2 this is applied on a site specific basis and exclusion of polygons based on size or distance has not been methodically undertaken across the broader areas of the datasets.

Mapping Confidence: Important habitat for this species is reasonably well understood and can be matched to regional ecosystem descriptions. While highest abundance is located within these habitats, the species can occur in other habitats and hence may occur outside of mapped habitats. Consequently, the map is considered to be of ***Moderate*** accuracy.

Evaluation under MNES Referral Guidelines:

Table A84. Evaluation of impact significance for south-eastern long-eared bat (*Nyctophilus corbeni*) under MNES Guidelines.

Criteria	Evaluation
'Important populations' and distribution of the species in the project development Area.	*The South-eastern long-eared bat* (*Nyctophilus corbeni*) *is rare throughout most of its distribution. In some areas however, it is more commonly recorded. These areas include the Brigalow Belt South and Nandewar Bioregions in north-eastern NSW* (SEWPAC 2013f). No definition of an 'important population' is provided. There are seven known database records for the project development area. One record is from approximately 25 km north of Miles. Six records are from an area approximately 30 km south-west of Millmerran. There is also a survey record from approximately 18 km north of Miles. **Survey area 2**: Field survey trapped one individual of this species. The species could occur in all remnant and mature regrowth vegetation on the property. This vegetation is part of a large contiguous area of suitable remnant vegetation which extends beyond the property boundaries. It is not known if this individual represents an 'important population' but should be treated as such. **Survey area 7 and 8**: These properties border much larger tracks of near-

Criteria	Evaluation
	contiguous forest associated with State Forest, and as such, may contribute to a larger patch of suitable habitat for the south-eastern long-eared bat. **Survey area 9:** While there is vegetation consistent with this species habitat preference, this patch is probably too minor in extent to support permanent populations. There is no known population for these properties. **Survey area F**: Recent surveys by Ecosure recorded an individual of this species (Coffey *pers.comm*). Habitat within the area is suitable for the species even though the patch is relatively minor in extent.
Criteria 1: lead to a long-term decrease in the size of an important population.	**Survey area 2:** The survey record indicates that all remnant and mature regrowth vegetation on the property may support an important population of south-eastern long-eared bat. The project could possibly lead to a long-term decrease in the size of an important population, although the loss of individuals would be localised. Significant impacts under Criteria 1 are to be expected. **Survey area 7 and 8**: It is not possible to totally discount occurrence of the species on any of these properties. Pre-clearance survey will be required once project footprints have been identified. **Survey area 9:** The species is not expected to occur and activities will not therefore lead to a decrease in population size. **Survey area F**: The survey record indicates that patches of remnant and mature regrowth vegetation on the property may support an important population of south-eastern long-eared bat. The project could possibly lead to a long-term decrease in the size of an important population. Hence significant impacts under Criteria 1 are expected.
Criteria 2: reduce the area of occupancy of an important population.	**Survey area 2 and F:** The project could reduce the area of occupancy of an important population. Although the loss of habitat is minor in the context of surrounding available habitat, significant impacts under Criteria 2 are expected. **Survey area 7, 8, 9:** Will not reduce the area of occupancy of an important population based on detail provided in Criteria 1.
Criteria 3: fragment an existing important population.	**Survey area 2:** Broadscale clearing of survey area 2 will result in minor impact to a wildlife corridor of state significance, but it will not impact the broader east-west trending wildlife corridor which passes to the north. The project will not fragment an existing important population if the species occurs in the contiguous habitat beyond the boundaries of survey area 2. Hence impacts under Criteria 3 are not expected to be significant. **Survey area 7, 8, 9:** Will not fragment an existing important population based on detail provided in Criteria 1. **Survey area F**: Survey area F is already located within a landscape subject to some degree of fragmentation. Remaining remnant vegetation on the property is separated from much larger contiguous remnant vegetation by short distances (i.e., <500 m) of modified land. On balance, most areas of remnant vegetation occur to the west, while the bulk of land to the east has been subject to agricultural clearing. As such, vegetation on the property is most likely to be near the limit of south-east long-eard bat habitat in the local area. The loss of this habitat is therefore unlikely to fragment the population and impact under Criteria 3 are not expected.
Criteria 4: adversely affect habitat critical to the survival of the species.	**Survey area 2** and **F:** The project could adversely affect habitat critical to survival of the species, although impacts are expected to be localised and not affect the broader population/habitat. Hence significant impact is not expected. **Survey area 7, 8, 9**: Will not adversely affect habitat critical to survival of the species based on detail provided in Criteria 1.
Criteria 5: disrupt the breeding cycle of an important population.	**Survey area 2, F:** Impacts to the breeding cycle of this species will be restricted to a small number of individuals within survey area 9. Impacts will not affect breeding in the broader population/habitat and significant impact is not expected. **Survey area 7, 8, 9**: Will not disrupt the breeding cycle of an important population based on detail provided in Criteria 1.

Criteria	Evaluation
Criteria 6: modify, destroy, remove, isolate or decrease habitat leading to the decline of the species.	**Survey area 2, F:** The project could modify, destroy, remove, isolate or decrease habitat leading to decline of the species. However impacts are expected to be localised and unlikely to affect the broader population. Hence significant impact under this criteria are not expected. **Survey area 7, 8, 9**: Will not modify, destroy, remove, isolate or decrease habitat leading to decline of the species based on detail provided in Criteria 1.
Criteria 7: result in the establishment of a harmful invasive species.	**Survey area 2, 7, 8, 9, F**: Will not result in the establishment of an invasive species. Extensive measures to control the introduction and spread of exotic species within the proponent's tenements are proposed.
Criteria 8: introduce a disease that may cause the species to decline.	**Survey area 2, 7, 8, 9, F**: Will not result in the introduction of a disease.
Criteria 9: interfere with the recovery of the species.	**Survey area 2, F:** One of the objectives of the *draft National Recovery Plan for the South-eastern Long-eared Bat* (*Nyctophilus corbeni*) (Schulz and Lumsden 2010) is to: Identify key populations and protect these from habitat loss and fragmentation. Broadscale clearing of survey area 2 and F does not comply with this objective and significant impact under Criteria 9 is expected. **Survey area 7, 8, 9**: Will not interfere with the recovery of the species based on detail provided in Criteria 1.

Conclusions:

Survey area 2 and F: The south-eastern Long-eared bat (*Nyctophilus corbeni*) has been recorded in remnant and advanced regrowth on survey area 2 and on survey area F. Assuming the development would result in clearing of core habitat known and core habitat possible within survey areas 2 and F, a decrease in population size and extent is expected. Hence it is likely that there will be a significant impact under the definitions of Criteria 1 and Criteria 2. Whilst significant, these impacts will be localised and are not expected to affect the broader population. Significant impact is also expected under Criteria 9 as any development action which disturbs known habitat for the species is contrary to the draft recovery plan for the species.

Survey areas 7, 8, 9: No known populations occur on survey area 7, 8, or 9, although further work is required to assess this species presence, particularly on survey area 7 and 8. Based on the assumption that the species is not present, the magnitude of impacts from development on these three properties is of extremely low magnitude and significant impact under MNES criteria is not expected. This assumes pre-clearance surveys are undertaken in areas of potential habitat (core habitat possible) and the species is not recorded.

This species inhabits larger patches of vegetation (i.e., >5000 ha); few records occur in fragmented or isolated habitats. While narrow gathering lines and roadways (<50 m wide) may not affect this species (based on its occurrence in large areas dissected by management tracks), the impacts of wider easements is unknown.

The potential for cumulative impacts remains uncertain although if habitat is cleared, development activities will potentially reinforce cumulative impact to the species incurred across a range of

interacting projects. Rehabilitation upon decomission has the potential to establish native vegetation, which over time should progress toward a native vegetation community. The loss of habitat therefore, may be reversible.

Rule(s) for survey effort required in accordance with survey guidelines: DEWHA (2010a) guidelines recommend 20 trap nights over five nights using both mist netting and harp trapping for every 50 ha of habitat, although mist netting requires specialised licencing that is impractical. Harp traps should be placed in flyways, amoungst cluttered vegetation and over water pools/creeklines (where possible). It is recognised that acheiving 20 trap nights in every 50 ha is unlikely in all cases given the extent of the project development area. The following mitigation measured should be applied based on methods of DEWHA (2010a) although adapted based on information collected during EIS and SREIS studies:

:

- Areas classed as 'core habitat known' should be avoided and do not require survey work on this basis.
- Areas classed 'core habitat possible' should be avoided, but if not possible further survey work should be conducted before any gas related work is undertaken.
- This species can only be reliably identified in the hand, acoustic recording (i.e., anabat) is inadequate, and therefore harp trapping and/or mist netting must be undertaken.

Surveys should be conducted between October to April, and as the species can be difficult to detect multiple surveys may be required. If an individual is recorded in an area of large contiguous habitat, the survey can cease (unless other species are also being targeted) and work should not proceed without evaluation under MNES guidelines. Fauna surveys must be undertaken by suitably qualified ecologists/biologists with a Queensland Scientific Purposes Permit and Ethics approval.

References – MNES Fauna Species

Baker, A. J., Pereira, S. L., Rogers, D. I., Elbourne, R. and Hassell, C. J. (2007). Mitochondrial-DNA evidence shows the Australian painted snipe is a full species, *Rostratula australis*. *Emu* 107, 185-189.

Eyre, T. J., Ferguson, D. J., Hourigan, C. L., Smith, G. C., Mathieson, M. T., Kelly, A. L., Venz, M. F. and Hogan, L. D. (2012). Terrestrial Vertebrate Fauna Survey Assessment Guidelines for Queensland. *Department of Science, Information Technology, Innovation and the Arts*, Queensland Government, Brisbane.

Spark, P. (2010). Survey of the Habitat Requirements and Review of the Conservation Status of the Five-clawed Worm-skink (*Anomalopus mackayi*) within the Namoi River Catchment. Report to the Namoi Catchment Management Authority: Threatened Grassland Reptile Species Project, Tamworth. *North West Ecological Services*, Tamworth.

Baptista, L. F., Trail, P. W. and Horblit, H. M. (1997). 'Family Columbidae (Pigeons and Doves),' in Handbook of the birds of the world: Vol. 4. Sandgrouse to cuckoos, eds. J. del Hoyo, A. Elliott and J. Sargatal, *Lynx Edicions*, Barcelona. pp. 60-245.

BCC (2006). Collared Delma Conservation Action Statement. *Brisbane City Council*, Brisbane.

Beruldsen, G. (2003). Australian birds, their nests and eggs. *Phoenix Offset*, China.

Birds Queensland (2011). Bird sightings. (available online) Birds Queensland. http://birdsqueensland.org.au (accessed 4th January 2011).

Black, R., Houston, W. and Jaensch, R. (2010). Evidence of regular seasonal migration by Australian painted snipe *Rostratula australis* to the Queensland tropics in autumn and winter. *Stilt* 58, 1-9.

Blakers, M., Davies, S. J. J. F. and Reilly, P. N. (1984). The atlas of Australian birds. *Melbourne University Press*, Melbourne.

Brereton, R. and Backhouse, G. (2003). Action Statement No. 35 Southern Earless Dragon *Tympanocryptis lineata pinguicolla*. Dept. Natural Resources & Environment, Melbourne. Available from http://www.dse.vic.gov.au/CA256F310024B628/0/48AA9275A4E8C84DCA25709200225080/$File/035+Grassland+Earless+Dragon+1993.pdf

Brigalow Belt Reptiles Workshop (2010). Proceedings from the workshop for the nine listed reptiles of the Brigalow Belt bioregions. 18-19 August 2010. *Queensland Herbarium*, Brisbane.

Christidis, L. and Boles, W. E. (2008). Systematics and taxonomy of Australian birds. *CSIRO Publishing,* Collingwood.

Churchill, S. (2008). Australian bats. Second Edition. *Allen & Unwin*, Crows Nest.

Cogger, H. G. (2000). Reptiles and amphibians of Australia. *Reed New Holland*, Sydney.

Cogger, H. G., Cameron, E. E., Sadlier, R. A. and Eggler, P. (1993). The action plan for Australian reptiles. *Australian Nature Conservation Agency*, Canberra.

Covacevich, J. A., Couper, P. J. and McDonald, K. R. (1998). Reptile diversity at risk in the Brigalow Belt, Queensland. *Memoirs of the Queensland Museum* 42, 475-486.

Covacevich, J., Dunmall, W. and Sorley, J. A. (1988). 'Reptiles,' in Lake Broadwater: The natural history of an inland lake and its environs. ed. G. Scott. *Darling Downs Institute Press*, Toowoomba. pp. 265-273.

Crome, F. H. J. (1976). Breeding, moult and food of the squatter pigeon in north-eastern Queensland. *Australian Wildlife Research* 3, 45-59.

Davidson, C. (1993). Recovery Plan for the Collared Legless Lizard (*Delma torquata*). *Department of Environment and Heritage*, Brisbane.

Department of Environment and Heritage Protection (DEHP) (2012a). Regional Ecosystem Digital Data Version 7.0. *Queensland Government*, Brisbane.

EHP (2013). Brigalow scaly-foot. Department of Environment and Heritage Protection, Brisbane. http://www.ehp.qld.gov.au/wildlife/animals-az/brigalow_scalyfoot.html.

DERM (2011). Queensland Biodiversity Offset Policy (version 1). 3 October 2011. *Department of Environment and Resource Management,* Brisbane.

DEWHA (2010a). Survey guidelines for Australia's threatened bats: Guidelines for detecting bats listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. *Department of Environment, Water, Heritage and the Arts*, Canberra.

DEWHA (2010b). Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. *Department of Environment, Water, Heritage and the Arts*, Canberra.

Drury, W. (2001). Reptiles under threat in Queensland's Southern Brigalow Belt. *World Wide Fund for Nature*, Brisbane.

DEWPaC (2011) Survey guidelines for Australia's threatened reptiles. Guidelines for detecting reptiles listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. *Department of Sustainability, Environment, Water, Population and Communities,* Canberra.

SEWPAC (2012). Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012. *Department of Sustainability, Environment, Water, Population and Communities,* Canberra.

SEWPAC (2013a). *Anomalopus mackayi* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 17 Jan 2013 16:36:40 +1100.

SEWPAC (2013b). *Anthochaera phrygia* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 7 Feb 2013 16:44:30 +1100.

SEWPAC (2013c). *Egernia rugosa* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Sat, 26 Jan 2013 10:22:09 +1100.

SEWPAC (2013d). *Furina dunmalli* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Feb 2013 12:00:55 +1100.

SEWPAC (2013e). *Geophaps scripta scripta* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Wed, 13 Mar 2013 11:20:14 +1100.

SEWPAC (2013f). *Nyctophilus corbeni* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 14 Mar 2013 10:35:33 +1100.

SEWPAC (2013g). *Paradelma orientalis* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 17 Jan 2013 14:20:18 +1100.

SEWPAC (2013h). *Rostratula australis* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities, Canberra*. Available from: http://www.environment.gov.au/sprat. Accessed Thu, 14 Mar 2013 09:13:58 +1100.

SEWPAC (2013i). *Tympanocryptis pinguicolla* in Species Profile and Threats Database, *Department of Sustainability, Environment, Water, Population and Communities*, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 5 Mar 2013 14:27:50 +1100.

Duncan, A., Barker, G. B. and Montgomery, N. (1999). The action plan for Australian bats. *Environment Australia*, Canberra.

Eddie, C. (2012). 'Yakka Skink,' In: Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 224-225.

Ehmann, H. (1992). Encyclopedia of Australian animals: Reptiles. *Angus and Robertson*, Sydney.

EPA (2003). BPA BRB South Fauna Expert Panel in Brigalow Belt South Biodiversity Planning Assessment. *Environmental Protection Agency*, Brisbane.

EPA (2008a). BPA BRB South Fauna Expert Panel Report – V 1.3, June 2008. *Environmental Protection Agency*, Brisbane.

EPA (2008b). Regent honeyeater *Xanthomyza phrygia* Conservation Management Profile. *Environmental Protection Agency*, Brisbane. Available from: http://www.derm.qld.gov.au/register/p02354aa.pdf.

Fensham, R. J. (1999). Native grasslands of the Central Highlands, Queensland, Australia: Floristics, regional context and conservation. *Rangeland Journal* 21, 82-103.

Fitzgerald, M. (1996). Conservation Management Profile, Five clawed worm-skink *Anomalopus mackayi*. *Environmental Protection Agency*, Brisbane. Available at http://www.derm.qld.gov.au/register/p02321aa.pdf

Ford, H., Davis, W. E., Debus, S., Ley, A., Recher, H. and Williams, B. (1993). Foraging and aggressive behaviour of the regent honeyeater *Xanthomyza phrygia* in northern New South Wales. *Emu* 93, 277-281.

Ford, J. (1986). Avian hybridisation and allopatry in the region of the Einasleigh Uplands and Burdekin-Lynd Divide, north-eastern Queensland. *Emu* 86, 87-110.

Franklin, D. C. (1999). Evidence of disarray amongst granivorous bird assemblages in the savannas of northern Australia, a region of sparse human settlement. *Biological Conservation* 90, 53-68.

Franklin, D., Menkhorst, P. and Robinson, J. (1989). Ecology of the regent honeyeater *Xanthomyza phrygia. Emu* 89, 140-154.

Frith, H. J. (1982). Pigeons and doves of Australia. *Rigby*, Adelaide.

Garnett, S. ed. (1993). Threatened and extinct birds of Australia. Royal Australasian Ornithologists Union and Australian National Parks and Wildlife Service, Moonee Ponds.

Garnett, S. T. and Crowley, G. M. (2000). The action plan for Australian birds. *Environment Australia*, Canberra.

Garnett, S. T., Szabo, J. K. and Dutson, G. (2011). The action plan for Australian birds 2010. *CSIRO Publishing*, Collingwood.

Geering, D. (2012). 'Regent Honeyeater,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 316-317.

Geering, A., Agnew, L. and Harding, S. (2007). Shorebirds of Australia. *CSIRO Publishing*, Collingwood.

Geering, D. and French, K. (1998). Breeding biology of the regent honeyeater *Xanthomyza phrygia* in the Capertee Valley, New South Wales. *Emu* 98, 104-116.

Gow, G. R. and Swanson, S. (1977). Snakes and lizards of Australia. *Angus and Robertson Publishers*, Sydney.

Higgins, P. J. and Davies, S. J. J. F. eds. (1996). Handbook of Australian, New Zealand and Antarctic birds, Vol. 3. Snipe to pigeons. *Oxford University Press*, Melbourne.

Higgins, P. J., Peter, J. M. and Steele, W. K. eds. (2001). Handbook of Australian, New Zealand and Antarctic birds, Vol. 5. Tyrant-flycatchers to chats. *Oxford University Press*, Melbourne.

Hobson, R. (2002). Vertebrate fauna survey of remnant native grasslands of the eastern Darling Downs. *Queensland Parks and Wildlife Service*, Toowoomba.

Hobson, R. (2012a). 'Dunmall's Snake,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, CSIRO Publishing, Collingwood. pp. 243-244.

Hobson, R. (2012b). 'Long-legged Worm-Skink,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 222-223.

Johnstone, R. E. and Storr, G. M. (1998). Handbook of Western Australian birds. Vol. 1. Non-passerines (emu to dollarbird). *Western Australian Museum*, Perth.

Kutt, A. S., Hannah, D. S. and Thurgate, N. Y. (2003). Distribution, habitat and conservation status of *Paradelma orientalis* Gunther 1876 (Lacertilia: Pygopodidae). *Australian Zoologist* 32, 261-264.

Lane, B. A. and Rogers, D. I. (2000). The Australian painted snipe *Rostratula (benghalensis) australis*: An endangered species? *Stilt* 36, 26-34.

Lindenmayer, D. B. and Fischer, J. (2006). Habitat fragmentation and landscape change. An ecological and conservation perspective. *CSIRO Publishing*, Canberra.

Marchant, S. and Higgins, P. J. eds. (1993). Handbook of Australian, New Zealand and Antarctic birds, Vol. 2. Raptors to lapwings. *Oxford University Press*, Melbourne.

McFarland, D., Venz, M. and Reis, T. (1999). Priority Species Summaries. An Attachment to the Report: Terrestrial Vertebrate Fauna of the Brigalow Belt South Bioregion: Assessment and Analysis for Conservation Planning. *Queensland Environmental Protection Agency*, Brisbane.

Melville, J., Goebel, S., Starr, C., Keogh, J. S. and Austin, J. J. (2007). Conservation genetics and species status of an endangered Australian dragon, *Tympanocryptis pinguicolla* (Reptilia: Agamidae). *Conservation Genetics* 8, 185-195.

Menkhorst, P. W. (1997). Regent Honeyeater Recovery Plan 1994-1998. *Department of Natural Resources and Environment,* Melbourne.

Menkhorst, P., Schedvin, N. and Geering, D. (1999). Regent Honeyeater Recovery Plan - 1999-2003. *Vic NRE*. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/regent-h-eater/index.html.

Morris, A. K. (1993). Second report of the New South Wales Ornithological Records Appraisal Committee June 1993. *Australian Birds* 26, 121-133.

NSW NPWS (2003). Threatened species of the New England Tablelands and north west slopes of New South Wales. *NSW National Parks and Wildlife Service*, Coffs Harbour.

Oliver, D. L. (2000). Foraging behaviour and resource selection of the regent honeyeater *Xanthomyza phrygia* in northern New South Wales. *Emu* 100, 12-30.

Oliver, D., Ley, A. and Williams, M. B. (1998). Breeding success and nest-site selection of the regent honeyeater *Xanthomyza phrygia* near Armidale, New South Wales. *Emu* 98, 97-103.

Oring, L.W., Rogers, D., Oring, K.E. and Tzaros, C. (2004). Snipes in peril. *Wingspan* 14, 10-15.

Parnaby, H. E. (2009). A taxonomic review of Australian greater long-eared bats previously known as *Nyctophilus timoriensis* (Chiroptera: Vespertilionidae) and some associated taxa. *Australian Zoologist* 35, 39-81.

Peck, S. (2003). Conservation Status Review and Management Recommendations for the Collared Delma *Delma torquata* in Brisbane City. Report prepared for Brisbane City Council.

Peck, S. (2012a). 'Brigalow Scaly-foot,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 220-221.

Peck, S. (2012b). 'Collared Delma,' in Queensland's threatened animals, eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 218-219.

Pizzey, G. (1980). A field guide to the birds of Australia. *Collins*, Sydney.

Porter, R. (1998). Observations on a large population of the vulnerable pygopodid, *Delma torquata*. *Memoirs of the Queensland Museum* 42, 565-572.

Pringle, J. D. (1987). The shorebirds of Australia: The National Photographic Index of Australian wildlife. *Angus and Robertson*, North Ryde.

Reardon, T. (2012). 'South-eastern Long-eared Bat,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 386-387.

Reis, T. (2012). 'Squatter Pigeon (southern subspecies),' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 254-255.

Richardson, R. (2006). Draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012. Report to the Department of the Environment, Water, Heritage and the Arts, Canberra. *WWF-Australia*, Brisbane.

Robertson, P. and Cooper, P. (2000). Recovery plan for the Grassland Earless Dragon *Tympanocryptis lineata pinguicolla* 2000 - 2004. *Environment Australia*, Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/earless-dragon/index.html.

Robertson, P. and M. Evans (2009). National Recovery Plan for the Grassland Earless Dragon *Tympanocryptis pinguicolla*. *ACT Department of Territory and Municipal Services*, Canberra, Australian Capital Territory: Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/tympanocryptis-pinguicolla.html.

Rogers, D., Hance, I., Paton, S., Tzaros, C., Griffioen, P., Herring, M., Jaensch, R. Oring, L. Silcocks, A. and Weston, M. (2005). **'**The breeding bottleneck: breeding habitat and population decline in the Australian painted snipe,' in Status and conservation of seabirds in the East Asian-Australasian Flyway, ed. P. Straw, Proceedings of the Australasian Shorebirds Conference 13-15 December 2003, Canberra. pp. 15-23.

Ryan, S. (2006). Conservation Management Profile: Collared Delma *Delma torquata*. Ecosystem Conservation Branch, *Environmental Protection Agency*, Brisbane.

Saunders, D. A., Hobbs, R. J. and Margules, C. R. (1991). Biological consequences of ecosystem fragmentation: A review. *Conservation Biology* 5, 18-32.

Schodde, R. and Mason, I. J. (1997). 'Aves (Columbidae to Coraciidae),' in Zoological Catalogue of Australia. Vol. 37.2, eds. W.W.K. Houston and A. Wells, *CSIRO Publishing*, Melbourne.

Schulz, M. and Eyre, T. J. (1997). New distribution and habitat data for the pygopodid, *Paradelma orientalis* (Gunther 1876). *Memoirs of the Queensland Museum* 42, 212.

Schulz, M. and Lumsden, L. (2010). (Draft) National Recovery Plan for the South-eastern Long-eared Bat *Nyctophilus corbeni*. *Victorian Department of Sustainability and Environment*, Melbourne.

Shea, G. M. (1987). Notes on the biology of *Paradelma orientalis*. *Herpetofauna* 17, 5-6.

Shine, R. (1981). Ecology of Australian elapid snakes of the genera *Furina* and *Glyphodon*. *Journal of Herpetology* 15, 219-224.

Starr, C. R. and Leung, L. K.-P. (2006). Habitat use by the Darling Downs population of grassland earless dragon: Implications for conservation. *Journal of Wildlife Management* 70, 897-903.

Stephenson, G. and Schmida, G. 2008. A second record of the elapid snake *Furina dunmalli* from New South Wales. *Herpetofauna* 38, 22-23.

Storr, G. M. (1973). List of Queensland birds. Western Australian Museum Special Publication No. 5, Perth.

Tremul, P. R. (2000). Breeding, feeding and arboreality in *Paradelma orientalis*: A poorly known, vulnerable pygopodid from Queensland, Australia. *Memoirs of the Queensland Museum* 45, 599-609.

TSN (2008). Brigalow Belt bioregion: a biodiversity jewel. [Online]. Threatened Species Network. WWF-Australia. Available from: http://www.wwf.org.au/publications/reptiles-brigalo-belt.pdf.

Turbill, C. and Ellis, M. (2006). Distribution and abundance of the south-eastern form of the greater long-eared bat *Nyctophilus timoriensis*. *Australian Mammalogy* 28, 1-6.

Turbill, C., Lumsden, L. F. and Ford, G. I. (2008). 'South-eastern & Tasmanian Long-eared Bats *Nyctophilus* spp,' in The mammals of Australia, Third Edition. eds. S. Van Dyck, and R. Strahan, *Reed New Holland*, Sydney. pp. 527-528.

Tzaros, C., Ingwersen, D. and Rogers, D. (2012). 'Australian Painted Snipe,' in Queensland's threatened animals. eds. L. K. Curtis, A. J. Dennis, K. R. McDonald, P. M. Kyne and S. J. S. Debus, *CSIRO Publishing*, Collingwood. pp. 274-275.

Venz, M., Mathieson, M. and Schulz, M. (2002). Fauna of the Dawson River Floodplain. *Queensland Parks and Wildlife Service*, Brisbane.

Watkins, D. (1993). A national plan for shorebird conservation in Australia. RAOU Report Series. 90. *RAOU*, Melbourne.

Wilson, S. (2005). A field guide to reptiles of Queensland. *Reed New Holland*, Sydney.

Wilson, S. and Swan, G. (2010). A complete guide to reptiles of Australia. Third Edition. *New Holland Publishers*, Sydney.

APPENDIX E. Migratory Fauna Species

Migratory Birds

Thirty-five species of bird listed as Migratory under the EPBC Act have been recorded in or near the project development area and/or are predicted to occur by Fielder (2012)and the EPBC Act Protected Matters Report generated from the Protected Matters Search Tool maintained by SEWPaC http://www.environment.gov.au/epbc/pmst/index.html (**Appendix F).** Species are listed as Migratory under the EPBC Act due to their inclusion under one of more of the following:

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
- China-Australia Migratory Bird Agreement (CAMBA)
- Japan-Australia Migratory Bird Agreement (JAMBA)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

Two of these species, painted snipe *Rostratula benghalensis* (*sensu lato*) and regent honeyeater (*Xanthomyza phrygia*) have been dealt with as Australian painted snipe (*Rostratula australis*) and regent honeyeater (*Anthochaera phrygia*) in **Appendix D**. They are listed as Vulnerable and Endangered, respectively, under the EPBC Act and the listing of these two species as Migratory under different common and/or scientific names reflects taxonomic changes. The remaining 33 species are all listed as Special Least Concern under the NC Act.

When assessing the significant impact criteria for Migratory species under the EPBC Act it is appropriate to group species. The 33 species to be assessed (**Table A85**) will be grouped under the headings:

- Migratory terrestrial species.
- Migratory wetland species.
- Migratory shorebirds (waders).

Information on ecology, habitat, distribution, threatening processes and evaluation under MNES referral guidelines will also be provided under these three broad headings.

Table A85. Migratory species recorded in or near the project development area and/or predicted to occur.

Species Group	
Species	**International agreement (s)** **Alternative nomenclature**
Terrestrial	
white-throated needletail (*Hirundapus caudacutus*)	CAMBA, JAMBA, ROKAMBA; listed under ROKAMBA as *Chaetura caudacuta*
fork-tailed swift (*Apus pacificus*)	CAMBA, JAMBA, ROKAMBA
eastern osprey (*Pandion cristatus*)	Bonn Convention; listed as *Pandion haliaetus*
white-bellied sea-eagle (*Haliaeetus leucogaster*)	CAMBA
oriental cuckoo (*Cumulus optatus*)	CAMBA, JAMBA, ROKAMBA; listed as *Cuculus saturatus*

Species Group	
Species	**International agreement (s)** **Alternative nomenclature**
rainbow bee-eater (*Merops ornatus*)	JAMBA
rufous fantail (Rhipidura rufifrons)	Bonn Convention
satin flycatcher (*Myiagra cyanoleuca*)	Bonn Convention
black-faced monarch (*Monarcha melanopsis*)	Bonn Convention
spectacled monarch (Symposiarchus trivirgatus)	Bonn Convention; listed as *Monarcha trivirgatus*
Australian reed-warbler (*Acrocephalus australis*)	Bonn Convention; listed as clamorous reed-warbler (*Acrocephalus stentoreus*)
WETLAND	
garganey (*Anas querquedula*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
eastern great egret (*Ardea modesta*)	CAMBA, JAMBA; listed as *Egretta alba*
cattle egret (*Ardea ibis*)	CAMBA, JAMBA; listed under CAMBA as *Ardeola ibis*, under JAMBA as *Bubulcus ibis*
glossy ibis (Plegadis falcinellus)	Bonn Convention, CAMBA
Caspian tern (Hydroprogne caspia)	CAMBA, JAMBA
white-winged black tern (*Chlidonias leucopterus*)	CAMBA, JAMBA
Cotton pygmy goose (*Nettapus coriomandelis)*	CAMBA, JAMBA
SHOREBIRDS	
Pacific golden plover (*Pluvialis fulva*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
oriental plover (*Charadrius veredus*)	Bonn Convention, CAMBA, JAMBA
Latham's snipe (*Gallinago hardwickii*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
black-tailed godwit (*Limosa limosa*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
bar-tailed godwit (*Limosa lapponica*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
little curlew (*Numenius minutus*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
whimbrel (Numenius phaeopus)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
common sandpiper (*Actitis hypoleucos*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA; listed under CAMBA and ROKAMBA as *Tringa hypoleucos*
common greenshank (*Tringa nebularia*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
marsh sandpiper (*Tringa stagnatilis*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
wood sandpiper (*Tringa glareola*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
red-necked stint (*Calidris ruficollis*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
sharp-tailed sandpiper (*Calidris acuminata*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
curlew sandpiper (*Calidris ferruginea*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA
ruff (*Philomachus pugnax*)	Bonn Convention, CAMBA, JAMBA, ROKAMBA

Migratory Terrestrial Birds

This grouping of species follows the broad headings used by SEWPaC for Migratory species, other than for white-throated needletail, fork-tailed swift and Australian reed-warbler. In this instance the majority of their occurrence is associated with terrestrial habitats and they are included on that basis.

Ecology:

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- In Australia, are almost completely aerial species, possibly even sleeping on the wing, though occasionally roost in trees.

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Nest on cliffs and in large trees but eastern osprey also nests on artificial structures such as power poles and towers (Debus 1998; NSW NPWS 2002).

Oriental cuckoo (*Cuculus optatus*):

- Usually only present in Australia between September and May, returning to PNG and Asia during Australian winter

Rainbow bee-eater (*Merops ornatus*):

- Often observed plucking bees and winged insects from above fields, and shrublands. A ground nesting species.

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Very active species, spending muc time foraging in tree tops and along branches for small invertebrates.

Australian reed-warbler (*Acrocephalus australis*):

- Prefers dense vegetation along watercourses. Migratory in southeast Queensland, arriving in spring.

Habitat and distribution:

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- In Australia, are almost completely aerial species, possibly even sleeping on the wing, though occasionally roost in trees.
- Found over a wide variety of habitat, including open and highly modified areas, cities, forests and the ocean (Higgins 1999).
- A seasonal visitor to Australia between October and April.

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Occur along the entire Australian coastline and extend far inland, typically along major rivers or on large lakes and reservoirs.

Oriental cuckoo (*Cuculus optatus*):

- Occurs in rainforest, vine thicket and open forest and woodland and sometimes found in mangroves. Often recorded in gardens and plantations (Blakers et al. 1984; Higgins 1999).

Rainbow bee-eater (*Merops ornatus*):

- A common species that occurs in almost any habitat suitable for catching insects, including towns and other highly modified areas (Higgins 1999).

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Occur in moist habitats, including along gullies and near watercourses (Higgins et al. 2006a).
- Satin flycatcher (*Myiagra cyanoleuca*) is virtually confined to east of the Great Dividing Range (Boles 1988).

Australian reed-warbler (*Acrocephalus australis*):

- Prefers dense swamp vegetation in and adjacent to most wetland types (Higgins et al. 2006b).

Major threats and risks :

White-throated needletail (*Hirundapus caudacutus*) and fork-tailed swift (*Apus pacificus*):

- No apparent major threat to either species overall, either in Australia or elsewhere (SEWPAC 2013a, c).
- Occasionally killed by collision with man-made structures.
- Fork-tailed swift is occasionally killed by cats (*Felis catus*) (Higgins 1999).
- A potential threat is a reduction in prey due to loss of habitat (Low 1995; SEWPAC 2013a).

Eastern osprey (*Pandion haliaetus*) and white-bellied sea-eagle (*Haliaeetus leucogaster*):

- Loss of breeding sites and disturbance at nests (Marchant and Higgins 1993; Debus 1998; NSW NPWS 2002).
- Eastern osprey is threatened by reduction in quality and quantity of fish stocks, collision with or electrocution by power lines, and the use of pesticides (NSW NPWS 2002).
- White-bellied sea-eagle is occasionally illegally shot or poisoned (Marchant and Higgins 1993).

Oriental cuckoo (*Cuculus optatus*):

- Sometimes killed by cats and by collisions with windows and lighthouses (Higgins 1999).

Rainbow bee-eater (*Merops ornatus*):

- Threats to the species are minimal, although cane toads (*Rhinella marina*) have been found to prey on the eggs and nestlings (Boland 2004).

Rufous fantail (*Rhipidura rufifrons*), satin flycatcher (*Myiagra cyanoleuca*), black-faced monarch (*Monarcha melanopsis*) and spectacled monarch (*Monarcha trivirgatus*):

- Loss and fragmentation of moist forest breeding habitat and remnant vegetation and corridors within migration routes (Higgins et al. 2006a).

Australian reed-warbler (*Acrocephalus australis*):

- Loss of habitat due to development (Higgins et al. 2006b). Has benefited from the creation of artificial waterbodies and has extended its distribution in some areas (Blakers et al. 1984).

Potential project-related impacts (unmitigated):

- Some loss and fragmentation of foraging and migration habitat for forest species such as rufous fantail (*Rhipidura rufifrons*).

Mitigation Measures:

Commitments made by Arrow to minmise clearing, manage weeds and rehabilitate areas, as documented within **Table A1**, will minimise impacts on migratory terrestrial birds.

Evaluation under MNES Referral Guidelines

Under the MNES referral guidelines there is no clear definition as to the number of individuals, or percentage of the population reguired to define an ‚ecologically significant proportion' of a terrestrial migratory species. To acquire data on migratory terrestrial species, 25 square km WildNet searches were undertaken to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A86**). Survey areas 8,9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated (e.g., white-bellied sea-eagle).

Based on the presented information, no important populations are likely to occur within the subject properties. Evaluation of these species under MNES guidelines is provided in **Table A87**.

Table A86. Available records/ population evaluation**

Species*	Survey area 2			Survey area 7			Survey area 8,9,F		
	25km search #	Likely Occurrence	Likelihood of significant population	25km search #	Likely Occurrence	Likelihood of significant population	25km search #	Likely Occurrence	Likelihood of significant population
white-throated needletail (*Hirundapus caudacutus*)	4	Possible	Very low	25	Possible	Very low	27	Possible	Very low
fork-tailed swift (*Apus pacificus*)	3	Possible	Very low	4	Possible	Very low	5	Possible	Very low
eastern osprey (*Pandion haliaetus*)	-	Unlikely	Very low	1	Unlikely	Very low	1	Possible	Very low
white-bellied sea-eagle (*Haliaeetus leucogaster*)	-	Known	Very low	55	Possible	Very low	52	Likely	Very low
oriental cuckoo *(Cuculus optatus)*	-	Unlikely	Very low	-	Unlikely	Very low	0	Unlikely	Very low
rainbow bee-eater (*Merops ornatus*)	18	Known	Low	68	Known	Low	66	Known	Low
rufous fantail (*Rhipidura rufifrons*)	-	Unlikely	Very low	6	Unlikely	Very low	6	Unlikely	Very low
satin flycatcher (*Myiagra cyanoleuca*)	1	Low	Very low	-	Low	Very low	-	Low	Very low
black-faced monarch (*Monarcha melanopsis*)	-	Unlikely	Very low	-	Unlikely	Very low	-	Unlikely	Very low
spectacled monarch (*Monarcha trivirgatus*)	-	Unlikely	Very low	-	Unlikely	Very low	1	Unlikely	Very low
Australian reed-warbler (*Acrocephalus australis*)	1	Possible	Very low	22	Unlikely	Very low	18	Possible	Very low

* Species listed are derived from the EPBC Protected Matters Report (**Appendix F**) and from EHP's WildNet database.

** Number of WildNet records within 25 km radius of the centre point of the property.

Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

Table A87. Evaluation of impact significance for Migratory terrestrial birds under MNES Guidelines.

Criteria	Evaluation
• substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	An area of 'important habitat' for a migratory species is: a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or b. habitat that is of critical importance to the species at particular life-cycle stages, and/or c. habitat utilised by a migratory species which is at the limit of the species range, and/or d. habitat within an area where the species is declining (DEWHA 2009a). **Survey area 2**: There is no evidence to suggest the property supports 'important habitat' for Migratory terrestrial species. **Survey area 7, 8, 9, F**: Other than the common and widespread rainbow bee-eater, the most frequently recorded species for these properties is white-bellied sea-eagle. In the project development area this species is associated with large waterbodies, none of which are present on these properties. Rather, records will be from locations such as Lake Broadwater. There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species. Based on current knowledge, project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory terrestrial species.
• result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species,	**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species based on detail provided in Criteria 1. Extensive measures to control the introduction and spread of invasive species within the proponent's tenements are proposed (see table 1)
• seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates). 'Population', in relation to migratory species, means the entire population or any geographically separate part of the population whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia (DEWHA 2009a). **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory terrestrial species known or considered likely to occur.

Migratory Wetland Birds

Habitat:

Garganey (*Anas querquedula*):

- Sewage ponds, lakes and swamps (Marchant and Higgins 1990).

Eastern great egret (*Ardea modesta*), cattle egret (*Ardea ibis*) and glossy ibis (*Plegadis falcinellus*):

- Eastern great egrets (*Ardea modesta*) occur on rivers, estuaries, tidal mudflats, swamps, man-made dams, sewage farms and wet pasture (Marchant and Higgins 1990; McKilligan 2005).
- Cattle egret (*Ardea ibis*) inhabits grasslands and wetlands, often foraging in pasture and crops.
- Glossy ibis (*Plegadis falcinellus*) prefers inland freshwater wetlands with abundant aquatic flora (Marchant and Higgins 1990).

Caspian tern (*Hydroprogne caspia*) and white-winged black tern (*Chlidonias leucopterus*):

- Mostly coastal, but also inland wetlands including lakes and rivers (Higgins and Davies 1996).

Lake Broadwater contains potential habitat for all five of the listed migratory wetland birds. The Lake and associated muddy shallow pond edges and the lake edge provide suitable foraging and retreat sites for the listed species.

Threats:

Garganey (*Anas querquedula*):

- Vagrant to Queensland (Marchant and Higgins 1990). Specific threats unknown.

Eastern great egret (*Ardea modesta*), cattle egret (*Ardea ibis*) and glossy ibis (*Plegadis falcinellus*):

- Loss of breeding habitat through drainage of wetlands, river regulation and groundwater extraction (Marchant and Higgins 1990; Kingsford and Johnson 1998; SEWPAC 2013b).
- Eastern great egret (*Ardea modesta*) and glossy ibis (*Plegadis falcinellus*) are threatened by destruction and modification of freshwater habitats by clearing, livestock, burning, increased salinity and weed invasions (Marchant and Higgins 1990).
- Predation of cattle egret (*Ardea ibis*) nestlings by cats (*Felis catus*) (SEWPAC 2013b) and breeding glossy ibis (*Plegadis falcinellus*) by foxes (*Vulpes vulpes*) (Marchant and Higgins 1990).

Caspian tern (*Hydroprogne caspia*) and white-winged black tern (*Chlidonias leucopterus*):

- Threats to terns are largely confined to breeding colonies. Birds are affected by degradation of feeding areas (Blakers et al. 1984; Higgins and Davies 1996; Garnett and Crowley 2000).

Project-related Threats:

- The temporary loss of vegetation and hence habitat within Long Swamp for the construction of gas-gathering lines.

- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater and Long Swamp.
- Deterioration of water quality within Long Swamp and Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Long Swamp and Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported either directly through clearing practices (Long Swamp) or by surface water flow in Broadwater and Surveyors Gully.

Mitigation Measures:

- Wetland areas (i.e., Lake Broadwater) should be avoided, with a 500 m buffer implemented.
- Infrastructure should not be placed in Long Swamp, or within 100 m of this waterway.

Evaluation under MNES Referral Guidelines

Under the MNES referral guidelines there is no clear definition as to the number of individuals, or percentage of the population reguired to define an ecologically significant proportion' of a wetland migratory species. To acquire data on migratory wetland species, 25 square km WildNet searches were undertaken to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A88**). Survey areas 8,9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated.

Four of the migratory wetland birds (Gargeney (*Anas querquedula*) excluded) are likely to be consistent visitors at Lake Broadwater. However, none of the properties support 'important habitat' for migratory terrestrial species. Dams and wetlands on properties are likely to be visited by a number of these species at various times although it is considered that project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory wetlands species. Further, there is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory wetlands species known or considered likely to occur. Evaluation of these species under MNES guidelines is provided in **Table A89**.

Table A88. Available records/ population evaluation**

Species*	Survey area 2			Survey area 7			Survey area 8,9,F		
	25km search #	Likely Occurrence	Likelihood of significant population	25km search #	Likely Occurrence	Likelihood of significant population	25km search #	Likely Occurrence	Likelihood of significant population
garganey (*Anas querquedula*)	-	Very low	Very low	-	Very low	Very low	-	Very low	Very low
eastern great egret (*Ardea modesta*)	4	Known	Low	114	Possible	Low	91	Very high	Low
cattle egret (*Ardea ibis*)	-	Very high	Low	8	Possible	Low	8	Very high	Low
glossy ibis (*Plegadis falcinellus*)	-	Possible	Low	29	Possible	Low	26	Very high	Low
Caspian tern (*Hydroprogne caspia*)	-	Possible	Very low	-	Low	Very low	-	Possible	Very low
white-winged black tern (*Chlidonias leucopterus*)	-	Possible	Very low	-	Low	Very low	7	Possible	Very low

* Species listed are derived from the EPBC Protected Matters Report (**Appendix F**) and from DEHP's WildNet database.

** Number of WildNet records within 25 km radius of the centre point of the property.

Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

Table A89. Evaluation of impact significance for Migratory wetlands birds under MNES Guidelines.

Criteria	Evaluation
• substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species,	An area of 'important habitat' for a migratory species is: a. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, and/or b. habitat that is of critical importance to the species at particular life-cycle stages, and/or c. habitat utilised by a migratory species which is at the limit of the species range, and/or d. habitat within an area where the species is declining (DEWHA 2009a). **Survey area 2**: There is no evidence to suggest the property supports 'important habitat' for Migratory wetlands species. **Survey area 7, 8, 9, F**: Eastern great egret is common and widespread, occurring in a wide variety of habitats. There is no evidence to suggest the properties support 'important habitat' for Migratory wetlands species. Based on current knowledge, project activities are not expected to substantially modify, destroy or isolate an area of 'important habitat' for these Migratory wetlands species.
• result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species,	**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory terrestrial species based on detail provided in Criteria 1. Measures to control the introduction and spread of invasive species within the proponent's tenements are proposed (see Table 1).
• seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an 'ecologically significant proportion' of the population varies with the species (each circumstance will need to be evaluated). Some factors that should be considered include the species' population status, genetic distinctiveness and species specific behavioural patterns (for example, site fidelity and dispersal rates). 'Population', in relation to migratory species, means the entire population or any geographically separate part of the population whose members cyclically and predictably cross one or more national jurisdictional bondaries including Australia. **Survey area 2, 7, 8, 9, F**: There is no evidence to suggest that the project area supports an 'ecologically significant proportion of the population' of any of the Migratory wetlands species known or considered likely to occur.

Migratory Shorebirds

The Protected Matters Report recognises 15 birds (**Appendix F**) as 'Migratory shorebird species', but 'important habitat' under MNES referral guidelines differs from that of the 'Migratory Wetlands Birds' listed above. The migratory shorebirds discussed below are members of the families Charadriidae (plovers) and Scolopacidae (sandpipers). Guidelines for assessing these species are provided in *Significant impact guidelines for 36 migratory shorebird species: Migratory species. EPBC Act policy statement 3.21* (DEWHA 2009b).

Habitat:

Oriental plover (*Charadrius veredus*) and little curlew (*Numenius minutus*):

- Prefer short, dry grasslands. Also occur on claypans, sporting fields, lawns, around the margins of terrestrial wetlands and recently burnt woodland (Lane 1987; Marchant and Higgins 1993; Higgins and Davies 1996; Geering et al. 2007).

Other sandpipers:

- Mostly occur in coastal areas, particularly in the intertidal zone. Many are also found on freshwater and artificial waterbodies such as rivers, swamps, dams and sewage ponds. Latham's snipe (*Gallinago hardwickii*) will also occur in any vegetation around wetlands, including grasslands, heath, woodland and forest (Higgins and Davies 1996).

Threats:

Oriental plover (*Charadrius veredus*) and little curlew (*Numenius minutus*):

- In Australia, oriental plover (*Charadrius veredus*) occurs mostly in sparsely settled areas and has no immediate threats to survival. Occasionally killed by vehicles on roads (Marchant and Higgins 1993).
- Little curlew (*Numenius minutus*) is threatened by loss and degradation of wetlands that act as important stop-over sites during migration, particularly in the Northern Territory (Bellio et al. 2006).

Other sandpipers:

- Wetland degradation, pollution, changes to hydrology, drainage and reclamation of wetlands, human disturbance and invasive plants (Garnett et al. 2011).

Project-related Threats:

- Alterations in surface water flow impacting flood frequency and intensity of Lake Broadwater.
- Deterioration of water quality in Lake Broadwater through processes such as increased sedimentation and/or increased salinity from upstream activities.
- Increased weed invasion of Lake Broadwater affecting the composition and structure of bank vegetation. Weed propagules may be transported by surface water flow in Broadwater and Surveyors Gully.

Mitigation Measures:

- Wetland areas (i.e., Lake Broadwater) should be avoided, with a 500 m buffer implemented (see **Table A1**)

Evaluation under MNES Referral Guidelines

An estimate of local shorebird populations has been provided in **Table 90**. The data is based on 25 square km WildNet searches to determine the number of records in proximity to each of the survey areas (2,7,8,9,and F; see **Table A90**). Survey areas 8,9 and F are in close proximity, and therefore contained within the one 25km search. Further, these properties are in close proximity to Lake Broadwater, and as such, the number of the records for survey areas 8, 9, and F are likely to be inflated and may include taxa unlikely within the survey areas (e.g., common greenshank).

Total records for the entire project development area have also been provided. It is obvious from this data that the number of birds within the project development area, and therefore almost certainly within individual properties, is well below the 0.1% *significant portion of the population* threshold (see table 86). There is no evidence to suggest the project area otherwise supports 'important habitat' for migratory shorebird species with the possible exception of Latham's snipe (*Gallinago hardwickii*), which is predominantly associated with Lake Broadwater. As habitat suitability for migratory shorebirds is low it is expected that the project area does not support an 'ecologically significant proportion of the population' of any of the Migratory shorebird species known or considered likely to occur.

The majority of migratory shorebirds are very rare visitors to the project area due to a lack of suitable habitat throughout the area. The presence of Lake Broadwater in proximity to the survey areas dramatically increases the likelihood of migratory shorebirds occuring, and it is thought that the majority of records of migratory wetland species are in association with Lake Broadwater.

No activities within a 500m buffer of Lake Broadwater, a Wetland of National Significance where most shorebird records originate, will occur (see **Table A91**). Therefore, based on the MNES impact criteria (policy 3.21), no impacts on shorebirds is expected.

Table A90. Available records/ population evaluation**

Species	PDA**	Survey area 2			Survey area 7			Survey area 8,9,F			EIS Area^	0.1% threshold##
		25km search#	Likely Occurrence	Likelihood of significant population	25km search area#	Likely Occurrence	Likelihood of significant population	25km search area#	Likely Occurrence	Likelihood of significant population	Likelihood of significant population	
Pacific golden plover (*Pluvialis fulva*)	-	0	Unlikely	Very Low	1	Unlikely	Very Low	1	Unlikely	Very Low	Very Low	**100**
oriental plover (*Charadrius veredus*)	-	0	Unlikely	Very Low	1	Unlikely	Very Low	0	Unlikely	Very Low	Very Low	70
Latham's snipe (*Gallinago hardwickii*)	30	0	Unlikely	Very Low	2	Unlikely	Very Low	27	Likely	Low	High	36
black-tailed godwit (*Limosa limosa*)	1	0	Unlikely	Very Low	1	Unlikely	Very Low	2	Unlikely	Very Low	Very Low	160
bar-tailed godwit (*Limosa lapponica*)	1	0	Unlikely	Very Low	1	Unlikely	Very Low	2	Unlikely	Very Low	Very Low	325
little curlew (*Numenius minutus*)	-	0	Unlikely	Very Low	0	Unlikely	Very Low	0	Unlikely	Very Low	Very Low	180
whimbrel (*Numenius phaeopus*)	-	0	Unlikely	Very Low	2	Unlikely	Very Low	2	Unlikely	Very Low	Very Low	100
common sandpiper (*Actitis hypoleucos*)	-	0	Unlikely	Very Low	1	Unlikely	Very Low	1	Unlikely	Very Low	Very Low	25
common greenshank	6	0	Unlikely	Very Low	10	Unlikely	Very Low	10	Unlikely	Very Low	Very Low	60

Species	PDA**	Survey area 2			Survey area 7			Survey area 8,9,F			EIS Area^	0.1% threshold[##]
		25km search[#]	Likely Occurrence	Likelihood of significant population	25km search area[#]	Likely Occurrence	Likelihood of significant population	25km search area[#]	Likely Occurrence	Likelihood of significant population	Likelihood of significant population	
(*Tringa nebularia*)												
marsh sandpiper (*Tringa stagnatilis*)	25	0	Unlikely	Very Low	24	Unlikely	Very Low	24	Unlikely	Very Low	Very Low	100
wood sandpiper (*Tringa glareola*)	**1**	**0**	Unlikely	Very Low	1	Unlikely	Very Low	1	Unlikely	Very Low	Very Low	100
red-necked stint (*Calidris ruficollis*)	**-**	**0**	Unlikely	Very Low	3	Unlikely	Very Low	3	possible	Low	Very Low	325
sharp-tailed sandpiper (*Calidris acuminata*)	**38**	**0**	Unlikely	Very Low	1	Unlikely	Very Low	24	Possible	Moderate	Low	60
curlew sandpiper (*Calidris ferruginea*)	**3**	**0**	Unlikely	Very Low	2	Unlikely	Very Low	3	Unlikely	Very Low	Very Low	180
Ruff (*Philomachus pugnax*)	**-**	**0**	Unlikely	Very Low	1	Unlikely	Very Low	1	Unlikely	Very Low	Very Low	-

* Species listed are derived from the EPBC Protected Matters Report (**Appendix F**), DEHP's WildNet database (post 1979 records) and Birds Australia New Atlas database (1994-2009 records). Searches were conducted of the entire project development area.

** Birds Australia New Atlas database for the entire project development area (WildNet database not available for areas > 25 km radius).

[#] Number of WildNet records within 25 km radius of the centre point of the property. Three separate 25 km radius searches were conducted to capture the five properties under discussion, with one search encompassing survey area 8, 9 and F. These searches include areas outside of the project development area.

[##] 0.1% of the population estimate for the East Asian-Australasian flyway (Bamford et al. 2008).

^Likelihood of significant population occurring across the entire EIS area, with the exclusion of Lake Broadwater.

Table A91. Evaluation of impact significance for Migratory shorebirds under MNES Guidelines.

Criteria	Evaluation
• Loss of important habitat	Nationally important habitat for migratory shorebirds is defined as habitat that supports at least: • 0.1% of the flyway population of a single species • 2000 migratory shorebirds, or • 15 shorebird species (DEWHA 2009b). Important habitat for Latham's snipe (*Gallinago hardwickii*) occurs at sites that have previously been identified as internationally important for the species, or sites that: • support at least 18 individuals of the species, and • are naturally occurring open freshwater wetland with vegetation cover nearby (for example, tussock grasslands, sedges, lignum or reeds within 100 m of the wetland) (DEWHA 2009b). There is no evidence to suggest the project area supports 'important habitat' for migratory shorebird species with the possible exception of Latham's snipe (*Gallinago hardwickii*). Although 14 species have been recorded for one of the search areas, most of these species have been recorded only once or twice. It seems very unlikely, therefore, that any one location in the area supports 15 species of Migratory shorebird. **Survey area 2**: There is no record of any individual of any of the 15 species for this property. There is no evidence the property supports 'important habitat' for any of the 15 species. **Survey area 7**: Based on the number of records of each species there is no evidence the property supports 'important habitat' for any of the 15 species, as defined. **Survey area 8, 9, F**: The total number of WildNet records for the 25 km search radius for these three properties includes sufficient numbers of Latham's snipe (*Gallinago hardwickii*) for potential 'important habitat' for the species. Most, if not all of these records, are likely to be for Lake Broadwater (WildNet records do not provide location details), which is to the north of survey area 8. The number of records dates back to 1980, suggesting that it is unlikely that a single location in these properties supports 18 or more individuals. Of the 30 Latham Snipe (*Gallinago hardwickii*) records in the Birds Australia database, 20 are from Lake Broadwater and in immediate surrounding areas (within prescribed buffers),. This data was collected over a 16 year period, with maximum counts of four individuals. There is no evidence that Lake Broadwater supports at least 18 individuals of Latham's snipe (*Gallinago hardwickii*). Current development plans do not include direct impacts on Lake Broadwater. A 500 m exclusion zone is planned for Lake Broadwater (see Table 1). Based on current knowledge, project activities are not expected to result in the loss of an area of 'important habitat' for Migratory shorebird species.
• Degradation of important habitat leading to a substantial reduction in migratory shorebirds using the site.	**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above. Extensive measures to control the introduction and spread of invasive species within the proponent's tenements are proposed (see Table 1).
• Increased disturbance leading to a substantial reduction in migratory shorebirds using important habitat.	**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above. An exclusion zone of 500m is placed around the regionally significant Lake Broadwater (see Table 1).

Criteria	Evaluation
• Direct mortality of birds leading to a substantial reduction in migratory shorebirds using important habitat	**Survey area 2, 7, 8, 9, F**: There is no evidence to suggest the properties support 'important habitat' for Migratory shorebird species based on detail provided in the Criteria above. Overhead powerlines supplying power to wells and facilities has the potential to increase bird strike mortality. However on balance, overhead powerlines will not be placed in areas of high bird activity (e.g., Lake Broadwater). Further, pre-clearence surveys will document potential bird strike risks (e.g., large farm dams) ensuring that appropriate mitigation is employed. Suitable mitigation could include re-routing powerline alignments or the use of line marking devices.

References – Migratory Fauna Species

Bellio, M. G., Bayliss, P., Morton, S. and Chatto, R. (2006). 'Status and conservation of the Little Curlew *Numenius minutus* on its overwintering grounds in Australia,' in Waterbirds around the world, eds. G. C. Boere, C. A. Galbraith and D. A. Stroud, The Stationery Office, Edinburgh, UK.

Blakers, M., Davies, S. J. J. F. and Reilly, P. N. (1984). The atlas of Australian birds. Melbourne University Press, Melbourne.

Boland, C. R. J. (2004). Introduced cane toads are active nest predators and competitors of rainbow bee-eaters *Merops ornatus*: observational and experimental evidence. *Biological Conservation* 120. 53-62.

Boles, W. E. (1988). The robins & flycatchers of Australia: The National Photographic Index of Australian wildlife. Angus and Robertson, North Ryde.

Debus, S. (1998). The birds of prey of Australia: A field guide to Australian raptors. Oxford University Press, Melbourne.

DEWHA (2009a). Matters of National Environmental Significance: Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999. Department of Environment, Water, Heritage and the Arts, Canberra.

DEWHA (2009a). Significant impact guidelines for 36 migratory shorebird species. Migratory species. EPBC Act policy statement 3.21. Department of Environment, Water, Heritage and the Arts, Canberra.

Fielder DP, Davidson W & Barratt PJ. (2011). Aquatic Conservation Assessments (ACA), using AquaBAMM, for the wetlands of the Queensland Murray–Darling Basin. Brisbane: Department of Environment and Resource Management.

Garnett, S. T. and Crowley, G. M. (2000). The action plan for Australian birds. Environment Australia, Canberra.

Garnett, S. T., Szabo, J. K. and Dutson, G. (2011). The action plan for Australian birds 2010. CSIRO Publishing, Collingwood.

Geering, A., Agnew, L. and Harding, S. (2007). Shorebirds of Australia. CSIRO Publishing, Collingwood.

Higgins, P. J. (ed.) (1999). Handbook of Australian, New Zealand and Antarctic birds, Vol. 4, Parrots to dollarbird. Oxford University Press, Melbourne.

Higgins, P. J. and Davies, S. J. J. F. (eds.) (1996). Handbook of Australian, New Zealand and Antarctic birds, Vol. 3. Snipe to pigeons. Oxford University Press, Melbourne.

Higgins, P. J, Peter, J. M. and Cowling, S. J (eds.) (2006a). Handbook of Australian, New Zealand and Antarctic birds. Vol. 7. Boatbill to starlings. Part A: Boatbill to larks. Oxford University Press, South Melbourne.

Higgins, P. J, Peter, J. M. and Cowling, S.J (eds.) (2006b). Handbook of Australian, New Zealand and Antarctic birds. Vol. 7. Boatbill to starlings. Part B: Dunnock to starlings. Oxford University Press, South Melbourne.

Kingsford, R. T. and Johnson, W. (1998). Impact of water diversions on colonially-nesting waterbirds in the Macquarie Marshes of arid Australia. *Colonial Waterbirds* 21. 159-170.

Lane, B. A. (1987). Shorebirds in Australia. Nelson Publishers, Melbourne.

Low, T. (1995). The animals of Brisbane: A vertebrate status review. Unpublished report prepared for Brisbane City Council.

Marchant, S. and Higgins, P. J. (eds.) (1990). Handbook of Australian, New Zealand and Antarctic birds, Vol. 1. Ratites to ducks, Part B, Australian pelican to ducks. Oxford University Press, Melbourne.

Marchant, S. and Higgins, P. J. (eds.) (1993). Handbook of Australian, New Zealand and Antarctic birds, Vol. 2. Raptors to lapwings. Oxford University Press, Melbourne.

McKilligan, N. (2005). Herons, egrets and bitterns: Their biology and conservation in Australia. CSIRO Publishing, Collingwood.

NSW NPWS (2002). Threatened species of the upper north coast of New South Wales: Fauna. NSW Parks and Wildlife Service, Coffs Harbour.

SEWPAC (2013a). *Apus pacificus* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Mon, 18 Mar 2013 11:18:23 +1100.

SEWPAC (2013b). *Ardea ibis* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Mon, 18 Mar 2013 11:35:54 +1100.

SEWPAC (2013c). *Hirundapus caudacutus* in Species Profile and Threats Database, Department of Sustainability, Environment, Water, Population and Communities, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Mon, 18 Mar 2013 11:21:13 +1100.

Appendix F. NC Act Listed Species Habitat Mapping Rules

Habitat mapping rules for NC Act species, updated for the SREIS, are detailed within the following section, providing the basis for calculation of habitat offset requirements under relevant state policy (DERM 2011b). These mapping rules define the most likely areas or habitats in which these species will occur. Identification of these habitats should be used to guide field survey requirements, targeting survey towards those areas or vegetation types most likely to host sensitive species (i.e. those listed under the NC Act or EPBC Act). Following thorough field survey, areas mapped as 'core habitat possible' or 'general habitat' can be downgraded to 'general habitat' or 'absence suspected'.

Waaje Wattle (*Acacia barakulensis*)

1. Confirmed species records should be buffered by a 1km circumference and treated as "core habitat known" where buffers intersect remnant vegetation ("core habitat known" mapping not to include non-remnant and mature regrowth habitats).
2. RE polygons with confirmed high precision records (precision < 500 m) should be treated as "core habitat known".
3. The species may occur throughout the northern parts of the project development area (north of -27.75), particularly in the Barakula State Forest and adjoining freehold land. The following REs occurring in this area should be classed as "core habitat possible":
    - RE11.5.1; *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces
    - RE11.5.4; *Eucalyptus crebra, Callitris glaucophylla, C. endlicheri, E. chloroclada, Angophora leiocarpa* on Cainozoic sand plains/remnant surfaces. Deep sands
    - RE11.5.21; *Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces
    - RE11.7.5; Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks
    - RE 11.7.4; *Eucalyptus decorticans* and/or *Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius* on Cainozoic lateritic duricrust
    - RE11.7.6; *Corymbia citriodora or Eucalyptus crebra* woodland on Cainozoic lateritic duricrust
    - RE11.7.7; *Eucalyptus fibrosa subsp. nubila* +/- Corymbia spp. +/- Eucalyptus spp. on Cainozoic lateritic duricrust
4. Areas of "core habitat possible" subject to detailed survey without recording the species should be considered "general habitat".
5. All other remnant and regrowth vegetation in the project development area and all cleared agricultural and grazing land should be treated as "absence suspected".

6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Acacia tenuinervis

1. Confirmed species records should be buffered by a 1 km circumference and treated as "core habitat known" ("core habitat known" mapping not to include non-remnant habitats although mature regrowth should be included).
2. RE polygons with confirmed records should be treated as "core habitat known".
3. The following REs occurring in the Chinchilla area (north of -27.75) northwards should be classed as "core habitat possible":
    - RE11.7.5: Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.
    - RE 11.7.4: *Eucalyptus decorticans* and/or Eucalyptus spp., Corymbia spp., Acacia spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust
    - RE11.7.6: *Corymbia citriodora* or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust
    - RE11.5.1 to the north of Chinchilla should be classified as general habitat.
4. All regrowth non-remnant vegetation derived from REs classified as "core habitat known" should be treated as "general habitat".
5. All other remnant vegetation and non remnant and cleared agricultural and grazing land in the project development area should be treated as "absence suspected".
6. For heterogeneous polygons the above rules are applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Sandstone Prickle Bush (*Apatophyllum teretifolium*)

1. Confirmed species records should be buffered by a 1 km circumference and treated as "core habitat known" ("core habitat known" mapping not to include non-remnant habitats nor mature regrowth).
2. RE polygons coinciding with confirmed records should be treated as "core habitat known".
3. The following REs occurring north of Chinchilla (north of -27.75), particularly in the Barakula and Gurulmundi area should be classed as "core habitat possible":
    - RE11.7.4
    - RE11.7.5
    - RE 11.7.6

4. All other remnant vegetation and non-remnant (including mature regrowth) vegetation and cleared agricultural and grazing land south of -27.5 should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Forster’s wiregrass (*Aristida forsteri*)

1. Confirmed species records should be buffered by a 1 km circumference and treated as “core habitat known” (“core habitat known” not to include non-remnant nor mature regrowth habitats).
2. RE polygons coinciding with confirmed records should be treated as “core habitat known”.
3. The following REs occurring in the south west of the project development area (west of Millmerran) in the Wondul Range and Bringalilly SF (between 151.11 and 151.97 longitude) should be classed as “core habitat possible”:
    - RE11.7.5
    - RE11.7.4
4. All other remnant and non-remnant (including mature regrowth) vegetation in the preoject development area should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Bailey’s cypress (*Callitris baileyi*)

1. Confirmed species records (<500m precision) should be buffered by a 1 km circumference with all remnant and mature regrowth habitats captured within the buffer treated as “core habitat known”. Recent regrowth not be be included within ‘core habitat known’ calculations.
2. RE polygons with confirmed high precision records (<500m precision) should be treated as “core habitat known”.
3. The following REs in the Gurulmundi area to the north of Chinchilla (-27.75) should be considered “core habitat possible”.
    - RE11.7.4
    - RE11.7.5
    - RE11.7.6
    - RE11.5.1
4. All other remnant vegetation and cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.

Calotis glabrescens

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (“core habitat known” not to include non-remnant nor mature regrowth habitats).
2. RE polygon/s with confirmed records (<500m precision) should be treated as “core habitat known”.
3. The following REs within the project development area should be classed as “general habitat”:
    - RE11.5.1
    - RE11.5.4
    - RE11.7.4
4. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Cryptandra ciliata

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (“core habitat known” calculations not to include non-remnant or mature regrowth habitats).
2. RE polygons with confirmed records (<500 m precision) should be classed as “core habitat known”.
3. The following REs in the vicinity of Gurulmundi and Barakula in the northern part of the project development area (north of -27.75 should be classed as “general habitat”):
    - RE11.7.4
    - RE11.7.5
    - RE11.7.7
    - RE11.7.6
    - RE11.5.1
    - RE11.5.21
4. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Cyperus clarus

1. Confirmed species record (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (‘core habitat known’ calculations to include mature regrowth habitats and derived grasslands but not recent regrowth habitats in revised mapping databases).
2. RE polygons with confirmed records (<500 m precision) should be classed as “core habitat known”.
2. The following REs should be classed as “core habitat possible”:
    - RE11.3.2
    - RE11.3.3
    - RE11.3.21 and RE11.3.24
    - RE11.3.27
3. Non remnant (derived grasslands) on alluvium should be considered “general habitat”.
4. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Blake’s Spikerush (*Eleocharis blakeana)*

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (clearance calculations to include mature regrowth but not other non-remnant habitats).
2. RE and mature regrowth polygons (<500 m precision) with confirmed records should be treated as “core habitat known”.
3. The following REs should be classed as “core habitat possible”:
    - 11.3.27d (associated with overflow lagoons and flood channels)
    - 11.3.25 (associated with overflow lagoons and flood channels)
    - 11.3.3 (associated with overflow lagoons and flood channels)
    - 11.3.4 (associated with overflow lagoons and flood channels)
    - 11.3.2 (associated with overflow lagoons)
    - 11.3.1 (associated with gilgai)
    - 11.4.3 (associated with gilgai)
4. Non-remnant vegetation derived from potential habitat (core habitat possible), farm dams and drainage lines and channels in non-remnant grazing land on land zone 3 and 4 should be classed as “general habitat”.

5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Plunkett Mallee *(Eucalyptus curtisii)*

1. Confirmed species records (<500 m precision) should be buffered by a 1 km circumference and treated as “core habitat known” (clearance calculations not to include non-remnant habitats although mature regrowth is included).
2. RE polygons coinciding with confirmed records (<500 m precision) should be treated as “core habitat known”.
3. The following REs should be classed as “core habitat possible”:
   - 11.7.2
   - 11.7.4
   - 11.7.5
   - 11.7.6
   - 11.7.7
4. The following REs and habitats should be classed as “general habitat”:
   - 11.5.1
   - 11.5.4
   - 11.5.21
   - Regrowth and mature regrowth vegetation derived from RE11.7.2, 11.7.4, 11.7.5, 11.7.6 and 11.7.7.
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.
6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Fimbristylis vagans

1. Confirmed species records (<500 m) should be buffered by a 1 km circumference and treated as “core habitat known” (clearance calculations to include mature regrowth but not to include other non-remnant habitats).
2. RE polygons with confirmed records (<500 m) should be treated as “core habitat known”.
3. The following REs should be classed as “core habitat possible”:

- 11.3.25
- 11.3.3
- 11.3.2
- 11.3.4
- 11.3.27

4. Large and established dams and major drainage lines and channels in non-remnant grazing land on land zone 3 should be classed as “general habitat”. This includes non-remnant vegetation from listed habitat REs (11.3.25, 11.3.4, 11.3.2, 11.3.27). Many of these features will not have been mapped.
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as “absence suspected”.

Micromyrtus carinata

1. Confirmed species records (<500 m) should be buffered by a 1 km circumference and treated as “core habitat known” (clearance calculations to include mature regrowth but not to include other non-remnant habitats).
2. RE polygons with confirmed records (<500 m) should be treated as “core habitat known”.
3. The following REs in the Gurulmundi locality (north of Chinchilla, -27.75, in general) should be classed as “core habitat possible” (clearance calculations not to include non-remnant nor mature regrowth habitats):
   - 11.7.2
   - 11.7.4
   - 11.7.5
4. All other remnant vegetation and cleared non-remnant land in the project development area should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Pomaderris coomingalensis

1. Confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (clearance calculations not to include non-remnant nor mature regrowth habitats).
2. REs polygons coinciding with confirmed records (<500m precision) should be classed as “core habitat known”:
3. The following REs South of -26.80 should be classed as “core habitat possible”:
   - RE11.7.5

- RE11.7.4

4. All other remnant vegetation and cleared agricultural and grazing land in the project development area should be treated as “absence suspected”.
5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Ptilotus extenuatus

1. As a precautionary measure, confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (‘core habitat known’ calculations to include mature regrowth habitats but not other regrowth vegetation).
2. The following REs within the project development area should be classed as “core habitat possible”:
   - RE11.3.2
   - RE11.3.21
4. The following REs within the project development area should be classed as “general habitat”:
   - Derived grassland
5. All other remnant, regrowth and cleared agricultural land should be classified as “absence suspected”.

Rutidosis lanata

1. Confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (clearance calculations not to include non-remnant habitats although mature regrowth is included).
2. RE polygons coinciding with confirmed records (<500m precision) should be treated as “core habitat known”.
3. The following REs should be classed as “core habitat possible”:
   - 11.3.4
   - 11.3.2
   - 11.3.17
   - 11.9.5
   - 11.9.7
4. All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as “absence suspected”.

5. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Solanum papaverifolium

1. Confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (clearance calculations to include mature regrowth and derived grassland but not other non-remnant habitats).
2. RE and mature regrowth polygons (including derived grasslands) coinciding with confirmed records (<500m precision) should be treated as “core habitat known”:
3. The following REs should be classed as “core habitat possible”:
    - RE 11.3.2
    - RE 11.3.21
    - RE 11.3.24
    - Derived grasslands on alluvium.
4. Regrowth vegetation derived from habitats associated with ‘core habitat possible’ habitats should be classified as “general habitat”.
5. All other remnant and regrowth vegetation and cleared agricultural land in the project development area should be treated as “absence suspected”.
6. For heterogeneous polygons the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Solanum stenopterum

1. Confirmed species records (<500m precision) should be buffered by a 1km circumference and treated as “core habitat known” (clearance calculations to mature regrowth and derived grassland habitats but not other non-remnant habitats).
2. RE and mature regrowth polygons (including derived grassland) with confirmed records (<500m precision) should be treated as “core habitat known”.
3. The following REs should be classed as “core habitat possible”:
    - 11.3.2
    - 11.3.1
    - 11.3.17
    - Derived grasslands on alluvium.
4. Any remnant and non-remnant roadside habitats derived from the above REs between Dalby, Cecil Plains and Millmerran should be treated as “general habitat”.

5. Regrowth vegetation derived from potential habitats should be considered “general habitat”
6. All other remnant vegetation and cleared agricultural land in the project development area should be treated as “absence suspected”.

Picris barbarorum

1. As a precautionary measure the following regional ecosystems within the project development area should be classed as “core habitat possible”:
    - RE 11.3.2, RE11.3.21 (‘high’ confidence when applied to property specific mapping, ‘moderate’ when applied to 1: 40 000 scale mapping and ‘low’ when applied to mapping produced by EHP, 2012a). The mature regrowth dataset (EHP 2012b) is to be included within calculations.
2. The following should be classed as ‘general habitat’:
3. Non-remnant derived grasslands on land zone 3 (‘High’ level of confidence applied).
    - Regrowth vegetation derived from relevant regional ecosystems (confidence as in 2 apply).
4. All other remnant vegetation in the project development area and cleared agricultural and grazing land should be treated as “absence suspected”.

For heterogeneous polygons the above rules were applied where the relevant regional ecosystems were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Appendix G. NC Act Fauna Habitat Mapping Rules

Bulloak Jewel Butterfly (*Hypochrysops piceatus*)

1. All remnant vegetation within 1 km of a recent (1980+), reliable (location information provided) record is classed as 'core habitat known.' This allows for the species' mobility. Mature regrowth and other recent regrowth vegetation is excluded from this calculation.
2. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".
3. The species may occur anywhere in the project development area south of Chinchilla (-27.75).
4. South of Chinchilla, communities with a canopy or subcanopy of bulloak (*Allocasuarina luehmannii*) (e.g., REs 11.3.18, 11.5.1, 11.5.1a, 11.5.4, 11.5.21, 11.9.9, 11.10.1d) that have never been cleared (based on available aerial photos) are classed as ' .' Visual inspection or survey is required for further discernment of suitability (e.g., ground strata condition and bulloak size) and as such, ´core habitat possible' has been applied to all of the above RE polygons regardless of condition. Mature regrowth and recent regrowth vegetation is not included within the assessment
5. Due to the lack of known populations in the north of the project development area, 'core habitat possible' north of Kumbarilla should be downgraded to ´general habitat.'
6. Remaining REs are classed as 'absence suspected.'
7. Land used for cropping purposes is classed as 'absence suspected.'
8. Land used for grazing purposes is classed as 'absence suspected.' Within these areas, isolated fragments of suitable bulloak habitat may occur in sizes too small to be mapped.
9. For heterogeneous polygons, the above rules are applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
10. Two vegetation patches consistent with this species' habitat preferences were located during the surveys and should be the subject of further investigation if potentially affected by infrastructure. These two patches ('core habitat possible – particular interest') centre on AS25 (S27.06220^{o}; E150.91284^{o}) and AS42 (S27.53984^{o}; E151.16907^{o}). Larval attendant ants (*Anonychomyrma sp. itinerans* group) were confirmed present at the latter location during recent surveys.

Pale Imperial Hairstreak (*Jalmenus eubulus*)

1. The known distribution of this species encompasses the entire project development area.

2. Within the area, all areas of remnant brigalow (REs 11.3.1, 11.4.3, 11.9.1, 11.9.4b, 11.9.5, 11.9.6, 11.9.10) are classed as 'core habitat possible.'
3. All remnant and regrowth vegetation within one km of a recent (1980+), accurate ((location information provided) record is classed as 'core habitat known.' This allows for the species' mobility.
4. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".
5. Remaining REs are classed as 'absence suspected.'
6. Cleared agricultural and grazing land is classed as 'absence suspected.'
7. For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. However, due to the species' mobility, the habitat value category should refer to the entire polygon.

Rough Collared Frog (*Cyclorana verrucosa*)

1. The known distribution of this species encompasses the entire project development area.
2. Within the area, the species may occur anywhere ephemeral surface water collects, particularly in association with clay plains or waterways. The species is not reliant on remnant vegetation although a distinction has been made between remnant and non-remnant vegetation for the mapping of important habitat. Non-remnant (non-remnant lands) on land zones 3, 4 and 5 are particularly prone to flooding and should be classed as 'general habitat.' This equates to terrain mapping units Ia -Id, IIa - IId, and IIIa to IIId in the terrain mapping analyisis provided in the Surat Gas EIS (Chapter 12.3.6).
3. REs 11.9.5, 11.9.6 and 11.9.10 may also contain clay or gilgaied soils, which are very suitable for this species. These should be mapped as 'core habitat possible.'
4. REs 11.9.7, 11.9.9, 11.9.9a, 11.5.4, 11.5.1/1a, and 11.5.20 are classed as 'general habitat.'
5. 'Core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (reliable location data provided) record is classed as 'core habitat known.'
6. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".
7. Cleared agricultural land subject to tilling is classed as 'absence suspected.'

Golden-tailed Gecko (*Strophurus taenicauda*)

1. The known distribution of this species encompasses the entire project development area.
2. Within the area, the REs 11.3.1, 11.3.17, 11.4.3, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.9.1, 11.9.5, 11.9.6, 11.9.7, 11.9.9,

11.9.9a, 11.9.10, 11.9.13, 11.10.1, 11.10.1a and 11.10.1d are classed as ‘core habitat possible.’

3. Within the area, REs 11.3.4, 11.3.14, 11.3.18, 11.3.19, 11.4.12 are classed as ‘general habitat.’
4. Patches of ‘core habitat possible’ less than 10 ha in extent *and* not within 100 m of a larger area of remnant vegetation are classed as ‘general habitat.’ This must be applied on a site-specific basis and has not been applied uniformly across the project development area.
5. ‘Core habitat possible’ and ‘general habitat’ within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’
6. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
7. All areas of advanced regrowth (5+ yrs) should be treated as remnant vegetation and classed according to the above rules. This must be done on a site specific basis as mapping across the project development area currently does not consistently delineate such habitats.
8. Regrowth areas <5 years are classed as ‘absence suspected’ (limitations as per 6).
9. Cleared agricultural and grazing land is classed as ‘absence suspected.’
10. For heterogeneous polygons, the above rules are applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.

Common Death Adder (*Acanthophis antarcticus*)

1. The known distribution of this species encompasses the entire project development area.
2. All remnant vegetation >100 ha in extent or within 500 m of a larger vegetation patch should be classed as ‘core habitat possible’ with the exception of grasslands (REs 11.3.21 and 11.3.24). This must be applied on a site-specific basis and has not been applied uniformly across the project development area.
3. ‘Core habitat possible’ within one km of a recent (1980+), accurate (location information provided) record is classed as ‘core habitat known.’
4. Regrowth vegetation including mature regrowth should is classed ‘absence suspected.’
5. Cleared farmland or tilled crops are classed ‘absence suspected.’

Grey Snake (*Hemiaspis damelii*)

1. The known distribution of this species encompasses the entire project development area.

2. All remnant vegetation where surface water could collect provides potential habitat for this species. In particular, vegetation on land zones 3, 4, should be classed as 'core habitat possible', particularly REs 11.3.1, 11.3.2, 11.3.4, 11.3.17, 11.3.25, 11.3.27b, 11.4.3 and 11.4.3a. In addition, the following REs have clay soils, gilgais or are likely to be subject to temporal ponding and should also be 'core habitat possible'; REs 11.9.5, 11.9.6 and 11.9.10. This equates to terrain mapping units Ia -Id, IIa - IId, and IIIa to IIId in the terrain mapping analyisis provided in the Surat Gas EIS (Chapter 12.3.6).
3. REs on Land Zone 5 (RE11.5.1/1a, 11.5.4 and 11.5.20) should be regarded as 'general habitat'.
4. Remaining remnant vegetation within 50 m of a creekline, stream or other waterway should be classed 'general habitat.' This must be applied on a site-specific basis and has not been applied uniformly across the project development area.
5. 'Core habitat possible' or 'general habitat' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.' (including mature regrowth vegetation).
6. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".
7. Mature regrowth is to be classed according to its parent regional ecosystem.
8. Tilled and heavily cropped land is classed as 'absence suspected'.
9. Cleared grazing land can be used by the species, particularly where soil structure includes dark clays with surface cracks and gilgais. Some grazing land which retains fallen debris, short regrowth (particularly brigalow) and grass may also be suitable for the species. Likelihood of, or proximity to, ephemeral pooling water following rainfall should also be considered. These habitats cannot be mapped based on existing RE mapping and can only be assessed by ground-truthing.

Cotton Pygmy-goose (*Nettapus coromandelianus*)

1. The known distribution of this species encompasses the entire project development area.
2. Areas of open water associated with Lake Broadwater should be mapped as 'core habitat known.'
3. Large lakes, artificial dams and wetlands (RE11.3.27) on the Condamine River Floodplain (and its major tributaries) greater than five ha in extent should be classed as 'core habitat possible.'
4. All 'core habitat possible' within one km of a known recent (1980+) record should be 'core habitat known.'

5. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
6. All remaining terrestrial habitats should be classed as ‘absence suspected.’

Freckled Duck (*Stictonetta naevosa*)

1. The known distribution of this species encompasses the entire project development area.
2. Lake Broadwater should be mapped as ‘core habitat known.’
3. All remaining terrestrial habitats should be classed as ‘absence suspected.’

Black-necked Stork (*Ephippiorhynchus asiaticus*)

1. The known distribution of this species encompasses the entire project development area.
2. The water containment area of Lake Broadwater and a buffer of 100 m should be considered ‘core habitat known.’
3. Areas within Long Swamp where water collection might occur following surface flow should be considered ‘core habitat possible.’
4. Large artificial dams (e.g., >five ha; vegetation community WA2) should be classed as ‘core habitat possible.’ These habitats have not been consistently mapped across the project development area and require site specific assessments.
5. Waterbodies (REs 11.3.4, 11.3.25, 11.3.27d and vegetation communities WA and WA1) along the Condamine River and its major tributaries (e.g., Wilkie and Charleys Creek) are classed as ‘core habitat possible.’
6. ‘Core habitat possible’ within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’ (including mature regrowth vegetation).
7. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
8. Remaining REs, cleared farmland or tilled crops are classed as ‘absence suspected.’
9. Records of this species in modified landscapes (e.g., farming land) away from any large dams are considered to be incidental occurrences by transient individuals. These reflect opportunistic foraging and do not indicate important habitat values. Consequently, no ‘core habitat known’ buffer should be included around the record -S27.13154 E151.19791.

Square-tailed Kite (*Lophoictinia isura*)

1. The known distribution of this species encompasses the entire project development area.

6. The species has very broad habitat requirements, potentially using all woodland and forested areas. However, square-tailed kites will more frequently use riparian vegetation, especially RE 11.3.25 and RE11.3.4 to a lesser extent. These REs and all remnant vegetation within 100 m of a creekline or waterway should be mapped as 'core habitat possible.' Mature regrowth derived from these REs should also be classified as 'core habitat possible.' Mapping of 100 m buffer zones adjacent to waterways must be applied on a site-specific basis and has not been applied uniformly across the project development area.

2. The species is more likely to occur within large contiguous patches of vegetation greater than 500 ha. These patches, and any patches within 500 m of another patch whose cumulative total approximates 500 ha, should be mapped as 'core habitat possible.' This must be applied on a site-specific basis and has not been applied uniformly across mapping in the project development area.

3. All remaining remnant vegetation should be mapped as 'general habitat.'

4. Patches of vegetation smaller in extent than 10 ha and separated by more than one km from adjacent vegetation should be mapped as 'absence suspected.' This must be applied on a site-specific basis and has not been applied uniformly across mapping in the project development area.

5. All 'core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (location data provided) record is classed as 'core habitat known.'

6. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".

7. Open pasture, crops and urban landscapes are classed as 'absence suspected.'

Grey Goshawk (*Accipiter novaehollandiae*)

1. The known distribution of this species encompasses the entire project development area.

2. REs 11.3.25, 11.3.27b, 11.8.3 and 11.9.4a are suitable for this species and should be mapped as 'general habitat.' Mature regrowth and other regrowth vegetation should not be included with remnant vegetation.

3. All other areas of remnant vegetation should be mapped as 'absence suspected.'

4. All areas of non-remnant vegetation and cleared land should be mapped as 'absence suspected.'

Glossy Black-Cockatoo (*Calyptorhynchus lathami*)

1. The known distribution of this species encompasses the entire project development area.
2. REs containing belah (*Casuarina cristata*) (REs 11.3.1. 11.3.17, 11.4.3, 11.4.3a, 11.4.3b, 11.4.10, 11.4.12, 11.8.3, 11.9.4b, 11.9.5) throughout the area are classed as 'core habitat possible.'
3. The species will utilise belah regrowth and hence mature regrowth of the above communities should be classed 'core habitat possible.'
4. REs containing *Allocasuarina inophloia* (REs 11.5.1, 11.5.4, 11.7.4, 11.9.9, 11.10.1) are classed as 'general habitat'.
5. 'Core habitat possible' and 'general habitat' within one km of a recent (1980+), accurate (location data provided) is classed as 'core habitat known.'
6. RE polygons coinciding with confirmed records (location data provided) should be treated as "core habitat known".
7. All remaining regional ecosystems are classed 'absence suspected.'
8. Non-remnant and agricultural land is classed 'absence suspected.'
9. For heterogeneous polygons, the above rules were applied where the relevant REs were found in the polygon descriptions. The habitat value category refers only to that part of the polygon where suitable habitat is present.
10. The species can use individual or small clumps of large *A. cristata* in non-remnant areas. These resources cannot be mapped and must be evaluated through field inspection on a site by site basis.

Turquoise Parrot (*Neophema pulchella*)

1. Turquoise parrots prefer grassy woodlands (REs 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.25, 11.3.26, 11.3.27, 11.8.2, 11.9.9 and 11.9.9a) and these should be mapped as 'core habitat possible', except where they occur north of Cecil Plains (north of -27.525).
2. North of Cecil Plains (-27.525), REs 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.19, 11.3.25, 11.3.26, 11.3.27, 11.8.2, 11.9.9 and 11.9.9a should be mapped as 'general habitat.'
3. Forest and woodlands with denser understories can also be used by this species, but with less frequency. These habitats (REs 11.4.12, 11.5.1, 11.7.4, 11.7.6, 11.7.7, 11.9.7, 11.9.10 and 11.9.13) should be mapped as 'general habitat.'

4. Mature regrowth vegetation from all REs listed above should be classed as ‘general habitat.’

5. All ‘core habitat possible’ and ‘general habitat’ within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’

6. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.

7. Remaining remnant vegetation should be mapped as ‘absence suspected.’

8. Open pasture, crops and urban landscapes are classed as ‘absence suspected.’

Painted Honeyeater (*Grantiella picta*)

1. The known distribution of this species encompasses the entire project development area.
2. Likely habitat coincides with mistletoe, which is most prevalent in regional ecosystems (REs) 11.3.1, 11.3.17, 11.4.3, 11.4.3a, 11.4.10, 11.9.5, 11.96 and 11.9.10. These areas should be mapped as ‘core habitat possible.’ This includes mature regrowth and advance regrowth (regrowth > 15 years) habitats.
3. Mistletoe is also prevalent in linear roadside fragments of acacia regrowth (veg comm BRB) and should be mapped as ‘core habitat possible’ even if not considered remnant vegetation. These habitats have not been consistently mapped across the project development area and require site specific assessments.
4. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
5. All land (remnant or non-remnant) within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’
6. All remaining regional ecosystems are ‘absence suspected.’

Black-chinned Honeyeater (*Melithreptus gularis*)

1. The known distribution of this species encompasses the entire project development area.
2. Vegetation communities dominated by eucalyptus species (REs 11.3.4, 11.3.14, 11.3.18, 11.3.19, 11.3.25, 11.3.26, 11.3.27a, 11.3.27b, 11.4.3a, 11.4.10, 11.4.12, 11.5.1, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.4, 11.7.4c, 11.7.6, 11.7.7, 11.8.2a, 11.9.1, 11.9.7, 11.9.9, 11.9.9a, 11.9.10, 11.9.13, 11.10.1, 11.10.1a, 11.10.1b) are classed as ‘core habitat possible.’ Mature regrowth vegetation is treated according to its parent RE.

3. All ‘core habitat possible’ within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’
4. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
5. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
6. Open pasture, crops and urban landscapes are classed as ‘absence suspected.’

Little Pied Bat (*Chalinolobus picatus*)

1. The known distribution of this species encompasses the entire project development area.
2. All remnant vegetation, with the exception of grasslands without canopy trees (REs 11.3.21, 11.3.24), is considered ‘core habitat possible.’ However, it is noted that within these areas the species is most likely to occur along waterways. This assessment also includes mature regrowth and other advanced regrowth vegetation.
3. All ‘core habitat possible’ within one km of a recent (1980+), accurate (location data provided) record is classed as ‘core habitat known.’
4. RE polygons coinciding with confirmed records (location data provided) should be treated as “core habitat known”.
5. All remaining areas are mapped as ‘absence suspected.’

Appendix H. Summary Flora Site Data

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB01	SURVEY AREA 2 Girraween	26.5028	150.2152	11.3.4	11.7.4	Open woodland (14-18m) (PCC 18%) of Angophora leiocarpa with a lower tree layer of Eucalyptus exserta, Acacia apprepta Eucalyptus rubiginosa and Callitris glaucophylla. Sparse shrub layer of Acacia apprepta and A. crassa subsp. crassa Grassy groundcover (58%) dominated by Poaceae (GB1/1).	Weathered sandstone on gently sloping plataeu.	Woodland. T1 14-19m, PCC 18%, BA 8m2/ha, Stems 140/ha; T2 6-10m, PCC 63%, BA 3m2/ha, Stems 1100/ha; S1 3-6m, PCC 10%, BA 0/m2/ha, Stems 380/ha; S2 1-3m, PCC 10%, Stems 440/ha; GC 0-1m, 58%.	Total vegetative cover 58%; Bare ground 15%; Leaf litter 27%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 82%; Native perennial herb 12%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 4%; Exotic shrub <1m 0%.	Total species 35; Total native 34; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB02	SURVEY AREA 2 Girraween	26.5019	150.2121	Non-R	Non-R	Shrubland of Acacia ixiophylla with occasional emergent Eucalyptus exserta. Grassy groundcover dominated by Aristida caput-medusae. Occasional emergents of Eucalyptus exserta.	Deeply weathered sandstone with residual sandy soil	Shrubland. E 8-10m, PCC 5-10%; S1 1-3m, 40-50%; GC 0-1m, 70-80%.	Dominated by native grasses.	NA
Bio	GB03	SURVEY AREA 2 Girraween	26.4980	150.2214	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.5	Shrubland of Melaleuca uncinata with a low shrub layer of Micromyrtus sessilis and a groundcover dominated by Triodia sp.	Sandy plataeu surface	Shrubland. S1 1-4m, PCC 52%, Stems 9000/ha; S2 1-2 m, PCC 34%, Stems 2140/ha; GC 0-1m, FPC 75%.	Total vegetative cover 75%; Bare ground 13%; Leaf litter 12%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 71%; Native perennial herb 4%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 25%; Exotic shrub <1m 0%.	Total species 15; Total native 15; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB04	SURVEY AREA 2 Girraween	26.4833	150.2212	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus crebra with a second tree layer of Callitris glaucophylla and Allocasuarina Luehmannii. Groundcover dominated by Eulalea aurea, Panicum decompositum, and Paspalidium sp.	Loamy plain with soil > 50 cm depth over weathered sandston	Woodland. T1 12-18m, PCC 34%, BA 5m2/ha, Stems 140/ha; T2 6-10m, PCC 30%, BA 2m2/ha, Stems 100/ha; S1 3-6m, PCC 30%, BA 1/m2/ha, Stems 1180/ha; S2 1-3m, PCC 10%, Stems 520/ha; GC 0-1m, 56%.	Total vegetative cover 56%; Bare ground 4%; Leaf litter 40%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 82%; Native perennial herb 18%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 39; Total native 39; Total naturalised 0.
Bio	GB05	SURVEY AREA 2 Girraween	26.4821	150.2084	11.7.4	11.5.1	Woodland of Eucalyptus populnes with E. crebra and Callitris glaucophylla. Second tree layer dominated by C. glaucophylla and Allocasuarina Luehmannii.	Loamy plain over a fine grained weathered sandstone plataeu	Woodland. T1 10-15m, PCC 29%, BA 3m2/ha, Stems 240/ha; T2 6-10m, PCC 27%, BA 5m2/ha, Stems	Total vegetative cover 35%; Bare ground 4%; Leaf litter 61%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 60%; Native perennial herb	Total species 49; Total native 48; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									500/ha; S1 2-6m, PCC 14%, BA 4/m2/ha, Stems 700/ha; S2 1-3m, PCC 5%, Stems 480/ha; GC 0-1m, 35%.	34%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 6%; Exotic shrub <1m 0%.	
Q	GB06	SURVEY AREA 2 Girraween	26.4818	150.2148	Non-R	11.5.1a	Woodland of Eucalyptus populnea with a shrub layer of Allocasuarina Luehmannii. Moderately disturbed.	Loamy plain	Woodland. T1 14-18m, PCC 30%.	Dominated by native grasses.	NA
Q	GB07	SURVEY AREA 2 Girraween	26.4962	150.2193	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Callitris glaucophylla with scattered Eucalyptus crebra and Allocauarina Luehmannii.	Loamy plain	Woodland. T1 12-18m, PCC 30-40%..	Dominated by native grasses.	NA
T	GB08	SURVEY AREA 2 Girraween	26.5016	150.2210	Non-R	11.7.4	Shrubland of Acacia apprepta and Eucalyptus exserta with a sparse lower shrub layer of Melaleuca nodosa, Prostanthera sp., Leucopogon sp. and A. apprepta.	Loamy plain	Shrubland. S1 5-7m, PCC 64%, BA 12m2/ha, Stems 4620/ha; S2 1-3m, PCC 8%, Stems 600/ha; GC 0-1m, FPC 80%.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB09	SURVEY AREA 2 Girraween	26.5037	150.2201	11.3.4	11.3.4	Riparian woodland of Eucalyptus tereticornis with Angophora leiocarpa and a shrub layer of Leptospernum polygalifolium.	Alluvial channels	Woodland. T1 18-23m, PCC 40%, BA 12m2/ha, Stems 120/ha; T2 10-14m, PCC 12%, BA 2m2/ha, Stems 60/ha; S1 2-6m, PCC 32%, BA 0/m2/ha, Stems 3760/ha; S2 1-2m, PCC 30%, Stems 140/ha; GC 0-1m, 88%.	Total vegetative cover 88%; Bare ground 7%; Leaf litter 5%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 100%; Native perennial herb 0%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 24; Total native 23; Total naturalised 1.
S	GB10	SURVEY AREA 2 Girraween	26.5045	150.2196	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.4	Woodland of Eucalyptus exserta with a dense shrub layer of Acacia apprepta. Grassy native dominated groundcover.	Lateritic plataeu surface	Woodland. T1 8-13m, PCC 54%, BA 9m2/ha, Stems 160/ha; T2 2-6m, PCC 46%, BA 3m2/ha, Stems 1120/ha;	Total vegetative cover 41%; Bare ground 0%; Leaf litter 59%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 93%; Native perennial herb	Total species 24; Total native 24; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									S1 2-6m, PCC 10%, BA 0/m2/ha, Stems 440/ha; S2 1-2m, PCC 15%, Stems 440/ha; GC 0-0.5m, 41%.	7%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Bio	GB11	SURVEY AREA 2 Girraween	26.5108	150.2213	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.7	Woodland of Eucalyptus elegans, Eucalyptus fibrosa with a mid dense shrub layer of Acacia ixiophylla and scattered Callitris glaucophylla.	Loamy plain	Woodland. T1 12-18m, PCC 34%, BA 10m2/ha, Stems 1200/ha; T2 6-10m, PCC 24%, BA 4m2/ha, Stems 300/ha; S1 3-6m, PCC 18%, BA 0/m2/ha, Stems 3400/ha; S2 1-3m, PCC 10%, Stems 2700/ha; GC 0-1m,	Total vegetative cover 52%; Bare ground 15%; Leaf litter 33%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 81%; Native perennial herb 2%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 15%; Exotic shrub <1m 0%.	Total species 20; Total native 20; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									52%.		
Bio	GB12	SURVEY AREA 2 Girraween	26.4986	150.2224	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.5	Shrubland of Melaleuca uncinata with a low shrub layer of Micromyrtus sessils.	Loamy plain	Shrubland. S1 1-3m, PCC 62%, Stems 7040/ha; S2 0.5-1m, PCC 16%, Stems 2600/ha; GC 0-0.5m, FPC 40%.	Total vegetative cover 40%; Bare ground 34%; Leaf litter 26%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 8%; Native perennial herb 3%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 89%; Exotic shrub	Total species 19; Total native 19; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB13	SURVEY AREA 2 Girraween	26.4999	150.2283	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.7	Woodland of Eucalyptus fibrosa subsp. nubila with associated E. exserta and Callitris glaucophylla.	Inndurated sandstone (rubble exposed on surface)	Woodland. T1 11-15m, PCC 26%, BA 5m2/ha, Stems 80/ha; T2 8-10m, PCC 52%, BA 7m2/ha, Stems 580/ha; S1 3-6m, PCC 14%, BA 2 m2/ha, Stems 480/ha; S2 1-2m, PCC 8%, Stems 400/ha; GC 0-1m, 55%.	Total vegetative cover 57%; Bare ground 14%; Leaf litter 31%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 87%; Native perennial herb 7%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 6%; Exotic shrub <1m 0%.	Total species 37; Total native 30; Total naturalised 0.
Q	GB14	SURVEY AREA 2 Girraween	24.4991	150.2269	Non-R	Non-R	Regrowth shrubland of Acacia apprepta.	Shallow soil over duricrust	Shrubland. S1 3-8m, PCC 30%.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB15	SURVEY AREA 2 Girraween	26.4860	150.2334	Mature Regrowth (11.5.21, 11.7.4, 11.5.4)	11.5.21	Woodland of Eucalyptus bloxsomei with a shrub layer of Micromyrtus sp and Acacia sp. (BGS15/1).	Loamy plain	Woodland. T1 14-18m, PCC 35%, BA 6m2/ha, Stems 140/ha; S1 2-5m, PCC 22%, BA 0/m2/ha, Stems 1060/ha; S2 1-3m, PCC 15%, Stems 400/ha; GC 0-1m, 62%.	Total vegetative cover 62%; Bare ground 13%; Leaf litter 25%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 39%; Native perennial herb 2%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 56%; Exotic shrub <1m 0%.	Total species 30; Total native 30; Total naturalised 0.
Bio	GB16	SURVEY AREA 2 Girraween	26.4902	150.2377	11.5.21, 11.7.4, 11.5.4	11.3.25	Riparian woodland of Angophora floribunda with Eucalyptus tereticornis.	Incised bench in alluvial terrace	Open forest T1 16-24m, PCC 59%, BA 11m2/ha, Stems 160/ha; T2 12-16m, PCC 5%, BA 1m2/ha, Stems 60/ha; S1 1-4m, PCC	Total vegetative cover 83%; Bare ground 0%; Leaf litter 17%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 92%; Native perennial herb 7%; Exotic perennial grass 0%; Exotic	Total species 39; Total native 38; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									8%, BA 0/m2/ha, Stems 880/ha; GC 0-1m, 83%.	perennial herb 1%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Bio	GB17	SURVEY AREA 2 Girraween	26.4888	150.2350	Mature Regrowth (11.5.21, 11.7.4, 11.5.4)	11.3.4	Woodland of Eucalyptus tereticornis with associated E. crebra and Angophora floribunda.	Alluvial terrace	Woodland. T1 14-18m, PCC 15%, BA 6m2/ha, Stems 140/ha; T2 8-12m, PCC 18%, BA 0m2/ha; Stems 0/ha; S1 2-4m, PCC 28%, BA 2/m2/ha, Stems 140/ha; S2 1-2m, PCC 5%, Stems 80/ha; GC 0-1m, 88%.	Total vegetative cover 88%; Bare ground 0%; Leaf litter 12%; Total native cover 98%; Total exotic cover 2%; Native perennial grass/sedge 88%; Native perennial herb 10%; Exotic perennial grass 0%; Exotic perennial herb 2%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 39; Total native 38; Total naturalised 1.
T	GB18	SURVEY AREA 2 Girraween	26.4881	150.2317	Mature Regrowth (11.5.21, 11.7.4, 11.5.4)	11.5.1	Woodland of Angophora leiocarpa with subdominant Eucalyptus crebra, and Corymbia bloxsomei. Second tree layer of Callitris glaucophylla and Allocasuarina Luehmannii.	Sandy loam plain	Woodland. T1 18-22m, PCC 40%, BA 10m2/ha, Stems 120/ha; T2 10-14m,	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									PCC 15%, BA 2m2/ha, Stems 60/ha; S1 2-5m, PCC 20%, BA 0/m2/ha, Stems 760/ha; S2 1-2m, PCC 8%, Stems 6800/ha; GC 0-1m,40%.		
Bio	GB19	SURVEY AREA 2 Girraween	26.4970	150.2360	11.3.4 / 11.3.25	11.3.25	Riparian woodland of Angophora floribunda with Eucalyptus tereticornis and Corymbia bloxsomii. Sparse shrub layer of Leptospermum polygalifolium.	Incised bench in alluvial terrace	Open forest. T1 18-24m, PCC 54%, BA 16m2/ha, Stems 140/ha; T2 12-16m, PCC 5%, BA 2m2/ha, Stems 40/ha; S1 1-3m, PCC 10%, BA 0/m2/ha, Stems 360/ha; GC 0-1m, 86%.	Total vegetative cover 86%; Bare ground 6%; Leaf litter 8%; Total native cover 98%; Total exotic cover 2%; Native perennial grass/sedge 92%; Native perennial herb 6%; Exotic perennial grass 1%; Exotic perennial herb 1%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 45; Total native 43; Total naturalised 2.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB20	SURVEY AREA 2 Girraween	26.4965	150.2358	11.3.4 / 11.3.25	11.3.4	Woodland dominated by Corymbia bloxsomii with subdmoinant Angophora floribunda. A sparse shrub layer of Acacia spectabilis, Acacia crassia subsp. crassa and Callitris glaucophylla.	Upper alluvial terrace	Open forest. T1 18-24m, PCC 56%, BA 20m2/ha, Stems 260/ha; T2 12-16m, PCC 12%, BA 3m2/ha, Stems 100/ha; S1 1-3m, PCC 5%, BA 0/m2/ha, Stems 140/ha; GC 0-1m, 68%.	Total vegetative cover 68%; Bare ground 0%; Leaf litter 32%; Total native cover 94%; Total exotic cover 6%; Native perennial grass/sedge 60%; Native perennial herb 32%; Exotic perennial grass 3%; Exotic perennial herb 1%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 34; Total native 32; Total naturalised 2.
Q	GB21	SURVEY AREA 2 Girraween	26.4961	150.2343	Mature Regrowth (11.5.21, 11.7.4, 11.5.4)	11.5.21	Woodland of Corymbia bloxsomii and Eucalyptus tereticornis with a second tree layer of Callitris glaucophylla and a sparse shrub layer of Acacia spectabilis, Leucopogon sp and Leptospermum poygalifolium.	Sandy loam soils on gently sloping plain	Woodland. T1 14-18m, PCC 30-40%, BA 9m2/ha; T2 6-10m, PCC 10%, BA 9m2/ha; S1 1-3m, PCC 5%, BA 0m2/ha.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB22	SURVEY AREA 2 Girraween	26.4740	150.2494	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.7	Woodland of Eucalyptus fibrosa subsp. nubila with a shrub layer of Acacia ixiophylla and A. semilunata.	Loamy plain	Woodland. T1 16-23m, PCC 57%, BA 9m2/ha, Stems 180/ha; T2 10-14m, PCC 5%, BA 2m2/ha, Stems 100/ha; S1 3-6m, PCC 5%, BA 0 m2/ha, Stems 50/ha; S2 0.5-1.5m, PCC 29%, Stems 700/ha; GC 0-1m, 38%.	Total vegetative cover 38%; Bare ground 3%; Leaf litter 59%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 37%; Native perennial herb 5%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 58%; Exotic shrub <1m 0%.	Total species 29; Total native 29; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
S	GB23	SURVEY AREA 2 Girraween	26.4754	150.2481	11.5.21, 11.7.4, 11.5.4	11.5.1	Woodland of Eucalyptus crebra with Angophora leiocarpa and a second tree layer of Callitris glaucophylla and Allocasuarina Luehmannii. Mid dense shrub layer of A. Luehmannii, C. Glaucophylla and Acacia semilunata. Lwer shrub layer of Dodonaea macrossanii, Boronia bipinnata and Homoranthus sp.	Gently sloping sandy / loam plain	Woodland. T1 16-22m, PCC 48%, BA 5m2/ha, Stems 100/ha; T2 8-12m, PCC 8%, BA 2m2/ha, Stems 600/ha; S1 3-6m, PCC 5%, BA 0 m2/ha, Stems 600/ha; S2 1-3m, BA 0 m2/ha, Stems 400/ha; GC 0-1m, 38%.	Total vegetative cover 37%; Bare ground 1%; Leaf litter 62%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 59%; Native perennial herb 3%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 38%; Exotic shrub <1m 0%.	Total species 35; Total native 35; Total naturalised 0.
Q	GB24	SURVEY AREA 2 Girraween	26.4742	150.2467	11.5.21, 11.7.4, 11.5.4	11.5.21	Woodland of Angophora leiocarpa with subdominant Corymbia bloxsomei and Callitris glaucophylla. Sparse shrub layer of Acacia ixiophylla, Acacia spectabilis, Allocasuarina leuhmani, and C. glaucophylla. Groundcover dominated by Triodia sp. and Homoranthus sp.	Loamy plain	Woodland. T1 18-23m, PCC 30%.	Native dominated by Triodia sp. and Homoranthus sp.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB25	SURVEY AREA 2 Girraween	26.4732	150.2640	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus crebra with a second tree layer of Allocasuarina Luehmannii and a mid dense shrub layer of Acacia ixiophylla.	Loamy plain	Woodland. T1 14-18m, PCC 41%, BA 4m2/ha, Stems 140/ha; T2 6-12m, PCC 14%, BA 3m2/ha, Stems 280/ha; S1 2-5m, PCC 23%, BA 0/m2/ha, Stems 440/ha; S2 1-3m, PCC 27%, Stems 900/ha; GC 0-1m, 21%.	Total vegetative cover 21%; Bare ground 10%; Leaf litter 69%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 100%; Native perennial herb 0%; Exotic perennial grass 0%; Exotic perennial herb01%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 16; Total native 16; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB26	SURVEY AREA 2 Girraween	26.4775	150.2804	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Angophora leiocarpa with subdominant Eucalyptus sp. (GBS26/1) and Callitris glaucophylla. Second tree layer of C. glaucophylla. Upper shrub layer of C. glaucophylla, Acacia conferta and Acacia sp. (GBS26/2).	Loamy plain	Woodland. T1 16-20m, PCC 40%.	Native species groundcover dominated by Triodia sp.	NA
Q	GB27	SURVEY AREA 2 Girraween	26.4796	150.2787	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii and Acacia conferta.	Loamy plain	Woodland. T1 14-18m, PCC 40%.	NA	NA
Q	GB28	SURVEY AREA 2 Girraween	26.4821	150.2785	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1). Second tree layer of E. sp. (GBS26/1) and Callitris glaucophylla. Sparse shrub layer of C. glaucophylla, Acacia ixiophylla, and Alllocasuarina Luehmannii.	Loamy plain	Woodland. T1 16-20m, PCC 30-40%.	NA	NA
Q	GB29	SURVEY AREA 2 Girraween	26.4856	150.2786	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a second tree layer of Allocasuarina Luehmannii and Callitris glaucophylla. Mid dense shrub layer of A. Luehmannii, C. glaucophylla, and Acacia ixiophylla. Groundcover of Dodonaea macrossanii and Themeda triandra.	Undulation loamy plain. Hard pan layer exposed in gully incisions	Woodland. T1 14-18m, PCC 40%.	Groundcover of Dodonaea macrossanii and Themeda triandra.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB30	SURVEY AREA 2 Girraween	26.4864	150.2791	Non-R	Non-R (RE11.5.1 derived)	Regrowth woodland of Eucalyptus crebra with a dense shrub layer of Acacia ixiophylla.	Loamy plain	Woodland (disturbed). T1 8-12m.	NA	NA
S	GB31	SURVEY AREA 2 Girraween	26.4864	150.2506	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.7	Woodland of Eucalyptus fibrosa subsp. nubila and E. sp. (GBS26/1) with a shrub layer of Acacia semilunata, Callitris glaucophylla and Acacia leiocalyx.	Margins of low ironstone rise.	Woodland. T1 16-25m, PCC 35%, BA 6m2/ha, Stems 120/ha; T2 10-16m, PCC 9%, BA 9m2/ha, Stems 180/ha; S1 1.5-4m, PCC 12%, BA 0/m2/ha, Stems 160/ha; S2 0.5-1.5m, PCC 5%, Stems 280/ha; GC 0-0.5m, 37%.	Total vegetative cover 37%; Bare ground 20%; Leaf litter 43%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 76%; Native perennial herb 3%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 21%; Exotic shrub < 1m 0%.	Total species 23; Total native 23; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB32	SURVEY AREA 2 Girraween	26.4854	150.2491	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.7.4	Woodland of Eucalyptus sp. (GBS26/1) with associated Angophora leiocarpa. Sparse shrub layer of Acacia spp. and native dominant grassy groundcover.	Indurated sandstone jump up.	Woodland. T1 12-18m, PCC 30-40%.	Total vegetative cover 20%. Dominated by Aristida spp.	NA
Q	GB33	SURVEY AREA 2 Girraween	26.4852	150.2477	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a second tree layer of Callitris glaucophylla.	Gently sloping sandy / loam plain	Woodland. T1 18-25m, PCC 30-40%.	NA	NA
Q	GB34	SURVEY AREA 2 Girraween	26.4828	150.2616	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii, Acacia conferta, and A. semilunata.	Loamy plain	Woodland. T1 15-22m, PCC 30-40%.	Total vegetative cover 20%. Dominated by Aristida spp.	NA
Q	GB35	SURVEY AREA 2 Girraween	26.4875	150.2620	Non-R	Non-R	Regrowth shrubland dominated by Allocasuarina Luehmannii with assocaited Acacia semilunata and scattered Eucalyptus sp. (GBS26/1).	Loamy plain	Shrubland (regrowth) S1 2-4m, PCC 40%.	NA	NA
Q	GB36	SURVEY AREA 2 Girraween	26.4799	150.2709	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii, Acacia conferta, and A. semilunata.	Loamy plain	Woodland. T1 15-22m, PCC 30-40%.	NA	NA
Q	GB37	SURVEY AREA 2 Girraween	26.4839	150.2734	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii, Acacia conferta, and A. semilunata.	Loamy plain	Woodland. T1 15-22m, PCC 30-40%.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB38	SURVEY AREA 2 Girraween	26.4854	150.2754	11.7.4, 11.7.5, 11.7.7, 11.7.2	11.5.1	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii, Acacia conferta, and A. semilunata.	Loamy plain	Woodland. T1 15-22m, PCC 30-40%.	NA	NA
Q	GB39	SURVEY AREA 2 Girraween	26.4882	150.2755	Non-R	Non-R	Regrowth shrubland dominated by Allocasuarina Luehmannii with assocaited Acacia semilunata and scattered Eucalyptus sp. (GBS26/1).	Loamy plain	Shrubland (regrowth) S1 2-4m, PCC 40%.	NA	NA
Q	GB40	SURVEY AREA 2 Girraween	26.4925	150.2783	Non-R	Non-R	Woodland of Eucalyptus sp. (GBS26/1) with a mid dense shrub layer of Allocasuarina Luehmannii, Acacia conferta, and A. semilunata.	Loamy plain	Shrubland (regrowth) S1 2-4m, PCC 40%.	NA	NA
Q	GB41	SURVEY AREA 9	27.6118	151.1823	Non-R	Non-R	Sedgeland dominated by Cyperus sp., Marsilea sp., Eleocharis sp. and Phyla canescens*.	Alluvial plain with overflow depressions.	Sedgeland	Dominated by Cyperus sp., Marsilea sp., Eleocharis sp. and Lippia.	NA
Bio	GB42	SURVEY AREA 9	27.6113	151.1855	Mature Regrowth (11.3.25,11.3.4, 11.3.27)	11.3.4	Woodland of Eucalyptus tereticornis and E. populnea with a sparse second tree layer of Acacia stenophylla Eucalyptus tereticornis, Corymbia tessellaris and E. populnea. Groundcover dominated by Phyla canescens*	Alluvial plain with overflow depressions.	Woodland. T1 18-23m, PCC 45%, BA 2m2/ha, Stems 700/ha; T2 10-14m, PCC 8%, BA 2m2/ha, Stems 300/ha; GC 0-0.5m,	Total vegetative cover 87%; Bare ground 6%; Leaf litter 7%; Total native cover 30%; Total exotic cover 70%; Native perennial grass/sedge 13%; Native perennial herb 16%; Exotic perennial grass 1%; Exotic	Total species 26; Total native 17; Total naturalised 9.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									87%.	perennial herb 69%; Native shrub <1m 1%; Exotic shrub <1m 0%.	
Bio	GB43	SURVEY AREA 9	27.6104	151.1859	Mature Regrowth (11.3.25,11.3.4, 11.3.27)	11.3.25	Riparian woodland of Eucalyptus tereticornis with a second tree layer of Acacia stenophylla and Acacia salicina.	Sandy alluvial channels.	Woodland. T1 16-24m, PCC 41%, BA 6m2/ha, Stems 300/ha; T2 8-14m, PCC 29%, BA 6m2/ha, Stems 1800/ha; S1 2-6m, PCC 5%, BA 0/m2/ha, Stems 200/ha; GC 0-1m, 21%.	Total vegetative cover 21%; Bare ground 68%; Leaf litter 11%; Total native cover 57%; Total exotic cover 43%; Native perennial grass/sedge 100%; Native perennial herb 57%; Exotic perennial grass 29%; Exotic perennial herb 14%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 21; Total native 12; Total naturalised 9.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB44	SURVEY AREA 9	27.6125	151.1839	Mature Regrowth (11.5.1)	11.5.1a	Woodland/open woodland of Eucalyptus populnea.	Low rise of footslopes of loamy plain - interface between LZ 3 and LZ 5	Woodland. T1 8-11m, PCC 34%, BA 4m2/ha, Stems 900/ha; T2 6-8m, PCC 30%, BA 0m2/ha, Stems 200/ha; S1 2-6m, PCC 5%, BA 0/m2/ha, Stems 100/ha; GC 0-0.5m, 58%.	Total vegetative cover 58%; Bare ground 19%; Leaf litter 23%; Total native cover 98%; Total exotic cover 2%; Native perennial grass/sedge 83%; Native perennial herb 15%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 2%.	Total species 41; Total native 33; Total naturalised 8.
Bio	GB45	SURVEY AREA 9	27.6119	151.1751	Mature Regrowth (11.5.1)	11.5.1	Woodland dominated by Eucalyptus crebra with associated Callitris glaucophylla. A second tree layer of Allocasuarina Luehmannii and Melaleuca sp. Grassy groundcover dominated by Aristida caput-medusae and Eragrostis sp.	Loamy plain	Woodland. T1 18-22m, PCC 57%, BA 7m2/ha, Stems 1400/ha; T2 12-16m, PCC 8%, BA 3m2/ha, Stems 400/ha; S1 4-8m, PCC 29%, BA	Total vegetative cover 43%; Bare ground 13%; Leaf litter 44%; Total native cover 99%; Total exotic cover 1%; Native perennial grass/sedge 81%; Native perennial herb 14%; Exotic perennial grass 5%; Exotic	Total species 30; Total native 29; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									1/m2/ha, Stems 2900/ha; S2 1-3m, PCC 10%, Stems 2300/ha; GC 0-1m, 43%.	perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Bio	GB46	SURVEY AREA 9	27.6079	151.1872	11.3.25, 11.3.4, 11.3.27	11.3.25	Riparian woodland of Eucalyptus tereticornis and Angophora floribunda.	Incised bench in alluvial terrace	Woodland. T1 16-24m, PCC 44%, BA 6m2/ha, Stems 300/ha; T2 8-14m, PCC 24%, BA 4m2/ha, Stems 1700/ha; S1 2-6m, PCC 5%, BA 0/m2/ha, Stems 250/ha; GC 0-1m, 26%.	Total vegetative cover 26%; Bare ground 36%; Leaf litter 38%; Total native cover 33%; Total exotic cover 77%; Native perennial grass/sedge 15%; Native perennial herb 8%; Exotic perennial grass 23%; Exotic perennial herb 54%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 26; Total native 16; Total naturalised 10.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB47	SURVEY AREA 9	27.6077	151.1877	11.3.25, 11.3.4, 11.3.27	11.3.4	Woodland of Eucalyptus tereticornis with associated Angophora floribunda and a sparse second tree layer of Corymbia tessellaris.	Alluvial terrace	Woodland. T1 18-25m, PCC 47%, BA 4m2/ha, Stems 400/ha; T2 10-16m, PCC 18%, BA 3m2/ha, Stems 600/ha; S1 2-6m, PCC 5%, BA 0/m2/ha, Stems 200/ha; GC 0-1m, 85%.	Total vegetative cover 85%; Bare ground 14%; Leaf litter 1%; Total native cover 46%; Total exotic cover 54%; Native perennial grass/sedge 44%; Native perennial herb 2%; Exotic perennial grass 8%; Exotic perennial herb 46%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 32; Total native 18; Total naturalised 14.
Q	GB48	SURVEY AREA 9	27.6071	151.1873	11.3.25, 11.3.4, 11.3.27	11.3.27	Sedgeland dominated by Eleocharis plana and Juncus sp.	Alluvial plain with overflow depressions.	Sedgeland	NA	NA
Q	GB49	SURVEY AREA 9	27.6056	151.1864	Non-R	Non-R	Regrowth woodland of Eucalyptus populnea with a groundcover dominated by Phyla canescens*.	Alluvial plain.	Regrowth	Non native dominated by Phyla canescens*, with patches of Eragrostis curvula*.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB50	SURVEY AREA 9	27.6035	151.1834	Non-R	Non-R	Regrowth (heavily disturbed) woodland of Eucalyptus woolsiana, E, crebra, E. populnea and E. populnea X E. crebra.	Loamy plain	Non remnant	Non native dominated by Eragrostis curvula*.	NA
Q	GB51	SURVEY AREA 9	27.5964	151.1811	Mature Regrowth (11.5.1)	11.5.1	Woodland (disturbed) dominated by Eucalyptus crebra.	Loamy plain	Woodland. T1 12-18m, PCC 20-30%.	Native grassy groundcover dominated by Aristida spp.	NA
Q	GB52	SURVEY AREA 9	27.5904	151.1831	Mature Regrowth (11.5.1)	11.5.1	Woodland (disturbed) dominated by Eucalyptus crebra.	Loamy plain	Woodland. T1 12-16m, PCC 30-40%.	Native grassy groundcover dominated by Aristida spp.	NA
S	GB53	SURVEY AREA 9	27.5419	151.1934	Non-R	Non-R	Tussock grassland (derived) with scattered emergent Eucalyptus populnea.	Alluvial plain	Tussock grassland.	Total vegetative cover 84%; Bare ground 16%; Leaf litter 0%; Total native cover 63%; Total exotic cover 37%; Native perennial grass/sedge 42%; Native perennial herb 21%; Exotic perennial grass 0%; Exotic perennial herb 37%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 30; Total native 21; Total naturalised 9.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
S	GB54	SURVEY AREA 9	27.513	151.1924	Mature regrowth 11.3.25, 11.3.4, 11.3.27	11.3.4	Woodland of Eucalyptus tereticornis.	Alluvial plain	Woodland. T1 18-26m, PCC 40%, BA 9m2/ha, Stems 180/ha; T2 8-14m, PCC 18%, BA 3m2/ha, Stems 60/ha; GC 0-1m, 48%.	Total vegetative cover 48%; Bare ground 52%; Leaf litter 0%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 33%; Native perennial herb 67%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 14; Total native 13; Total naturalised 1.
Q	GB55	SURVEY AREA 9	27.5449	151.977	11.3.25, 11.3.4, 11.3.27b	11.3.25	Riparian woodland of Eucalyptus tereticornis with associated Angophora floribunda. Second tree layer of Eucalyptus tereticornis, A. floribunda and Acacia stenophyllaSparse rgoundcover of Lomandra longifolia, Cynodon dactylon* Eustrephus latifolius with Phragmites australis on river bank.	Alluvial channel.	Woodland. T1 18-28m, PCC 30-40%.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB56	SURVEY AREA 9	27.5385	151.1909	Mature Regrowth 11.5.1	11.5.1	Woodland of Eucalyptus crebra with co-dominant E. populnea and assocaited Eucalyptus tereticornis and Corymbia tessellaris. Native dominant grassy groundcover dominated by Aristida spp. and Chrysopogon fallax.	Gravelly rise above floodplain.	Woodland. T1 14-18m, PCC 30-40%.	Native grassy groundcover dominated by Aristida spp.	NA
S	GB57	SURVEY AREA 9	27.5447	151.1751	Mature regrowth 11.5.1	11.3.17	Woodland of Eucalyptus populnea with subdominant Casuarina cristata and associated E. crebra and E. woollsiana. Second tree layer of E. populnea and C. cristata. Open shrub layer of C. cristata, Acacia decora, Geijera parviflora and E. populnea.	Alluvial plain	Woodland. T1 18-26m, PCC 48%, BA 14m2/ha, Stems 960/ha; T2 8-15m, PCC 16%, BA 5m2/ha, Stems 320/ha; S1 2-6m, PCC 12%, BA 0/m2/ha, Stems 240/ha; GC 0-1m, 73%.	Total vegetative cover 73%; Bare ground 11%; Leaf litter 16%; Total native cover 76%; Total exotic cover 24%; Native perennial grass/sedge 66%; Native perennial herb 7%; Exotic perennial grass 0%; Exotic perennial herb 26%; Native shrub <1m 0%; Exotic shrub <1m 1%.	Total species 35; Total native 23; Total naturalised 12.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB58	SURVEY AREA 9	27.5566	151.1838	Mature regrowth 11.3.25, 11.3.4, 11.3.27	11.3.17	Woodland of Eucalyptus populnea with subdominant Casuarina cristata. Second tree layer of C. cristata and E. populnea with Alectryon oleofolius, Pittosporum phyrellioides and Acacia salicina. Mid dense shrub layer of C. cristata, P phrellioides, and A. salicina. Dense groundcover dominated by Phyla canescens*.	Alluvial plain	Woodland. T1 16-23m, PCC 32%, BA 4m2/ha, Stems 640/ha; T2 10-15m, PCC 11%, BA 3m2/ha, Stems 140/ha; S1 1-6m, PCC 47%, BA 1 m2/ha, Stems 700/ha; GC 0-0.5m, 95%.	Total vegetative cover 95%; Bare ground 1%; Leaf litter 4%; Total native cover 30%; Total exotic cover 70%; Native perennial grass/sedge 19%; Native perennial herb 11%; Exotic perennial grass 0%; Exotic perennial herb 68%; Native shrub <1m 0%; Exotic shrub < 1m 2%.	Total species 44; Total native 35; Total naturalised 9.
Bio	GB59	SURVEY AREA 9	27.5565	151.1844	Mature regrowth 11.3.25, 11.3.4, 11.3.27	11.3.27d	Woodland (palustrine wetland) of Eucalyptus camaldulensis with a very sparse shrub layer of Acacia stenophylla. Groundcover dominated by Eleocharis spp.	Depressions on alluvial plain.	Woodland. T1 16-24m, PCC 45%, BA 1m2/ha, Stems 600/ha; T2 8-12m, PCC 8%, BA 3m2/ha, Stems 60/ha; S1 1-4m, PCC 12%, BA	Total vegetative cover 89%; Bare ground/water 11%; Leaf litter 0%; Total native cover 97%; Total exotic cover 3%; Native perennial grass/sedge 80%; Native perennial herb 17%; Exotic perennial grass	Total species 21; Total native 20; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									0/m2/ha, Stems 40/ha; GC 0-1m, 89%.	0%; Exotic perennial herb 3%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Q	GB60	SURVEY AREA 9	27.5592	151.1858	11.3.25, 11.3.4, 11.3.27b	11.3.4	Woodland of Eucalyptus tereticornis with subdominant E. populnea and assocaited Corymbia tessellaris. Groundcover dominated by Phyla canescens*.	Alluvial plain (T2 terrace).	Woodland. T1 22-26m, PCC 50%, BA 8m2/ha; T2 12-16m, PCC 10%, BA 5m2/ha.	Exotic dominated by Phyla canescens*.	NA
Q	GB61	SURVEY AREA 9	27.5592	151.1858	11.3.25, 11.3.4, 11.3.27b	11.3.4	Woodland of Eucalyptus tereticornis with sub dominant Corymbia tessellaris and Angophora floribunda. Groundcover dominated by Lomandra longifolia and Phyla canescens*.	Alluvial plain.	Woodland. T1 16-26m, PCC 40%, BA 5m2/ha, Stems 80/ha; T2 8-12m, PCC 32%, BA 3m2/ha, Stems 340/ha; S1 1.5-5m, PCC 8%, BA 2/m2/ha, Stems 180/ha; GC 0-0.5m,	Total vegetative cover 79%; Bare ground 17%; Leaf litter 4%; Total native cover 54%; Total exotic cover 46%; Native perennial grass/sedge 40%; Native perennial herb 14%; Exotic perennial grass 5%; Exotic perennial herb 40%; Native shrub <1m 1%; Exotic shrub	Total species 39; Total native 29; Total naturalised 10.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									79%.	<1m 0%.	
Q	GB62	SURVEY AREA 9	27.5614	151.1837	11.3.25, 11.3.4, 11.3.27b	11.3.25	Riparian woodland/open forest of Eucalyptus tereticornis with a sparse shrub layer of Acacia salicina and A. stenophylla. Groundcover dominated by Phyla canescens*.	Alluvial channel.	Woodland. T1 15-22m, PCC 45-55%.	Exotic dominated by Phyla canescens*.	NA
Q	GB63	SURVEY AREA 9	27.5607	151.1820	11.3.25, 11.3.4, 11.3.27b	Non-R	Heavily disturbed woodland of Eucalyptus populnea with a sparse shrub layer of Acacia stenophylla and an exotic groundcover of Phyla canescens*.	Alluvial plain.	Woodland (disturbed). T1 8-12m.	Exotic dominated by Phyla canescens*.	NA
Q	GB64	SURVEY AREA 9	27.5636	151.1759	Mature Regrowth 11.3.2, 11.3.25	11.3.4	Woodland of Eucalyptus tereticornis with associated E. populnea. Groundcover dominated by Phyla canescens*.	Alluvial plain.	Woodland. T1 16-20m, PCC 30-40%.	Exotic dominated by Phyla canescens*.	NA
Q	GB65	SURVEY AREA 9	27.5664	151.1839	11.3.25, 11.3.4, 11.3.27b	11.3.25	Woodland of Eucalyptus tereticornis with associated Angophora floribunda and Corymbia tessellaris. Sparse shrub layer of Acacia stenophylla. Groundcover dominated by Phyla canescens*.	Alluvial channel.	Woodland. T1 16-22m, PCC 40-50%.	Exotic dominated by Phyla canescens*.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB66	SURVEY AREA 9	27.5702	151.1771	Non-R	11.3.2	Woodland of Eucalyptus populnea on alluvial plain. (Small patches amongst cleared paddock.)	Alluvial plain.	Woodland (disturbed). T1 10-15m.	NA	NA
Bio	GB67	SURVEY AREA 9	27.566	151.1670	Mature regrowth 11.3.2, 11.3.25	11.3.2	Woodland (disturbed) of Eucalyptus populnea with associated Eucalyptus tereticornis. Very sparse second tree and shrub layer of E. populnea with scattered Opuntia tomentosa*. Groundcover dominated by Eragrostis curvula*, Phyla canescens* and Bothriochloa sp.	Alluvial plain.	Woodland. T1 12-16m, PCC 46%, BA 8m2/ha, Stems 220/ha; T2 8-12m, PCC 8%, BA 1m2/ha, Stems 20/ha; S1 1-4m, PCC 5%, BA 0/m2/ha, Stems 140/ha; GC 0-1m, 69%.	Total vegetative cover 69%; Bare ground 14%; Leaf litter 17%; Total native cover 50%; Total exotic cover 50%; Native perennial grass/sedge 39%, Native perennial herb 11%; Exotic perennial grass 26%; Exotic perennial herb 24%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 43; Total native 32; Total naturalised 11.
Bio	GB68	SURVEY AREA 9	27.5645	151.1649	Mature regrowth 11.3.2, 11.3.25	11.3.2	Woodland (disturbed) of Eucalyptus populnea with associated Eucalyptus tereticornis. Very sparse second tree and shrub layer of E. populnea and Eucalyptus tereticornis with scattered Opuntia tomentosa*. Native domianted grassy groundcover dominated with inading	Alluvial plain.	Woodland. T1 12-16m, PCC 43%, BA 8m2/ha, Stems 240/ha; T2 7-10m,	Total vegetative cover 88%; Bare ground 1%; Leaf litter 11%; Total native cover 80%; Total exotic cover	Total species 51; Total native 46; Total naturalised 5.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
							Eragrostis curvula*.		PCC 6%, BA 1m2/ha, Stems 180/ha; S1 1-4m, PCC <5%, BA 0/m2/ha, Stems 240/ha; GC 0-1m, 88%.	20%; Native perennial grass/sedge 65%; Native perennial herb 14%; Exotic perennial grass 16%; Exotic perennial herb 4%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Q	GB69	SURVEY AREA 9	27.5653	151.1696	Mature regrowth 11.3.2, 11.3.25	11.3.4	Woodland of Eucalyptus tereticornis with associated Angophora floribunda. Native dominated groundcover of Imperata cylindrica and Lomandra longifolia.	Alluvial plain.	Woodland. T1 22-26m, PCC 50%.	Total vegetative cover 80%. Dominated by Imperata cylindrica and Lomandra longifolia.	NA
Q	GB70	SURVEY AREA 9	27.5649	151.1723	Mature regrowth 11.3.2, 11.3.25	11.3.2	Woodland of Eucalyptus populnea with scattered Casuarina cristata. Exotic groundcover dominated by Phyla canescens*.	Alluvial plain.	Woodland. T1 10-15m, PCC 30-40%.	Exotic groundcover dominated by Phyla canescens*.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Bio	GB71	SURVEY AREA 9	27.5584	151.1686	Non-R	11.4.3	Open forest of Acacia harpophylla with a second tree layer of A. harpophylla, Eucalyptus woolllsiana and Ventilago viminalis. Vert sparse ground cover of Capparis sp., Eremophila desertii, and A. harpophylla.	Clay plain.	Woodland. T1 15-21m, PCC 54%, BA 15m2/ha, Stems 480/ha; T2 8-12m, PCC 15%, BA 3m2/ha, Stems 180/ha; S1 2-6m, PCC <5%, BA 0 m2/ha, Stems 140/ha; GC 0-1m, 58%.	Total vegetative cover 58%; Bare ground 23%; Leaf litter 19%; Total native cover 98%; Total exotic cover 2%; Native perennial grass/sedge 83%; Native perennial herb 17%; Exotic perennial grass 2%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 43; Total native 37; Total naturalised 7.
Q	GB72	SURVEY AREA 9	27.5575	151.1691	Non-R	11.5.1a	Woodland of Eucalyptus populnea with associated Eucalyptus woollsiana and Angophora leiocarpa. Second tree layer of Eucalyptus populnea, Alectryon oleiofolia, Casuarina criststa, Pittosporum phyrellioides and Dodonaea lanceolata subsp. subsessilis. Native dominant groundcover.	Loamy plain	Woodland. T1 18-22m, PCC 40-50%.	Native species groundcover dominated by Aristida caput-medusae, Aristida sp., Dichanthium sericeum subsp. sericeum, Paspalidium sp., Chloris truncata, and Bothriochloa decipiens subsp.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
										decipiens.	
Bio	GB73	SURVEY AREA 9	27.5437	151.1693	11.5.1	11.5.20	Woodland of Eucalyptus woollsiana with associated E. crebra. Second tree layer of Allocasuarina Luehmannii. Native dominated groundcover of Aristida spp.	Loamy plain.	Woodland. T1 16-23m, PCC 49%, BA 8m2/ha, Stems 140/ha; T2 8-12m, PCC 5%, BA 1m2/ha, Stems 60/ha; S1 1-5m, PCC 18%, BA 6m2/ha, Stems 260/ha; GC 0-0.5m, 46%.	Total vegetative cover 46%; Bare ground 11%; Leaf litter 43%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 89%; Native perennial herb 9%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 2%; Exotic shrub <1m 0%.	Total species 32; Total native 28; Total naturalised 4.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
S	GB74	SURVEY AREA 7	27.1573	151.0323	11.3.2	11.3.3c	Open forest of Eucalyptus coolabah. Very sparse shrub layer of E. coolabah saplings and a groundcover of Phyla canescens* and Eleocharis sp.	Alluvial overflow channels.	Open forest. T1 8-12m, PCC 61%, BA 7m2/ha, Stems 200/ha; T2 6-10m, PCC 12%, BA 1m2/ha, Stems 60/ha; S1 1-5m, PCC <5%, BA 0/m2/ha, Stems 80/ha; GC 0-1m, 98%.	Total vegetative cover 98%; Bare ground 0%; Leaf litter 2%; Total native cover 50%; Total exotic cover 50%; Native perennial grass/sedge 45%; Native perennial herb 5%; Exotic perennial grass 0%; Exotic perennial herb 50%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 32; Total native 31; Total naturalised 1.
Q	GB75	SURVEY AREA 7	27.1556	151.0310	11.3.2	11.3.4	Woodland of Eucalyptus tereticornis with sub dominant E. populnea, and Corymbia clarksoniana. Sparse second tree layer of Eucalyptus tereticornis. Sparse shrub layer of Geijera parvifloia, Corymbia tessellaris, Opuntia tomentosa*, Alectryon oleiofolius, and Ventilago viminalis. Native dominated groundcover.	Alluvial plain.	Woodland. T1 23-30m, PCC 50%.	Total vegetative cover 70%. Native species dominated.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB76	SURVEY AREA 7	27.1517	151.0144	11.3.17	11.3.25	Riparian woodland of Eucalyptus tereticornis with associated E. coolabah, and a sparse shrub layer of Acacia stenophylla and A.salicina.	Alluvial channel.	Woodland. T1 22-26m, PCC 40-50%.	NA	NA
S	GB77	SURVEY AREA 7	27.1479	151.0137	Mature regrowth containing RE11.3.17	11.3.3	Woodland of Eucalyptus coolabah. Very sparse shrub layer of Acacia stenophylla and Casuarina cristata. Exotic groundcover of Cynodon dactylon* and Phyla canescens*.	Alluvial depressions.	Woodland. T1 14-19m, PCC 40%, BA 14m2/ha, Stems 240/ha; T2 6-10m, PCC 42%, BA 8m2/ha, Stems 220/ha; S1 1-6m, PCC 5%, BA 2/m2/ha, Stems 120/ha; GC 0-1m, 33%.	Total vegetative cover 33%; Bare ground 28%; Leaf litter 39%; Total native cover 27%; Total exotic cover 73%; Native perennial grass/sedge 60%; Native perennial herb 40%; Exotic perennial grass 0%; Exotic perennial herb 73%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 16; Total native 13; Total naturalised 3.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB78	SURVEY AREA 7	27.1592	150.9863	11.5.1	11.10.1d	Woodland of Eucalyptus crebra with associated E. woollsiana with a second tree layer of Callitris glaucophylla. Very sparse shrub layer of Acacia conferta and Opuntia tomentosa*. Native dominant groundcover of Chloris divaricata, Aristida spp., and Eragrostis parviflora.	Sandstone rises.	Woodland. T1 18-25m, PCC 30-40%.	Native dominant groundcover of Chloris divaricata, Aristida spp., and Eragrostis parviflora.	NA
Q	GB79	SURVEY AREA 7	27.1589	150.9887	11.5.1	11.10.1d	Woodland (disturbed) of Callitris glaucophylla with Eucalyptus crebra (logged).	Sandstone rises.	Woodland. T1 18-23m, PCC 30-40%.	Native species groundcover dominated by Aristida caput-medusae, Cheilanthes sieberi, Heteropogon contortus, Eragrostis sp., and Cyperus gracilis.	NA
Q	GB80	SURVEY AREA 7	27.1611	150.9772	11.5.1	11.7.4	Woodland (disturbed) dominated by Eucalyptus crebra with a second tree layer of Callitris glaucophylla, Allocasuarina inophloia and E. crebra. Shrub layer of C. glaucophylla and Acacia conferta. Sparse native dominated groundcover.	Sandstone rises.	Woodland. T1 22-28m, PCC 50%;T2 12-16m, PCC 10%; S1 1-6m, PCC 10%; GC 0-0.5m 20-30%.	Total vegetative cover 20-30%. Dominated by Aristida caput-medusae, Fimbristylis dichotoma, Eriachne mucronata, Aristida calycina and Eulalea aurea.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB81	SURVEY AREA 7	27.1614	150.9792	11.5.1	11.5.1	Woodland of Eucalyptus crebra with a second tree layer of Allocasuarina Luehmannii and Callitris glaucophyll, and a mid dense shrub layer of Allocasuarina Luehmannii and C. glaucophylla. Native groundcover dominated by Aristida spp.	Sandstone rises.	Woodland. T1 18-24m, PCC 30-40%.	Total vegetative cover 20-30%. Dominated by Aristida caput-medusae, Aristida calycina and Sporobolus creber.	NA
S	GB82	SURVEY AREA 7	27.1423	150.9941	Non-R	11.3.2(WM)	Woodland of Acacia pendula with scattered Eucalyptus populnea and Eucalyptus tereticornis.	Alluvial plain.	Woodland. T1 8-12m, PCC 52%, BA 10m2/ha, Stems 200/ha; T2 x-xxm, PCC 8%, BA 0m2/ha, Stems 0/ha; S1 1-3m, PCC 5%, BA 0m2/ha, Stems 140/ha; GC 0-1m, 86%.	Total vegetative cover 86%; Bare ground 4%; Leaf litter 10%; Total native cover 81%; Total exotic cover 19%; Native perennial grass/sedge 78%; Native perennial herb 22%; Exotic perennial grass 7%; Exotic perennial herb 12%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 53; Total native 46; Total naturalised 7.
Q	GB83	SURVEY AREA 7	27.1418	150.9947	Mature Regrowth 11.3.2	11.3.4 (regrowth)	Regrowth woodland of Eucalyptus tereticornis	Alluvial plain	Regrowth	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB84	SURVEY AREA 7	27.1406	150.9895	Non-R	11.3.1 (regrowth . 15 yrs)	Regrowth woodland of Acacia harpophylla (>15 yrs) merging with regrowth poplar box woodland	Alluvial plain	Regrowth	NA	NA
S	GB85	Duntroon	27.4679	150.0788	11.5.1	11.7.4	Woodland of Eucalyptus crebra with associated Corymbia trachyphloia, with a second tree layer of E. crebra, Callitris gluacophylla and alphitonia excelsa. Sparse native groundcover fominated by Aristida caput-medusae, Gahnia aspera and Xanthorrhoea johnstonii.	Loamy plain.	Woodland. T1 18-23m, PCC 40%, BA 7m2/ha, Stems 120/ha; T2 8-14m, PCC 16%, BA 6m2/ha, Stems 360/ha; S1 1-4m, PCC 32%, BA 2m2/ha, Stems 540/ha; GC 0-1m, 27%.	Total vegetative cover 27%; Bare ground 0%; Leaf litter 63%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 69%; Native perennial herb 21%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 10%; Exotic shrub <1m 0%.	Total species 34; Total native 34; Total naturalised 0.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
S	GB86	Duntroon	27.4492	151.0823	11.5.1	11.7.4	Woodland of Eucalyptus crebra with associated Corymbia trachyphloia. Second tree layer of C. glaucophylla, E. crebra, and Acacia sp. Sparse shrub layer of Acacia sp., Acacia conferta and Allocasuarina inophloia. Native dominant grassy groundcover.	Duricrust surface.	Woodland. T1 18-26m, PCC 63%, BA 6m2/ha, Stems 120/ha; T2 8-15m, PCC 16%, BA 5m2/ha, Stems 320/ha; S1 2-6m, PCC 20%, BA 1/m2/ha, Stems 540/ha; GC 0-1m, 53%.	Total vegetative cover 53%; Bare ground 0%; Leaf litter 47%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 45%; Native perennial herb 51%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 4%; Exotic shrub < 1m 0%.	Total species 36; Total native 36; Total naturalised 0.
S	GB87	Duntroon	27.4233	151.0808	11.5.1/ 11.5.20	11.5.20 merging with dominant 11.5.1	Woodland of Eucalyptus woollsiana and E. crebra. Sparse shrub layer of Callitris glaucophylla, E. crebra and Acacia conferta.	Loamy plain.	Woodland. T1 16-23m, PCC 30%, BA 8m2/ha, Stems 200/ha; T2 10-16m, PCC 18%, BA 9m2/ha, Stems 540/ha; S1 2-4m, PCC <5%, BA	Total vegetative cover 16%; Bare ground 4%; Leaf litter 80%; Total native cover 94%; Total exotic cover 6%; Native perennial grass/sedge 68%; Native perennial herb 36%; Exotic perennial grass 0%; Exotic	Total species 36; Total native 35; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									1m2/ha, Stems 260/ha; GC 0-0.5m, 12%.	perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 6%.	
Q	GB88	Duntroon	27.4295	151.0923	11.5.4a	11.7.4	Woodland of Eucalyptus crebra with associated E. exserta. Second tree layer of E. exserta, Callitris glaucophylla and Acacia sp. Native groundcover dominated by Aristida spp., and Paspalidium sp.	Duricrust surface.	Woodland. T1 18-24m, PCC 30-40%.	Native groundcover dominated by Aristida spp., and Paspalidium sp.	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
T	GB89	Duntroon	27.4187	151.0958	Mature regrowth 11.5.1, 11.5.20	11.5.1	Woodland of Eucalyptus crebra with associated Callitris glaucophylla. Second tree layer of E. crebra, Allocasuarina Luehmannii and Callitris glaucophylla. Native grooundcover.	Loamy plain.	Woodland. T1 12-18m, PCC 8%, BA 2m2/ha, Stems 600/ha; T2 8-10m, PCC 65%, BA 16m2/ha, Stems 1200/ha; S1 1-5m, PCC 4%, BA 1/m2/ha, Stems 700/ha; GC 0-1m, 70%.	Native grassy groundcover dominated by Aristida spp.	NA
S	GB90	Duntroon	27.4084	151.0923	11.5.1	11.5.1	Woodland of Eucalyptus crebra with Allocasuarina Luehmannii and Callitris glaucophylla. Second tree layer of E. crebra, Callitris glaucophylla, Allocasuarina Luehmannii and Melaleuca decora. Sparse shrub layer of A. Luehmannii, and C. glaucophylla. Native dominant groundcover.	Loamy plain.	Woodland. T1 12-16m, PCC 46%, BA 8m2/ha, Stems 220/ha; T2 8-12m, PCC 8%, BA 1m2/ha, Stems 20/ha; S1 1-4m, PCC 5%, BA	Total vegetative cover 70%; Bare ground 15%; Leaf litter 15%; Total native cover 50%; Total exotic cover 50%; Native perennial grass/sedge 39%, Native perennial herb 11%; Exotic perennial grass	Total species 30; Total native 29; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									0/m2/ha, Stems 140/ha; GC 0-1m, 69%.	26%; Exotic perennial herb 24%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
S	GB91	Duntroon	27.3974	151.0965	11.5.1, 11.5.20	11.5.20	Woodland of Eucalyptus woollsiana with a second tree layer of Allocasuarina Luehmannii and scattered Callitris glaucophylla. Sparse shrub layer of Acacia ixiophylla and Allocasuarina Luehmannii. Native dominant groundcover.	Loamy plain	Woodland. T1 20-26m, PCC 50%, BA 12m2/ha, Stems 140/ha; T2 10-16m, PCC 47%, BA 4m2/ha, Stems 220/ha; S1 4-6m, PCC 4%, BA 0/m2/ha, Stems 220/ha; S2 1-3m, PCC 5%, BA	Total vegetative cover 33%; Bare ground 0%; Leaf litter 67%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 82%; Native perennial herb 9%; Exotic perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 9%; Exotic shrub <1m 0%.	Total species 46; Total native 45; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									0/m2/ha, Stems 340/ha;GC 0-1m, 33%.		
Q	GB92	Duntroon	27.3838	151.1142	11.5.1, 11.3.2	11.5.20	Woodland of Eucalyptus woollsiana with sub dominant E. populnea. Mid dense second tree layer of Allocasuarina and Callitris glaucophylla. Native dominated groundcover.	Loamy plain.	Woodland. T1 16-22m, PCC 48%, BA 4m2/ha; T2 8-12m, PCC 14%, BA 16m2/ha; S1 1-5m, PCC 5%; GC 0-1m, 40%.	Total vegetative cover 40%. Dominated by Aristida spp.	NA
Q	GB93	Duntroon	27.3831	151.175	Non-R	Non-R	Tussock grassland (derived) dominated by Dichanthium sericeum subsp. sericeum, with Eriochloa procera, Eulalia aurea and Panicum queenslandicum.	Alluvial plain.	Tussock grassland. GC 0-0.5m, 80%.	Total vegetative cover 80%. Native species dominated.	Total species 23; Total native 19; Total naturalised 4.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
Q	GB94	Duntroon	27.3832	151.1797	Non-R	Non-R	Regrowth woodland of Eucalyptus tereticornis with associated shrub cover of Acacia stenophylla (derived11.3.27).	Swampy depression with surface water	Regrowth	NA	NA
Q	GB95	Duntroon	27.4535	151.1419	Mature regrowth 11.3.2	11.3.4	Woodland of Eucalyptus tereticornis with associated E. populnea. Native groundcover dominated by Dichanthium sericeum subsp. sericeum and Bothriochloa sp.	Alluvial plain	Woodland. T1 18-22m, PCC 45%, BA 6m2/ha; T2 10-14m, PCC 10%, BA 2m2/ha; S1 1-5m, PCC 20%, BA 0/m2/ha; GC 0-1m, 70%.	Total vegetative cover 70%. Native species dominated.	NA
Q	GB96	Survey area F	27.4884	151.1359	Non-R	Non-R	Woodland (disturbed) of Callitris glaucophylla with native dominnat groundcover of Cymbopogon refractus, Eragrostis spp.,and Aristida spp.	Alluvial plain.	Woodland (disturbed). T1 8-12m.	NA	NA

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
S	GB97	Survey area F	27.4903	151.1385	Mature regrowth 11.5.1	11.4.3	Open forest of Acacia harpophylla.	Clay plain.	Woodland. T1 14-18m, PCC 76%, BA 12m2/ha, Stems 440/ha; T2 6-10m, PCC 5%, BA 3m2/ha; Stems 280/ha; GC 0-1m, 73%.	Total vegetative cover 73%; Bare ground 9%; Leaf litter 18%; Total native cover 77%; Total exotic cover 23%; Native perennial grass/sedge 26%; Native perennial herb 51%; Exotic perennial grass 23%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	Total species 43; Total native 38; Total naturalised 5.
S	GB98	Survey area F	27.4877	151.1266	11.5.1	11.7.4	Woodland of Eucalyptus crebra with a second tree layer of Callitris glaucophylla. Mid dense groundcover dominated by Aristida spp. and Cymbopogon refractus.	Duricrust surface.	Woodland. T1 18-22m, PCC 31%, BA 4m2/ha, Stems 60/ha; T2 5-10m, PCC 30%, BA 2m2/ha, Stems 680/ha; S1 1-4m, PCC	Total vegetative cover 37%; Bare ground 6%; Leaf litter 43%; Rock 17%; Total native cover 100%; Total exotic cover 0%; Native perennial grass/sedge 54%; Native perennial herb 46%; Exotic	Total species 40; Total native 39; Total naturalised 1.

SITE LEVEL	SITE ID.	Location	LAT -S	LONG- E	EHPRE	SURVEY RE	VEG_STRUCTURAL & FLORISTIC DESCRIPTION	GEOLOGY_ LANDFORM	STRUCTURE	GROUNDCOVER CONDITION SUMMARY	SITE SPECIES RICHNESS
									27%, BA 3/m2/ha, Stems 540/ha; GC 0-1m, 37%.	perennial grass 0%; Exotic perennial herb 0%; Native shrub <1m 0%; Exotic shrub <1m 0%.	
Q	GB99	Survey area F	27.4866	151.1241	Non-R	Non-R	Regrowth woodland of Eucalyptus crebra with scattered large remnant trees of E. crebra. Grassy native dominated groundcover of Bothriochloa decipiens, Aristida caput-medusae, Fimbristylis dichotoma and Eragrostis schultzii.	Loamy plain.	NA	NA	
Q	GB100	Survey area F	27.4853	151.1187	Non-R	11.3.4	Woodland of Eucalyptus tereticornis with associated E. crebra and E. populnea. Second tree layer of Callitris glaucophylla. Native dominant groundcover of Lomandra longifolia and Aristida caput-medusae.	Alluvial plain.	Woodland. T1 16-20m, PCC 40%.	Native grassy groundcover dominated by Lomandra longifolia, and Aristida spp.	NA
Q	GB101	Survey area F	27.4834	151.1189	11.5.4, 11.3.18	11.3.18	Woodland of Eucalyptus populnea with associated E. populnea and Callitris glaucophylla. Second tree layer dominated by C. glaucophylla. Native dominant groundcover.	Alluvial plain.	Woodland. T1 18-22m, PCC 40-50%.	NA	NA

Appendix I. Regional Ecosystem Technical Descriptions

Structural categories provided within this section are derived from Neldner et al (2012).

Survey Area 2

Regional Ecosystem 11.3.25

Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.

VMA Status: Least concern

Biodiversity Status: Of concern

Description: This RE is associated with the riparian margins of the major drainage lines of Bottletree Creek. It is a fringing open forest ranging from 16-24 metres and a mean crown cover of 56%. Dominant canopy trees are rough barked apple (*Angophora floribunda*) and Queensland blue gum *(Eucalyptus tereticornis),* with occasional associated yellow bloodwood (*Corymbia bloxsomei).* A distinct sub-canopy is dominated by the above canopy species. The shrub layer which is sparse to very sparse (6-10% cover) ranges between 1-4 m in height and features *Leptospermum polygalifolium,* with associated species such as *Callitris glaucophylla, Acacia crassa* subsp*. crassa,* and saplings of the canopy dominants*.* Ground cover is dense, ranging between 83-86% percent foliage cover (PFC) with a dominance of native perennial grasses such as *Heteropogon triticeus, Dichanthium sericeum* subsp*. sericeum, Imperata cylindrica*, *Chloris divaricata*, *Cymbopogon refractus*, *Chrysopogon fallax, Aristida* spp. and *Lomandra longifolia*. Exotic species are limited to scattered Mayne's pest (*Verbena aristigera**), and prickly pear (*Opuntia stricta**). Mean plot species richness is 42.

Habitat features include a mean leaf litter cover of 12%, and a dense cover of native dominant grasses. The limited extent of coarse woody debris is possibly due to periodic flooding, with occasional hollows present in large rough barked apple trees lining the river bank.

The riparian habitat is considered in excellent condition on the basis of the health of the canopy and subcanopy (no dieback evident), a low incidence of exotic species in all stratum and particularly in the groundcover, and a lack of recent grazing.

Representative sites: 2 sites: Secondary (GBS16, 19)

Structural formation: Open forest: 100%; 2 sites (2 secondary)

Height EDL: Mean 20m; range 16-24m

PCC EDL: Mean 56.5%; range 54-59%

Species Recorded: Total: 64; Mean spp./site: 44

Native species: Mean spp./site: 42

Exotic species: Mean spp./site: 3

Stratum: T1

Ht avg. = 20.5 m, range 16-24

Crown cover avg. = 56.5 %, range 54-59%

Basal Area m2/ha = 13.5; range 11-16

Stem density/ha avg. = 150; range 140-160

Total species: 3 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Angophora floribunda (100%/48%), Eucalyptus tereticornis (100%/8.5%)

Frequent species: Corymbia bloxsomei (50%/<5%)

Stratum T2

Ht. avg. = 14 m, range 12-16 m

Crown cover avg. = 5 %, range 5-5%

Basal Area m2/ha = 1.55; range 1-2

Stem density/ha avg. = 50, range 40-60

Total species: 3 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Angophora floribunda (100%/4%), Eucalyptus tereticornis (100%/2%)

Frequent species: Allocasuarina Luehmannii (50%/1%).*

Stratum: S1

Ht. avg. = 2.5 m, range 1-4m

Crown cover avg. = 9 %, range 8-10%

Stem density/ha avg. = 620, range 360-880

Total species: 9 (89% native, 11% exotic)

Dominant species (frequency/mean PCC%): Leptospermum polygalifolium (100%/7%),

Frequent species: Callitris glaucophylla (50%/1%), Acacia crassa subsp. crassa (100%/1%), Brachychiton populnea (50%/1%), Opuntia stricta (50%/1%), Acacia semilunata (50%/1%), Acacia stenophylla (50%/1%), Angophora floribunda (50%/1%), Eucalyptus tereticornis (50%/1%).*

Stratum: G

Ht avg. = 0.5 m, range 0.25-0.75

PFC avg. = 84.5 %, range 83-86%

PFC Native sp. avg[4]. = 99%: PFC exotic sp. avg. = 1.5%

Total species: 27 (96% native, 4% exotic)

Dominant species (frequency): *Alloteropsis semialata (100%), Aristida calycina (100%), Asteraceae (GBS16/6) (100%), Cheilanthes sieberi (100%), Chrysocephalum apiculatum (100%), Cyanthillium cinereum (100%), Desmodium campylocaulon (100%), Dianella longifolia var. longifolia (100%), Dichanthium sericeum subsp. sericeum (100%), Digitaria ramularis (100%), Eragrostis sp. (GBS16/2) (100%), Verbena aristigera aristigera* (100%), Heteropogon triticeus (100%), Lomandra longifolia (100%), Oxalis sp. (GBS16/5) (100%), Pterotis rara (100%), Phyllanthus sp. (100%), Wahlenbergia communis (100%)*

Frequent species: *Ajuga australis (50%), Alternanthera nana (50%), Aristida acuta (50%), Aristida caput-medusae (50%), Aristida ramosus (50%), Asteraceae (GBS19/1) (50%), Asteraceae (GBS19/2) (50%), Brachychiton populnea (50%), Brachyscome sp. (50%), Chloris divaricate (50%), Chrysopogon fallax (50%), Crotalaria novae-hollandaei (50%), Cymbopogon refractus (50%), Desmodium varians (50%), Eragrostis sororia (50%), Eriochloa crebra (50%), Euphorbia sp. (GBS17/3) (50%), Fabaceae (GBS16/3) (50%), Fimbristylis dichotoma (50%), Fimbristylis virgatus (50%), Goodenia sp. (GBS4/3) (50%), Heteropogon contortus (50%), Imperata cylindrica (50%), Juncus usitatus (50%), Opuntia stricta* (Class 3) (50%), Panicum decompositum (50%), Paspalidium sp. (GBS13/1) (50Richardia brasiliensis* (50%), Rostellularia adscendens (100%), Sporobolus sp. (GBS16/7) (100%), Tricoryne anceps (50%), Urochloa mosambicensis* (50%)*

[4] % of total PFC

Regional Ecosystem 11.3.4

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

VMA Status: Of concern

Biodiversity Status: Of concern

Description: This community occurs on seasonally flooded alluvial plains associated with major drainage lines with typical sandy loam soils. The canopy height ranges between 14-24m and a mean crown cover of 28%. It is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and rough-barked apple *(Angophora floribunda)* with the associated yellow bloodwood (*Corymbia bloxsomei*), narrow leaved ironbark (*Eucalyptus crebra*), and smooth barked apple (*Angophora leiocarpa*).

The second tree layer is sparse and comprises the above canopy species together with white cypress (*Callitris glaucophylla*) and kurrajong (*Brachychiton populnea*). The shrub layer ranges between 1-4 m in height with a mean cover of 22%. Dominant species are moon wattle (*Acacia semilunata*), and white cypress, with frequent yellow tea tree (*Leptospermum polygalifolium*), black wattle (*Acacia crassa* subsp*. crassa),* bull oak *(Allocasuarina Luehmannii*), glory wattle *(Acacia spectabilis),* wilga *(Geijera parviflora),* and paper bark *(Melaleuca decora).*

The ground layer is ungrazed, diverse and in good condition with a mean PFC of 81%, which is dominated (97%) by native species. Dominant graminoids species are *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea, Gahnia aspera, Heteropogon contortus, Juncus* sp*.,* and *Paspalidium* sp., with common native herbs including *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Dianella longifolia* var*. longifolia, Rostellularia adscendens,* and *Wahlenbergia communis*. Exotic species are limited to scattered occurrences Mayne's pest (*Verbena aristigera**), gotu kola (*Centella asiatica*), buffel grass (*Pennisetum ciliare**) and liverseed grass (*Urochloa mosambicensis**).

Habitat features include, a mean leaf litter cover of 16%, mean coarse woody debris[5] of 40 logs and 170m of log/ha, and occasional hollows. Overall the alluvial habitats surveyed are in good condition. There is some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers*.* There is a low incidence of exotic species throughout. A dominance of increaser grasses such as wire grass (Aristida) species in the groundcover suggests impacts of previous grazing pressure on species composition, however a lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of dense native cover and high species richness.

Representative sites: 3 sites: Secondary (GBS 9, 17, 20)

Structural formation: Open forest: 33%; Woodland 33%; Open woodland 33%.

Height EDL: Mean 17m; range 14-24m

PCC EDL: Mean 37%; range 15-56%

Species Recorded: Total 60; Mean spp./site: 32

[5] As per Eyre *et al*. 2012.

Native species: Total 56; Mean spp./site: 31

Exotic species: Total 4; Mean spp./site: 1.3

Representative sites: 2 sites: Secondary (GBS16, 19)

Structural formation: Open forest: 100%; 2 sites (2 secondary)

Height EDL: Mean 20m; range 16-24m

PCC EDL: Mean 56.5%; range 54-59%

Species Recorded: Total: 64; Mean spp./site: 44

Native species: Mean spp./site: 42

Exotic species: Mean spp./site: 3

Stratum: T1

Ht. avg. = 20 m, range 16-24m

Crown cover avg. = 56.5 %, range 54-59%

Basal Area m2/ha = 13; range 6-20

Stem density/ha avg. = 173; range 60-140

Total species: 3 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Eucalyptus tereticornis (66%/20%), Corymbia bloxsomei (50%/19%)

Frequent species: Angophora leiocarpa (33%/<5%), E. crebra (33%/<5%), Angophora floribunda (33%/<5%)

Stratum T2

Ht. avg. = 12 m, range 8-16 m

Crown cover avg. = 12 %, range 10-14%

Basal Area m2/ha = 1.6; range 0-3

Stem density/ha avg. = 53, range 0-100

Total species: 6 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Eucalyptus tereticornis (100%/38%)

Frequent species: Angophora leiocarpa (33%/5%), Callitris glaucophylla (33%/<5%), Angophora floribunda (33%/<5%), Brachychiton populnea (33%/<5%), Corymbia bloxsomei (33%/<5%)

Stratum: S1

Ht. avg. = 3 m, range 1-6m

Crown cover avg. = 25 %, range 5-32%

Stem density/ha avg. = 1333, range 100-3760

Total species: 8 (100% native, 0% exotic)

Dominant species (frequency %): Acacia semilunata (100%), *Callitris glaucophylla* (100%)

Frequent species: Acacia crassa subsp. *crassa* (33%), *Acacia* sp. (GBS3/1) (33%), *Acacia spectabilis* (66%), *Xanthorrhoea johnsonii* (66%), *Allocasuarina Luehmannii* (33%), *Leptospermum polygalifolium* (33%)

Stratum: S2

Ht. avg. = 2 m, range 1-3m

Crown cover avg. = 11 %, range 5-30%

Stem density/ha avg. = 73.3, range 80-140

Total species: 5 (100% native, 0% exotic)

Dominant species (frequency %): Acacia semilunata (66%)

Frequent species: Acacia spectabilis (33%), *Callitris glaucophylla* (33%), *Xanthorrhoea johnsonii* (33%), *Leptospermum polygalifolium* (33%)

Stratum: G

Ht avg. = 0.5 m, range 0.25-0.75

PFC avg. = 81.3 %, range 68-88%

PFC Native sp. avg.[6] = 97.3%: PFC exotic sp. avg. = 2.7%

Total species: 59 (95% native, 5% exotic)

Dominant species (frequency): Lomandra longifolia (100%), Aristida caput-medusae (66%), Cheilanthes sieberi (66%), Chrysocephalum apiculatum (66%), Chrysopogon fallax (66%), Dianella longifolia var. longifolia (66%), Desmodium varians (66%), Dichanthium sericeum subsp. sericeum (66%), Eragrostis sp. (GBS16/2) (66%), Verbena aristigera (66%), Goodenia sp. (GBS4/3) (66%), Paspalidium sp. (GBS13/1) (66%), Sida rohlenae subsp. rohlenae (66%), Sporobolus sp. (GBS16/7) (66%), Wahlenbergia campanulata (66%),*

[6] % of total PFC

Xanthorrhoea johnsonii (66%),

Frequent species: Abilgaardia ovata (33%), Alloteropsis semialata (33%), Aristida calycina (33%), Aristida ramosa (33%), Asteraceae (GBS16/6) (33%), Asteraceae (GBS19/2) (33%), Boerhavia sp. (GBS17/2) (33%), Centella asiatica (33%), Chloris divaricata (33%), Chloris truncata (33%), Cyanthillium cinereum (33%), Cyperus polystachyus (33%), Desmodium campylocaulon (33%), Digitaria amonophila (33%), Digitaria brownii (33%), Dodonaea biloba (33%), Eleocharis sp. (GBS17/1) (33%), Epaltes australe (33%), Eragrostis shultzii (33%), Eragrostis sororia (33%), Eriochloa crebra (33%), Eulalia aurea (33%), Euphorbia sp. (GBS17/3) (33%), Fimbristylis dichotoma (33%), Gahnia aspera (33%), Heteropogon contortus (33%), Hibbertia sp. (GBS20/1) (33%), Hypericum gramineum (33%), Imperata cylindrica (33%), Juncus sp. (33%), Lomandra leucocephala subsp. leucocephala (33%), Oxalis sp. (GBS16/5) (33%), Panicum decompositum (33%), Panicum queenslandicum (33%), Pennisetum ciliare* (33%), Phyllanthus sp. (33%), Pleurocarpaea sp. (GBS3/5) (33%), Rostellularia adscendens (33%), Sida subspicata (33%), Urochloa mosambicensis* (33%), Zornia biarticulata (33%)*

Regional Ecosystem 11.5.1

Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains/remnant surfaces.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This woodland ecosystem occurs on sandy soils of old loamy plains. The canopy height ranges between 10-22m and a mean crown cover of 37%. It is dominated by narrow leaf ironbark *(Eucalyptus crebra)* with associated smooth barked apple *(Angophora leiocarpa),* white cypress *(Callitris glaucophylla),* poplar box *(Eucalyptus populnea),* and yellow bloodwood *(Corymbia bloxsomei).* The sparse second tree layer has an average height of 8.5m and is dominated by white cypress (*Callitris glaucophylla*) and bulloak (*Alloacasuarina Luehmannii)* with less frequent narrow leaf ironbark and smooth barked apple.

A diverse upper shrub layer ranges between 5-30% in cover with a mean height of 4%. Bull oak and white cypress predominate across all sites surveyed. Other typical species are moon wattle (*Acacia semilunata*), *Acacia ixiophylla, Melaleuca decora, Acacia apprepta, Acacia crassa* subsp. *crassa*, *Acacia* l*eiocalyx*, *Acacia spectabilis*, *Petalostigma pubescens, Alphitonia excelsa, Grevillea striata,* and *Ozanthamnus diosmifolius.* The lower shrub layer averaging at 2m in height and 18.5 % in cover, is similarly diverse with 18 species recorded. Dominant species are *Leucopogon* sp*.*, *Callitris glaucophylla*, *Acacia crassa* subsp*. crassa* and *Allocasuarina Luehmannii.*

A diverse ground layer comprising 76 species displays good condition with cover totally dominated by natives. Dominant species are *Aristida caput-medusae, Fimbristylis dichotoma, Chrysopogon fallax, Cyanthillium cinereum, Dodonaea macrossanii, Panicum decompositum, and Themeda triandra.* Frequent species include *Aristida calycina, Commelina lanceolata, Eragrostis sororia, Goodenia* sp. (GBS4/3), *Lomandra leucocephala* subsp*. leucocephala,* and *Pleurocarpaea* sp. (GBS3/5). Naturalised species are limited to scattered occurrences of *Melinus repens*, Opuntia stricta** (Class 3), *Opuntia tomentosa** (Class 3), *Paspalum dilatatum** and *Pennisetum ciliare*.*

The ecosystem supports a mean leaf litter cover of 58%. There is evidence of selective removal of narrow leaf ironbark and smooth barked apple, although the presence of mature trees, recruitment of canopy species in the shrub layers, and lack of exotic species, are indicative of the overall good condition of the habitat*.* As for the alluvial habitats there is a dominance of wire grass (Aristida) species in the groundcover suggestive of previous grazing pressure. A lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of a healthy native dominated groundcover and high species richness.

Representative sites: 15 sites: 4 Secondary (GBS 4, 5, 23, 25), 1 Tertiary (GBT 18): 10 Quaternary (GBQ 7, 26, 27, 28, 29, 33, 34, 36, 37, 38).

Structural formation: Woodland 100% (5 Sites[7])

Height EDL: Mean 14.5m; range 10-22m; std. dev. 3.75m

[7] NB. Structural data derived from secondary and tertiary sites only.

PCC EDL: Mean 37%; range 29-40%; std. dev. 5.5%

Species Recorded[8]: Total 107; Mean spp./site: 28; std. dev. 10

Native species: Total 56; Mean spp./site: 31

Exotic species: Total 3; Mean spp./site: <1

Stratum: T1

Ht. avg. = 14.5 m, range 10-22m; std. dev. 3.75m

Crown cover avg. = 37 %, range 29-40%; std. dev. 5.5%

Basal Area m2/ha avg. = 7.5; range 3-10; std. dev. 2.5

Stem density/ha avg. = 130; range 100-240; std. dev. 10

Total species: 5 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Eucalyptus crebra (100%/38%)

Frequent species: Angophora leiocarpa (40%/6%), Callitris glaucophylla (40%/5%), Eucalyptus populnea (40%/2.5%), Corymbia bloxsomei (20%/<5%)

Stratum T2

Ht. avg. = 8.5 m, range 6-14 m; std. dev. 0.5

Crown cover avg. = 22 %, range 8-30%; std. dev. 8

Basal Area m2/ha avg. = 2.5; range 2-5; std. dev. 0.5

Stem density/ha avg. = 190, range 60-600; std. dev. 905

Total species: 4 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Callitris glaucophylla (33%/15%), Alloacsuarian Luehmannii (100%/4%)

Frequent species: Eucalyptus crebra (60%/<5%), Angophora leiocarpa (40%/5%),

Stratum: S1

Ht. avg. = 4 m, range 2-6m; std. dev. 0.5

Crown cover avg. = 28.5%, range 5-30%; std. dev. 1.5

Stem density/ha avg. = 810, range 440-1180; std. dev. 370

[8] Secondary sites only

Total species: 13 (100% native, 0% exotic)

Dominant species (frequency %): Callitris glaucophylla (100%); *Allocasuarina Luehmannii* (100%),

Frequent species: Acacia semilunata (40%), *Acacia ixiophylla (40%), Melaleuca decora (40%), Acacia apprepta (20%), Acacia crassa* subsp. *crassa* (20%), *Acacia* leiocalyx (20%), *Acacia spectabilis* (20%), *Petalostigma pubescens (20%), Alphitonia excelsa (20%), Grevillea striata (20%), Ozanthamnus diosmifolius (20%).*

Stratum: S2

Ht. avg. = 2 m, range 1-3m; std. dev. 0

Crown cover avg. = 18.5 %, range 5-27%; std. dev. 8.5

Stem density/ha avg. = 710, range 520-900; std. dev. 190

Total species: 18 (95% native, 5% exotic)

Dominant species (frequency %): Leucopogon sp*. (100%), Callitris glaucophylla* (80%).

Frequent species: Allocasuarina Luehmannii (60%), Acacia amblygona (20%), Acacia crassa subsp. crassa (60%), Acacia ixiophylla (20%), Acacia leiocalyx subsp. leiocalyx (20%), Acacia muelleriana (20%), Acacia semilunata (20%), Acacia spectabilis (20%), Alphitonia excelsa (20%), Angophora leiocarpa (20%), Boronia bipinnata (20%), Homoranthus sp*. (20%), Jacksonia scoparia (20%), Ozothamnus diosmifolius (20%), Opuntia stricta* (Class 3) (20%), Solanum parviflolium (20%).*

Stratum: G

Ht avg. = 0.5 m, range 0.25-0.75

PFC avg. = 38.5 %, range 21-56%; std. dev. 17.5

PFC Native sp. avg.[9] = 100%: PFC exotic sp. avg. = 0%

Total species: 76 (94% native, 6% exotic)

Dominant species (frequency): Aristida caput-medusae (100%), Fimbristylis dichotoma (100%), Chrysopogon fallax (80%), Cyanthillium cinereum (80%), Dodonaea macrossanii (80%), Panicum decompositum (80%), Themeda triandra (80%).

Frequent species (frequency): Aristida calycina (60%), Commelina lanceolata (60%), Eragrostis sororia (60%), Goodenia sp. (GBS4/3) (60%), Lomandra leucocephala subsp. leucocephala (60%), Pleurocarpaea sp. (GBS3/5) (60%), Asteraceae (GBS4/2) (40%), Boronia sp. (GBS10/1) (40%), Brunoniella acaulis (40%), Chrysocephalum apiculatum (40%), Eulalia aurea (40%), Evolvulus alsinoides (40%), Maireana microphylla (40%), Paspalidium sp. (GBS13/1) (40%), Poaceae (GBS1/1) (40%), Poaceae (GBT8/1) (40%), Solanum ellipticum (40%), Wahlenbergia communis (40%), Alternanthera nana (20%), Anielema salicifolia (20%), Aristida sp. (GBS11/1) (20%),

[9] % of total PFC

Aristida sp. (GBS12/1) (20%), Asteraceae (GBQ26/4) (20%), Asteraceae (indet.) (20%), Calotis sp. (GBS5/4) (20%), Cheilanthes sieberi (80%), Chloris truncata (20%), Commelina diffusa (20%), Cymbopogon refractus (20%), Cyperus difformis (20%), Cyperus sp. (GBS45/1) (20%), Epaltes australe (20%), Eragrostis lacunaria (20%), Gahnia aspera (60%), Galactica tenuiflora (20%), Glycine tabacina (20%), Gonocarpus sp. (GBS5/5) (20%), Goodenia sp. (GBS4/4) (20%), Melinus repens (20%), Mitrasacme sp. (20%), Murdannia graminea (20%), Oldenlandia gallioides (20%), Opuntia stricta* (Class 3) (20%), Opuntia tomentosa* (Class 3) (20%), Panicum effusum (20%), Paspalidium constrictum (20%), Paspalidium distans (20%), Paspalum dilatatum* (20%), Pennisetum ciliare* (20%), Phyllanthus sp. (20%), Pimelea novae-hollandaei (20%), Scleria sphacelata (20%), Solanum sp. (GBS5/2) (20%), Solanum sp. (indet.) (20%), Sporobolus creber (20%), Tricoryne anceps (20%), Tricoryne elatior (20%), Triodia scariosa (20%), Tripogon loliformis (20%), Unknown compact shrub (GBQ27/1) (20%), unknown Low shrub (GBS25/2) (20%), Zornia biarticulata (20%).*

Regional Ecosystem 11.5.21

Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa woodland on Cainozoic sand plains/remnant surfaces.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This woodland ecosystem occurs on sandy soils of old loamy plains. The canopy height ranges between 14-23m and a mean crown cover of 32%. It is dominated by yellow bloodwood *(Corymbia bloxsomei)* in association with smooth barked apple *(Angophora leiocarpa),* narrow leaf ironbark *(Eucalyptus crebra),* Queensland blue gum *(Eucalyptus tereticornis),* and white cypress *(Callitris glaucophylla).*

The second tree layer is poorly formed and often absent with white cypress, bull oak (*Allocasuarina luehmanii*) and occasional narrow leaf ironbark. The shrub layer ranges between 1-5 m in height with a very sparse cover average of 11%. Characteristic species are *Acacia spectabilis*, *Callitris glaucophylla*, *Allocasuarina Luehmannii*. Others include *Acacia amblygona, Acacia ixiophylla, Acacia sp. (GBS15/1), Eucalyptus crebra, Hakea purpuea, Leptospermum polygalifolium, Leucopogon sp., Micromyrtus sessilis, Opuntia tomentosa * (Class 3),* and *Xylomelum cunninghamianum.*

The ground layer is in good condition with a mean PFC of 62%, and comprises the following native species: *Triodia scariosa, Aristida caput-medusae, Brachyscome sp., Cheilanthes sieberi, Chrysocephalum apiculatum, Cymbopogon refractus, Dianella brevipedunculata, Eragrostis sp., Eulaia aurea, Fimbristylis dichotoma, Goodenia sp (GBS4/3), Homoranthus sp. (GBS15/4), Lomandra leucocephala subsp. leucocephala, Murdannia graminea, Pimelea novae-hollandaei, Pleurocarpaea sp., Tricoryne elatior* and *Xanthorrhoea johnsonii*.

Representative sites: 3 sites: 1 Secondary (GBS15); 2 Quaternary (GBQ 21, 24).

Structural formation: Woodland 100% (3 sites)

Height EDL: Mean 18.25m; range 14-23m; std. dev. 2.25m

PCC EDL: Mean 32.5%; range 30-35%; std. dev. 2.5%

Species Recorded[10]: Total 35; Mean spp./site: 27

Native species: Total 34; Mean spp./site: 34

Exotic species: Total 1; Mean spp./site: <1

Stratum: T1

Ht. avg. = 18.25 m, range 14-23m; std. dev. 2.25m

Crown cover avg. = 32.5%; range 30-35%; std. dev. 2.5%

[10] Secondary sites only

Basal Area m2/ha avg. = 7.5; range 6-9; std. dev. NA (2 sites)

Stem density/ha avg. = 140; range NA; std. dev. NA

Total species: 5 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Corymbia bloxsomei (75%/30%)

Frequent species: Angophora leiocarpa (25%/13%), Eucalyptus crebra (25%/13%), Eucalyptus tereticornis (25%/3%), Callitris glaucophylla (25%)

Stratum T2

Ht. avg. = 8 m, range 0 m; std. dev. NA

Crown cover avg. = 10 %, range 0%; std. dev. NA

Basal Area m2/ha avg. = 9; range 0; std. dev. NA

Stem density/ha avg. = NA, range NA; std. dev. NA

Total species: 3 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Callitris glaucophylla (100%/5%), Alloacsuarian Luehmannii (100%/7%)

Frequent species: Eucalyptus crebra (50%/<5%)

Stratum: S1

Ht. avg. = 2.5 m, range 1-5m; std. dev. NA

Crown cover avg. = 11%, range 5-22%; std. dev. NA

Stem density/ha avg. = 1060, range 0; std. dev. NA

Total species: 13 (92% native, 8% exotic)

Dominant species (frequency %): Acacia spectabilis (66%), *Callitris glaucophylla* (33%); *Allocasuarina Luehmannii* (33%).

*Frequent species: Acacia amblygona (50%), Acacia ixiophylla (50%), Acacia sp. (GBS15/1) (25%), Eucalyptus crebra (25%), Hakea purpuea (25%), Leptospermum polygalifolium (25%), Leucopogon sp. (25%), Micromyrtus sessilis (25%), Opuntia tomentosa * (Class 3) (33%), Xylomelum cunninghamii (25%).*

Stratum: S2

Ht. avg. = 2 m, range 1-3m; std. dev. NA

Crown cover avg. = 15 %, range 0%; std. dev. NA

Stem density/ha avg. = 400, range 0; std. dev. NA

Total species: 6 (100% native, 0% exotic)

Dominant species (frequency %): Acacia ixiophylla (50%), Acacia sp. (GBS15/1) (50%), Callitris glaucophylla (50%), Hakea purpuea (50%), Leucopogon sp. (50%), Micromyrtus sessilis (50%).

Stratum: G

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 62 %, range 0%; std. dev. NA

PFC Native sp. avg.[11] = 100%: PFC exotic sp. avg. = 0%

Total species: 20 (100% native, 0% exotic)

Dominant species (frequency): Triodia scariosa (50%), Aristida caput-medusae (25%), Aristida sp. (GBS15/3) (25%), Brachyscome sp. (25%), Cheilanthes sieberi (25%), Chrysocephalum apiculatum (25%), Cymbopogon refractus (25%), Dianella brevipedunculata (25%), Eragrostis sp. (25%), Eulaia aurea (25%), Fimbristylis dichotoma (25%), Goodenia sp. (GBS4/3) (25%), Homoranthus sp. (GBS15/4) (50%), Lomandra leucocephala subsp. leucocephala (25%), Murdannia graminea (25%), Pimelea novae-hollandaei (25%), Pleurocarpaea sp. (GBS3/5), Tricoryne elatior (25%), Xanthorrhoea johnsonii (25%).

[11] % of total PFC

Regional Ecosystem 11.7.4

Eucalyptus decorticans and/or *Eucalyptus* spp., *Corymbia* spp*., Acacia* spp*., Lysicarpus angustifolius* on lateritic duricrust.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This woodland ecosystem is restricted to low hills and rises where soils are shallow and gravelly ridges. Characteristic species in the canopy are Queensland peppermint (*Eucalyptus exserta)* and smooth barked apple *(Angophora leiocarpa)* with less frequent white cypress *(Callitris glaucophylla)* and narrow leaf ironbark *(Eucalyptus crebra).* The average height of the canopy is 11m and mean crown cover is 41%.

A well-developed second tree layer has a mean cover of 55% and features Queensland peppermint, Miles mulga (*Acacia apprepta),* white cypress, false mahogany *(Eucalyptus rubiginosa),* and budgeroo *(Lysicarpus angustifolius).* Tall shrubs of *Acacia crassa* subsp*. crassa, Acacia julifera*, and *Acacia semilunata* dominate a sparse upper shrub layer. A distinct yet very sparse lower shrub layer features a range of low shrubs in particular *Leucopogon* sp*., Westringea chellii, Acacia conferta,* and *Micromyrtus sessilis.*

The ground layer is mid dense and diverse with 42 species recorded. The native graminoids, which include *Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Poaceae (GBS1/1), Poaceae (GBT8/1), Panicum decompositum, Scleria sphacelata,* and *Triodia scariosa,* account for 87% of total groundcover. The remainder of cover comprises perennial native herbs such as *Brunoniella acaulis, Cheilanthes sieberi, Goodenia sp. (GBS4/3),* and *Pleurocarpaea sp. (GBS3/5).* The woodland ecosystem is in good condition throughout its distribution on SURVEY AREA 2.

Representative sites: 4 sites: 2 Secondary (GBS1, 10); 1 Tertiary (GBT 8); 1 Quaternary (GBQ 32).

Structural formation: Open forest (50%); Woodland 50% (4 sites)

Height EDL: Mean 11.5; range 5-19m; std. dev. 5.5m

PCC EDL: Mean 41%; range 18-64%; std. dev. 23%

Species Recorded[12]: Total 61; Mean spp./site: 32

Native species: Total 60; Mean spp./site: 34

Exotic species: Total 1; Mean spp./site: <1

Stratum: T1

Ht. avg. = 12.75 m, range 10.5-17m; std. dev. 2.25m (3 sites)

Crown cover avg. = 44.5%; range 18-54%; std. dev. 9.5% (3 sites)

[12] Secondary sites only

Basal Area m2/ha avg. = 8.5; range 8-9; std. dev. 0.5 (2 sites)

Stem density/ha avg. = 150; range 140-160; std. dev. 10

Total species: 4 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Eucalyptus exserta (66%/30%), Angophora leiocarpa (66%/13%),

Frequent species: Callitris glaucophylla (25%/xx%), Eucalyptus crebra (25%/13%)

Stratum T2

Ht. avg. = 6 m, range 2-10 m; std. dev. 2 (2 sites)

Crown cover avg. = 54.5 %, range 46-63%; std. dev. 8.5 (2 sites)

Basal Area m2/ha avg. = 3; range 0; std. dev. 0 (2 sites)

Stem density/ha avg. = 1110, range 1100-1120; std. dev. 10 (2 sites)

Total species: 5 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Eucalyptus exserta (100%/5%), Acacia apprepta (100%/5%)

Frequent species: Callitris glaucophylla (50%/5%), Eucalyptus rubiginosa (50%/7%), Lysicarpus angustifolius (50%/<5%)

Stratum: S1

Ht. avg. = 4.8 m, range 2-7m; std. dev. 1

Crown cover avg. = 37%, range 10-64%; std. dev. 27

Stem density/ha avg. = 2500, range 380-4620; std. dev. 2120

Total species: 5 (100% native, 0% exotic)

Dominant species (frequency %): Acacia apprepta (75%),

Frequent species: Acacia crassa subsp. crassa (50%), *Acacia julifera* (25%), *Acacia semilunata* (25%), *Eucalyptus rubiginosa* (25%)

Stratum: S2

Ht. avg. = 2 m, range 1.5-2m; std. dev. 0

Crown cover avg. = 9 %, range 8-15%; std. dev. 1

Stem density/ha avg. = 520, range 440-600; std. dev. 80

Total species: 14 (100% native, 0% exotic)

Dominant species (frequency %): Leucopogon sp. (100%), Westringea chellii (75%), Acacia conferta (50%), Acacia semilunata (50%)

Frequent species: Lysicarpus angustifolius (25%), Acacia julifera (25%), Pittosporum sp. (25%), Micromyrtus sessilis (25%), Acacia apprepta (25%), Boronia bipinnata (25%), Prostanthera sp. (GBS10/3), Leucopogon sp. (GBS10/2) (25%), Dodonaea macrossanii (25%).

Stratum: G

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 49.5 %, range 41-58%; std. dev. 8.5

PFC Native sp. avg.[13] = 100%: PFC exotic sp. avg. = 0%

Total species: 42 (98% native, 2% exotic)

Dominant species (frequency): Aristida calycina (75%), Aristida caput-medusae (75%), Brunoniella acaulis (75%), Cheilanthes sieberi (75%), Eragrostis sororia (75%), Poaceae (GBS1/1) (75%), Poaceae (GBT8/1) (75%), Goodenia sp. (GBS4/3) (50%), Pleurocarpaea sp. (GBS3/5) (50%), Panicum decompositum (50%), Scleria sphacelata (50%),

Frequent species: Abilgaardia ovata (25%), Aristida sp. (GBS12/1) (25%), Asteraceae (GBS4/2) (25%), Boronia sp. (GBS10/1) (25%), Chrysocephalum apiculatum (25%), Dianella sp. (GBS1/6) (25%), Digitaria brownii (25%), Dodonaea macrossanii (25%), Drosera indica (25%), Emilia sonchifolia subsp. sonchifolia (25%), Eriachne obtusa (25%), Eulalia aurea (25%), Fimbristylis dichotoma (25%), Gahnia aspera (25%), Hibbertia cistoides (25%), Lepidosperma sp. (25%), Lomandra longifolia (25%), Oxalis sp. (25%), Panicum effusum (25%), Panicum queenslandicum (25%), Paspalidium sp. (25%), Phyllanthus virgatus (25%), Sida rohlenae subsp. rohlenae (25%), Stylidium eriorhizum (25%), Tricoryne anceps (25%), Tricoryne elatior (25%), Triodia scariosa (25%).*

[13] % of total PFC

Regional Ecosystem 11.7.5

Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This shrubland ecosystem is restricted to shallow sandy soils associated with lateritic duricrust plateau surfaces. A mid dense upper shrub layer of broombush (*Melaleuca uncinata*) forms the ecological dominant layer with minor occurrences of wattle (*Acacia spp.)* and micromyrtus *(Micromyrtus sessilis).* There are scattered emergents of white cypress *(Callitris glaucophylla)* and blue leaved ironbark *(Eucalyptus fibrosa* subsp*. nubila).* A distinct lower shrub layer is also dominated by broombush and micromyrtus in association with dodder laurel *(Cassytha pubsecens), Leucopogon sp. (GBS3/7), Hakea purpurea, Pimelea nova-anglica, Dillwynia* sp*. (GBS3/8)* and *Callitris glaucophylla.*

In comparison to woodland habitats this shrubland ecosystem is depauperate in species. Low species diversity is reflected in the ground layer that supports 12 species, of which the spinifex grass (*Triodia scariosa*) tends to dominate overall cover. Other species recorded are the grasses: *Panicum decompositum, Panicum queenslandicum, Paspalidium distans;* the herbs*, Cheilanthes sieberi, Drosera indica, Pleurocarpaea sp. (GBS3/5), Cassytha filiformis,* and *Boronia bipinnata.*

Representative sites: 2 sites: 2 Secondary (GBS 3, 12)

Structural formation: Open heath/open scrub (100%), (2 sites)

Height EDL: Mean 2.25; range 1-4m; std. dev. 0.25m

PCC EDL: Mean 57%; range 52-62%; std. dev. 5%

Species Recorded[14]: Total 27; Mean spp./site: 16; std. dev. 1

Native species: Total 27; Mean spp./site: 16

Exotic species: Total 0; Mean spp./site: 0

Stratum: S1

Ht. avg. = 2.25 m, range 1-4m; std. dev. 1

Crown cover avg. = 57%; range 52-62%; std. dev. 5%

Stem density/ha avg. = 8020, range 7040-9000; std. dev. 980

Total species: 5 (100% native, 0% exotic)

[14] Secondary sites only

Dominant species (frequency %): Melaleuca uncinata (100%)

Frequent species: Acacia sp. (GBS3/1) (50%)*, Acacia sp. (GBS3/4)* (50%)*, Acacia sp. (GBS12/3)* (50%)*, Micromyrtus sessilis* (50%)

Stratum: S2

Ht. avg. = 1.1 m, range 0.5-2m; std. dev. 0.4

Crown cover avg. = 25%, range 16-34%; std. dev. 9

Stem density/ha avg. = 2370, range 2140-2600; std. dev. 230

Total species: 10 (100% native, 0% exotic)

Dominant species (frequency %): Melaleuca uncinata (100%), Micromyrtus sessilis (100%), Acacia sp. (GBS3/1) (100%)

Frequent species: Acacia sp. (GBS3/4) (50%), Acacia sp. (GBS12/3) (50%), Cassytha pubsecens (50%), Leucopogon sp. (GBS3/7), Hakea purpurea (50%), Pimelea nova-anglica (50%), Dillwynia sp. (GBS3/8) (50%), Callitris glaucophylla (50%)

Stratum: G

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 57.5 %, range 40-75%; std. dev. 175

PFC Native sp. avg.[15] = 100%: PFC exotic sp. avg. = 0%

Total species: 12 (100% native, 0% exotic)

Dominant species (frequency): Cheilanthes sp. (100%), Drosera indica (100%), Pleurocarpaea sp. (GBS3/5) (100%)

Frequent species: Boronia bipinnata (50%), Cassytha filiformis (50%), Fimbristylis dichotoma (50%), Panicum decompositum (50%), Panicum queenslandicum (50%), Paspalidium distans (50%), Triodia scariosa (50%)

[15] % of total PFC

Regional Ecosystem 11.7.7

Eucalyptus fibrosa subsp. nubila +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This RE woodland and open forest ecosystem occurs on low hills and ranges formed from deeply weathered sediments. Soils are shallow with sandy and gravelly surface horizons. Blue leaved ironbark (*Eucalyptus fibrosa* subsp*. nubila)* forms a distinct canopy which ranges between 11 and 25m in height. The canopy may also include narrow leaf ironbark (*E. crebra*), Queensland peppermint (*E. exserta*) and white cypress (*Callitris glaucophylla*). These species also characterize a distinct yet discontinuous second tree layer. *Eucalyptus elegans* dominates the canopy in restricted locations although *Eucalyptus fibrosa* is always present.

Scattered tall shrubs such as *Acacia semilunata, Acacia conferta, Allocasuarina inophloia,* and *Callitris glaucophylla* form a sparse to very sparse upper shrub layer. The lower shrub layer is similarly sparse and poorly formed and also comprises *Leucopogon* sp., *Acacia ixiophylla, Acacia muelleriana, Hakea purpurea* and *Westringea cheelii*.

The native species dominated ground layer is mid dense with grasses such as Poaceae (GBS8/1), *Eulalea aurea, Paspalidium* sp., *Chloris truncata* and *Gahnia aspera* forming the majority of the cover. Characteristic native herbs and low herbaceous shrubs are *Dodonaea macrossanii, Dianella longifolia var. longifolia, Cheilanthes sieberi, Boronia bipinnata*, and *Brunoniella acaulis*. Leaf litter occupies 44% of total groundcover and fallen woody debris in the form of large branches and logs are abundant throughout the forest floor.

Representative sites: 4 sites: 4 Secondary (GBS11, 13, 22, 31)

Structural formation: Open forest (33%); Woodland 66% (3 sites)

Height EDL: Mean 17m; range 11-25m; std. dev. 3.75m

PCC EDL: Mean 31%; range 26-57%; std. dev. 4.5%

Species Recorded[16]: Total 60; Mean spp./site: 30; std. dev. 7%

Native species: Total 60; Mean spp./site: 30; std. dev. 7%

Exotic species: Total 0; Mean spp./site: 0

Stratum: T1

Ht. avg. = 17 m, range 11-25m; std. dev. 3.75 (3 sites)

Crown cover avg. = 31%; range 26-57%; std. dev. 4.5% (3 sites)

Basal Area m2/ha avg. = 5.5; range 5-9; std. dev. 0.5 (3 sites)

[16] Secondary sites only

Stem density/ha avg. = 100; range 80-180; std. dev. 20 (3 sites)

Total species: 4 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Eucalyptus fibrosa subsp. nubila (100%/19%)

Frequent species: Callitris glaucophylla (33%/4%), Eucalyptus crebra (33%/3%)

Stratum T2

Ht. avg. = 11 m, range 9-13 m; std. dev. 2 (3 sites)

Crown cover avg. = 30.5 %, range 5-52%; std. dev. 21.5 (3 sites)

Basal Area m2/ha avg. = 6; range 2-9; std. dev. 1 (3 sites)

Stem density/ha avg. = 287, range 100-580; std. dev. 200 (3 sites)

Total species: 5 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Eucalyptus fibrosa subsp. nubila (100%/14%)

Frequent species: Callitris glaucophylla (66%/5%), Eucalyptus crebra (66%/3%)

Stratum: S1

Ht. avg. = 4 m, range 1.5-6m; std. dev. 1; (3 sites)

Crown cover avg. = 10%, range 5-14%; std. dev. 1; (3 sites)

Stem density/ha avg. = 230, range 50-480; std. dev. 230; (3 sites)

Total species: 12 (100% native, 0% exotic)

Dominant species (frequency %): Eucalyptus fibrosa subsp. nubila (66%), Acacia semilunata (66%), Acacia muelleriana (66%), Callitris glaucophylla (66%)

Frequent species: Acacia ixiophylla (33%), *Acacia sp. (GBS13/3) (33%), Acacia conferta (33%), Allocasuarina inophloia (33%), Acacia apprepta (33%), Eucalyptus crebra (33%), Allocasuarina Luehmannii (33%), Melaleuca decora (33%)*

Stratum: S2

Ht. avg. = 1 m, range 1-1.5m; std. dev. 0.5; (3 sites)

Crown cover avg. = 14 %, range 5-29%; std. dev. 1.5; (3 sites)

Stem density/ha avg. = 480, range 260-780; std. dev. 70

Total species: 14 (100% native, 0% exotic)

Dominant species (frequency %): Callitris glaucophylla (66%), Acacia semilunata (66%), Leucopogon sp. (GBS3/7) (66%).

Frequent species: Acacia ixiophylla (50%), *Acacia sp. (GBS13/3) (50%), Acacia sp. (GBS22/1) (50%), Allocasuarina inophloia (25%), Acacia amblygona (25%), Acacia muelleriana (50%), Boronia bipinnata (50%), Dodonaea lanceolate var. subsessilifolia (25%), Leucopogon sp. (GBS22/2) (50%), Prostanthera sp. (GBS13/2) (50%), Platysace lanceolata (50%).*

Stratum: Ground

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 44 %, range 37-57%; std. dev. 10

PFC Native sp. avg.[17] = 100%: PFC exotic sp. avg. = 0%

Total species: 36 (100% native, 0% exotic)

Dominant species (frequency): Aristida caput-medusae (100%), Dodonaea macrossanii (100%), Gahnia aspera (100%), Panicum decompositum (100%), Phyllanthus sp. (100%), Poaceae (GBS1/1) (100%), Poaceae (GBT8/1) (100%).

Frequent species: Aristida sp. ((66%), Aristida calycina (66%), Cyanthillium cinereum (66%), Eragrostis sororia (66%), Eulalia aurea (66%), Goodenia sp (GBS4/3) (66%), Paspalidium sp. (GBS13/1) (66%), Pleurocarpaea sp. (GBS3/5) (66%), Scleria sphacelata (66%), Sida rohlenae subsp. rohlenae (66%), Tricoryne elatior (66%), Abilgaardia ovata (33%), Aristida acuta (33%), Aristida sp. (GBS12/1) (33%), Brunoniella acaulis (33%), Cheilanthes sp. (33%), Chloris truncata (33%), Dianella brevipedunculata (33%), Dianella longifolia var. longifolia (33%), Digitaria ramularis (33%), Entolasia stricta (33%), (33%), Goodenia sp. (GBS13/4) (33%), Hibbertia cistoides (33%), Lomandra filiformis (33%), Lomandra leucocephala subsp. leucocephala (33%), Pleurocarpaea sp. (GBS3/5) (33%).

[17] % of total PFC

Survey Area 9

Regional Ecosystem 11.3.2

Eucalyptus populnea woodland on alluvial plains.

VMA Status: Of concern

Biodiversity Status: Of concern

Description: This community is consistently dominated by poplar box (*Eucalyptus populnea*) with a canopy height ranging between 10-16m and a mean crown cover of 41%. Associated canopy trees are Queensland blue gum (*Eucalyptus tereticornis*) and belah (*Casuarina cristata*). A sparse second tree layer comprises the above canopy species. The shrub layer is generally poorly developed with scattered poplar box saplings and occasional shrubs of velvet pear (*Opuntia tomentosa**).

The condition of the groundcover is affected by infestations of African love grass (*Eragrostis curvula**), lippia (*Phyla canescens*), maynes pest (*Verbena aristigera**), and harissa cactus (*Harissia martini**), which contribute to a mean exotic cover of 35%. Dominant graminoids species are *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea,* and *Paspalidium* sp., with common native herbs of *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis*.

Overall the alluvial woodland habitats surveyed are in good condition. There is some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers. The presence of African love grass and other exotics suggests impacts of previous grazing pressure. However a lack of recent grazing and favourable summer rainfall conditions have resulted in dense ground cover and robust species richness.

Representative sites: 4 sites: 2 Secondary (GBS 67, 68); 2 Quaternary (GBQ66, 70)

Structural formation: Woodland 100%

Height EDL: Mean 13.3m; range 10-16m

PCC EDL: Mean 41%; range 35-46%

Species Recorded: Total 68; Mean spp./site: 47

Native species: Total 55; Mean spp./site: 39

Exotic species: Total 13; Mean spp./site: 8

Representative sites: 2 sites: Secondary (GBS16, 19)

Regional Ecosystem 11.3.4

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

VMA Status: Of concern

Biodiversity Status: Of concern

Description: This community occurs on alluvial terraces and overflow depressions along with the Condamine River frontage. The canopy is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and/or Queensland blue gum *(E. camaldulenisis)* although rough-barked apple *(Angophora floribunda),* poplar box (*E. populnea*) and Moreton Bay ash (*Corymbia tessellaris*) are locally common. The second tree layer is sparse and comprises the above canopy species and the sparse shrub layer of between 1-4 m features *Acacia salicina,* and *A. stenophylla*. The ground layer is degraded through the widespread floodplain infestations of lippia (*Phyla canescens*).

Representative sites: 8 sites: 4 Secondary (GBS 42, 47, 54, 59); x Quaternary (GBQ 60, 61, 64, 69)

Structural formation: Woodland 100%.

Height EDL: Mean 21.5m; range 16-26m

PCC EDL: Mean 44.6%; range 40-50%

Species Recorded: Total 56; Mean spp./site: 27

Native species: Total 52; Mean spp./site: 31

Exotic species: Total 6; Mean spp./site: 4

Regional Ecosystem 11.3.17

Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains

VMA Status: Endangered

Biodiversity Status: Endangered

Description: This community occurs on alluvial plains. The canopy which is dominated by poplar box (*E. populnea*), ranges between 16-26m in height with a mean PPC of 40%. Additional trees in the canopy layer are belah (*Casuarina cristata*), narrow leaf ironbark (*Eucalyptus crebra*) and grey box (*E. woollsiana*). The second tree layer is well developed and comprises the above canopy species together with western rosewood (*Alectryon oleofolius*), weeping pittosporum (*Pittosporum angustifolium*) and willow wattle (*Acacia salicina*). These species also are characteristic of a mid dense shrub layer which may also include showy wattle (*Acacia decora*), and wilga (*Geijera salicifolia*). Exotic ground covers, in particular lippia (*Phyla canescens**), contribute to approximately 50% of the overall cover, with scattered infestations of harissa cactus (*Harissia martini**), noogoora bur (*Xanthium occidentale**), and maynes pest (*Verbena aristigera**), African love grass (*Eragrostis curvula**), paspalum (*Pasplalum dilatatum**), and giant panic (*Magathrysus maximus* var. *maximus**). Native grasses and sedges dominate the cover.

Representative sites: 2 sites: 2 Secondary (GBS 57, 58)

Structural formation: Woodland 100%.

Height EDL: Mean 21m; range 16-26m

PCC EDL: Mean 40%; range 38-42%

Species Recorded: Total 66; Mean spp./site: 39

Native species: Total 52; Mean spp./site: 29

Exotic species: Total 14; Mean spp./site: 9

Regional Ecosystem 11.3.25

Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.

VMA Status: Least concern

Biodiversity Status: Of concern

Description: This RE is associated with the riparian margins of the major drainage lines of Condamine River and tributaries. It is a fringing open forest ranging from 16-28 metres and a mean crown cover of 46%. Dominant canopy trees are Queensland blue gum *(Eucalyptus tereticornis),* Queensland blue gum *(E. camaldulensis),* rough barked apple (*Angophora floribunda*) and Moreton bay ash (*Corymbia tessellaris*). A sparse sub-canopy is dominated by the above species with occasional willow wattle (*Acacia salicina*) and cooba (*A. stenophylla*). Shrub cover is very sparse (0-5% cover) with scattered willow wattle, cooba and prickly mimosa (*Acacia farnesiana**). The sparse ground cover which averages at 23% is attributed to scouring of groundcover species from recent flood events. Mean cover is dominated by exotic species with grasses such as giant panic (*Megathyrsus maximus var. maximus**), purple top Rhodes (*Chloris virgata**), and couch grass (*Cynodon dactylon**). Exotic cover is likely to increase in the riparian zone following summer growth. Natives such as mat rush (*Lomandra longifolia*) and blady grass (*Imperata cylindrica*) and sedge (*Cyperus* sp.) characterise the native component of the groundcover.

Representative sites: 5 sites: Secondary (GBS43, 46); Quaternary (GBQ55, 62, 65)

Structural formation: Woodland: 100%; 5 sites

Height EDL: Mean 19.5m; range 16-28m; 5 sites

PCC EDL: Mean 46%; range 40-55%; 5 sites

Species Recorded: Total: 37; Mean spp./site: 23; 2 sites

Native species: Mean spp./site: 14; 2 sites

Exotic species: Mean spp./site: 9; 2 sites

Regional Ecosystem 11.3.27d

Palustrine wetland (vegetated swamp).

VMA Status: Least concern

Biodiversity Status: Of concern

Description: This RE is associated with the alluvial depressions along the Condamine River floodplain. It is a palustrine wetland ecosystem with an overstorey of scattered Queensland blue gum (*Eucalyptus tereticornis*) over a sedgeland groundcover with semi-permanent water. The composition of the ground cover is simple and limited to eleocharis (*Eleocharis plana, E. spp.*), juncus (*Juncus* sp.) with scattered native herbs such as lesser joyweed (*Alternanthera denticulata*) and eclipta (*Eclipta prostrata*). Infestations of lippia (*Phyla canescens*) occur throughout the ecosystem.

Representative sites: 1 site: Quaternary (GBQ44)

Structural formation: sedgeland: 100%; 1 site

Height EDL: Mean 0.5m.

PCC EDL: Mean 65%.

Species Recorded: Total: 11

Native species: Mean spp./site: 8

Exotic species: Mean spp./site: 3

Regional Ecosystem 11.4.3

Acacia harpophylla and/or Casuarina cristata shrubby open forest on Cainozoic clay plains

VMA Status: Endangered

Biodiversity Status: Endangered

EPBC Status: Endangered

Description: This RE is restricted on the site to a small remnant on clay plains. It manifests as open forest between 15-24m in height and dominated by brigalow (*Acacia harpophylla*). A sparse second tree layer of brigalow, grey box (*Eucalyptus woollsiana*) and supplejack (*Ventilago viminalis*) occurs over a very sparse shrub layer of caperberry (*Capparis* sp.), turkey bush (*Eremophila desertii*), and brigalow.

The ground cover is 58% and has been impacted by grazing pressure with significant areas of bare ground. Cover is dominated by native perennial grasses and sedges with slender chloris (*Chloris divaricata*) being the most abundant species. Species diversity is high with 47 species recorded of which seven are naturalised. Exotic cover is limited to scattered button grass (*Dactyloctenium radulans**), gomphrena weed (*Gomphrena celesioides**), amaranthus (*Amaranthus viridus**), and occasional plants of prickly pear (*Opuntia stricta**).

Despite an ongoing impact of grazing, the remnant patch surveyed was in moderate condition displaying a healthy canopy and subcanopy, a species diverse groundcover, and a large amount of fallen woody debris. Ongoing impacts from grazing were however manifest in a poorly developed shrub layer.

Representative sites: 1 site: Secondary (GBS71)

Structural formation: Open forest: 100%; 1 site

Height EDL: Mean 18m

PCC EDL: Mean 54%

Species Recorded: Total: 47

Native species: Mean spp./site: 40

Exotic species: Mean spp./site: 7

Regional Ecosystem 11.5.1

Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains/remnant surfaces.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: This woodland ecosystem occurs on sandy soils of old loamy plains. The canopy height ranges between 14-20m with a mean crown cover of 38% dominated by narrow leaf ironbark *(Eucalyptus crebra)* with associated white cypress *(Callitris glaucophylla).* Less common associates are poplar box *(Eucalyptus populnea),* and Queensland blue gum (*Eucalyptus tereticornis*) and Moreton Bay ash *(Corymbia tessellaris).* The sparse second tree layer has an average height of 8.5m and is dominated by bulloak (*Alloacasuarina Luehmannii),* white cypress (*Callitris glaucophylla*), narrow leaf ironbark, and with less frequent paperbark (*Melaleuca decora*). An upper and lower shrub layer ranges between 5-30% in cover with bull oak predominating across all sites surveyed.

A diverse ground layer is in good condition with cover totally dominated by natives. Characteristic species are wire grass (*Aristida caput-medusae),* fimbristylis *(Fimbristylis dichotoma),* and beard grass *(Chrysopogon fallax).* Frequent species include *Aristida calycina, Commelina lanceolata, Eragrostis sororia, Lomandra leucocephala* subsp*. leucocephala,* and the fern *Cheilanthus sieberi.*

Previous disturbance regimes in the form of selective removal of narrow leaf ironbark for fencing posts and grazing has impacted this ecosystem. A dominance of wire grass (Aristida) species in the groundcover suggestive of previous grazing pressure. A lack of recent grazing and favourable summer rainfall conditions have resulted in the maintenance of a healthy native dominated groundcover and high species richness.

Representative sites: 4 sites: 1 Secondary (GBS 45); 3 Quaternary (GBQ 51, 52, 56).

Structural formation: Woodland 100% (4 Sites[18])

Height EDL: Mean 16.2m; range 14-20m; std. dev. 3.75m; 4 sites

PCC EDL: Mean 38%; range 25-57%; std. dev. 5.5%; 4 sites

Species Recorded[19]: Total 30; 1 site

Native species: Total 29; 1 site

Exotic species: Total 1; 1 site

[18] NB. Structural data derived from secondary and tertiary sites only.
[19] Secondary sites only

Regional Ecosystem 11.5.1a

Eucalyptus populnea woodland with Allocasuarina luehmannii low tree layer on Cainozoic sand plains/remnant surfaces.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: The best development of this woodland ecosystem features a canopy of poplar box (*Eucalyptus populnea*) with associated grey box (*Eucalyptus woollsiana*) and smooth barked apple (*Angophora leiocarpa*). It occurs on loamy plains and at the interface between alluvium and on low rises of remnant surfaces.

The second tree layer and shrub layers are sparse and characterised by western rosewood (*Alectryon oleiofolia*), belah (*Casuarina cristata*), weeping pittosporum (*Pittosporum phyrellioides*), white cypress (*Callitris glaucophylla*) and hop bush (*Dodonaea lanceolata subsp. subsessilis*).

Typical ground layer species are many-headed wire grass (*Aristida caput-medusae),* wire grass *(Aristida calycina),* comet grass *(Perotis rara),* Queensland blue grass *(Dicahnthium sericeum* subsp*. sericeum),* forest blue grass *(Bothriochloa bladhii*) and windmill grass (*Chloris truncata*).

Disturbed examples of the habitat are solely dominated by poplar box with a canopy height of between 8-12m.

Representative sites: 2 sites: 1 Secondary (GBS 44); 1 Quaternary (GBQ 72).

Structural formation: Woodland 100% (2 Sites[20])

Height EDL: Mean m; range 8-22m; 2 sites

PCC EDL: Mean 40%; range 35-45%; 2 sites

Species Recorded[21]: Total 47; 2 sites

Native species: Total 39; 2 sites

Exotic species: Total 8; 2 sites

[20] NB. Structural data derived from secondary and tertiary sites only.
[21] Secondary sites only

Regional Ecosystem 11.5.20

Eucalyptus moluccana and/or E. microcarpa/ E. pilligaensis +/- E. crebra woodland on Cainozoic sand plains.

VMA Status: Least concern

Biodiversity Status: No concern at present

Description: Regional ecosystem 11.5.20 is represented on the site by a woodland of 16-23m in height dominated by grey box (*Eucalyptus woollsiana*) with associated narrow leaf ironbark (*E. crebra*). It occurs on low rises of old loamy plains. These tree species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.).

A native groundcover is dominated by many-headed wire grass (*Aristida caput-medusae),* wire grass *(Aristida calycina),* love grass (*Eragrostis lacunaria*), barbed wire grass *(Cymbopogon refractus),* paspalidium *(Paspalidium sp.),* and windmill grass (*Chloris truncata*).

Representative sites: 1 sites: 1 Secondary (GBS 73).

Structural formation: Woodland 100% (1 Sites[22])

Height EDL: Mean 19.5m; range 16-23m

PCC EDL: Mean 40%; range 35-45%

Species Recorded[23]: Total 33

Native species: Total 29

Exotic species: Total 4

[22] NB. Structural data derived from secondary and tertiary sites only.
[23] Secondary sites only

Suvery Area 7 – EPBC Listed Ecological Community Descriptions

Weeping Myall Woodlands

VMA Status: Not Listed

Biodiversity Status: Not Listed

EPBC Status: Endangered

Description: This very restricted community occurs on alluvial plains in association with poplar box woodlands (RE11.3.2). It is a woodland ranging between and 8-12m in height with a cover of 52%. The upper stratum is dominated by weeping myall (*Acacia pendula*) with scattered trees of poplar box (*Eucalyptus populnea*) and Queensland blue gum (*Eucalyptus tereticornis*). A sparse second tree layer and shrub layer is limited to occasional shrubs of weeping myall.

The ground layer is dense and in good condition with a mean PFC of 86%, which is dominated (81%) by native species. Graminoids species such as *Panicum decompositum, Walwhalleya subxerophila*, and *Paspalidium* sp. dominate the cover with common native perennial herbs including *Commelina lanceolata, Pratia* sp., *Marselia drumondii*, and *Murdania gramineum*. Exotic species contribute 19% to the groundcover and are represented by lippia (*Phyla canescens**), with some limited occurrences of purple top Rhodes (*Chloris virgata**), and couch grass (*Cynodon dactylon**). The site is diverse supporting 53 species of which 46 are native and seven are naturalised. The majority of the species diversity occurs in the ground layer.

The weeping myall ecological community is consistent with the EPBC description (ref) existing as a small remnant in which it forms the dominant overstorey species and representing over 50% of trees present. Weeping myall also forms the subcanopy and shrub layers with patch size mapped as over 0.5 Ha. The community surveyed was in good condition with robust ground cover, high species diversity, healthy mature weeping myall trees which were recruiting in the lower structural layers. There is a low incidence of exotic species throughout.

Representative sites: 1 sites: Secondary (GBS 82)

Structural formation: Woodland 100%.

Height EDL: Mean 10m; range 8-12m

PCC EDL: Mean 52%

Species Recorded: Total 53

Native species: Total 46

Exotic species: Total 7

Stratum: T1

Ht. avg. = 10 m, range 8-12m

Crown cover avg. = 52 %

Basal Area m2/ha = 10

Stem density/ha avg. = 200

Total species: 3 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Acacia pendula (100%/52%)

Frequent species: Eucalyptus populnea (100%/8%), Eucalyptus tereticornis (100/0%)

Stratum T2

Ht. avg. = 6.5 m, range 5-8m

Crown cover avg. = 8%

Basal Area m2/ha = 0

Stem density/ha avg. = 0

Total species: 1 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Acacia pendula (100%/8%)

Stratum: S1

Ht. avg. = 2.5 m, range 1-4m

Crown cover avg. = 5 %

Stem density/ha avg. = 140

Total species: 1 (100% native, 0% exotic)

Dominant species (frequency %): Acacia pendula (100/5%)

Stratum: G

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 86 %

PFC Native sp. avg.[24] = 81%: PFC exotic sp. avg. = 19%

Total species: 53 (87% native, 13% exotic)

*Dominant species: Panicum decompositum, Paspalidium sp., Walwhalleya subxerophila, Phyla canescens**

[24] % of total PFC

Frequent species: Alternanthera denticulata, Bothriochloa bladhii, Bothriochloa decipiens, Chloris virgata, Chloris truncata, Chrysopogon fallax, Commelina lanceolata, Cynodon dactylon*, Cyperus concinus, Cyperus gracilis, Dichanthium sericeum subsp. sericeum, Echinochloa cruss-gallii*, Eleocharis sp., Epaltes australe, Eragrostis sororia, Ereochloa procera, Fimbristylis dichotoma, Gomphrena celesioides*, Marsilea drumondii, Murdannia gramineum, Opuntia tomentosa*, Oxalis sp., Panicum queenslandicum, Sporobolus creber, Wahlenbergia gracilis.*

Coolibah Woodlands (Regional Ecosystem 11.3.3c)

Eucalyptus coolabah woodland on alluvial plains.

VMA Status: Of concern

Biodiversity Status: Of concern

EPBC Status: Endangered

Description: This woodland/open forest ecosystem is restricted in distribution occurring on alluvial overflow channels associated with major drainage lines within survey area 7. It occurs as narrow slivers adjacent to riparian woodlands (RE11.3.25 and 11.3.4). Coolabah (*Eucalyptus coolabah)* dominates a canopy which ranges between 8 and 19m in height with cover ranging between 40 and 61%. A discontinuous second tree layer also features coolabah, and a sparse shrub layer consists of scattered coolabah saplings, river cooba (*Acacia stenophylla*) and belah (*Casuarina cristata*).

The ground layer exhibits a poor condition throughout with heavy invasion of lippia (*Phyla canescens**) and couch grass (*Cynodon dactylon**). Native sedge, grass and forb species characteristic of the palustrine wetland habitat are out competed by lippia and impacted by past grazing pressure. Typical native species include *Eleocharis* spp., *Marsilea hirsuta, Eclipta procera, Cyperus concinnus,* and *Crinum* sp. Evidence of disturbance is also present through dead canopy trees which occur throughout. Large boled trees with spreading crowns typical of good condition remnant habitat are uncommon.

Representative sites: 2 sites: 2 Secondary (GBS74, 77)

Structural formation: Open forest (50%); Woodland 50% (2 sites)

Height EDL: Mean 13.5m; range 8-19m; std. dev. 3.25m

PCC EDL: Mean 50.5%; range 40-61%; std. dev. 10.5%

Species Recorded[25]: Total 39; Mean spp./site: 24; std. dev. 8%

Native species: Total 37; Mean spp./site: 22; std. dev. 9%

Exotic species: Total 2; Mean spp./site: 2; std. dev. 1%

Stratum: T1

Ht. avg. = 13.5 m, range 8-19m; std. dev. 3.25 (2 sites)

Crown cover avg. = 50.5%; range 40-61%; std. dev. 10.5% (2 sites)

Basal Area m2/ha avg. = 10.5; range 7-14; std. dev. 3.5 (2 sites)

Stem density/ha avg. = 220; range 200-240; std. dev. 20 (2 sites)

[25] Secondary sites only

Total species: 1 (100% native, 0 exotic)

Dominant species (frequency/mean PCC%): Eucalyptus coolabah (100%/50%)

Stratum T2

Ht. avg. = 8 m, range 6-10 m; std. dev. 0 (2 sites)

Crown cover avg. = 27 %, range 12-42%; std. dev. 15 (2 sites)

Basal Area m2/ha avg. = 4.5; range 1-8; std. dev. 3.5 (2 sites)

Stem density/ha avg. = 140, range 80-140; std. dev. 80 (2 sites)

Total species: 1 (100% native, 0 exotic)

Dominant species (frequency%/mean PCC%): Eucalyptus coolabah (100%/27%)

Stratum: S1

Ht. avg. = 3.25 m, range 1-6m; std. dev. 0.25; (2 sites)

Crown cover avg. = 5%, range 0; std. dev. 0; (2 sites)

Stem density/ha avg. = 100, range 80-120; std. dev. 20; (2 sites)

Total species: 2 (100% native, 0% exotic)

Dominant species (frequency %): Eucalyptus coolabah (50%), Acacia stenophylla (50%), Casuarina cristata (50%)

Stratum: Ground

Ht. avg. = 0.5 m, range 0.25-0.75

PFC avg. = 65.5 %, range 33-98%; std. dev. 32

PFC Native sp. avg.[26] = 38.5%: PFC exotic sp. avg. = 11.5%

Total species: 38 (95% native, 5% exotic)

Dominant species (frequency): Phyla canescens, Cynodon dactylon*, Eleocharis sp., Marsilea hirsuta*

Frequent species: Eulalia aurea, Goodenia sp. (GBS4/3), Eclipta proecra, Neptunia gracilis, Cyperus concinnus, Murdania gramineum, Wahwhellya subxerophila, Asperula conferta, Crinum sp., Bothriochloa bladhii, Trichoglin procera, Oxalis sp., Bulbine bulbosa, Juncus continuus, Alternanthera denticulata, Phyllanthus sp.

[26] % of total PFC

Appendix J. SREIS Survey Flora Species List

* = Exotic species

Numbers in columns = number of records / flora site.

FLORA SPECIES LIST (Survey areas 2, 7, 8, 9 and F)[27]

SPECIES NAME	**Regional Ecosystems**																			
	11.3.1	**11.3.2**	**11.3.3**	**11.3.3c**	**11.3.4**	**11.3.17**	**11.3.18**	**11.3.25**	**11.3.27**	**11.4.3**	**11.5.1**	**11.5.1a**	**11.5.20**	**11.5.21**	**11.7.4**	**11.7.5**	**11.7.6**	**11.7.7**	**11.10.1d**	**Non-R**	**Total Records**
Abilgaardia ovata					1										1		1	1			4
Abutilon sp. (indet.)					1	1				2											4
Acacia amblygona											1			1				1			3
Acacia apprepta											1				3	1	1	1		2	9
Acacia burbigeae														1							1
Acacia burrowii																1		1			2
Acacia caroleae					1									1		1					3
Acacia conferta											6		1		4			1	1	2	15
Acacia crassa subsp. crassa					1			2			3				4					1	11
Acacia decora						1															1

[27] Nomenclature follows Bostock & Holland (2010) 'Census of the Queensland Flora'. * Denotes naturalised or doubtfully naturalised taxa according to Bostock & Holland (2010).

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Acacia falciformis															1						1
*Acacia farnesiana**					1			1												1	3
Acacia flexifolia																		1			1
Acacia harpophylla	1									2											3
Acacia ixiophylla											4		1	1			1	1		2	10
Acacia leiocalyx subsp. leiocalyx											3							1			4
Acacia microsperma											1										1
Acacia muelleriana											1							1			2
Acacia omalophylla																1					1
Acacia pendula		1																			1
Acacia salicina					1	1		4												1	7
Acacia semilunata					3			1			6				3			3		4	20
Acacia semirigida								1													1
Acacia sp. (indet.)											1										1
Acacia spectabilis					2						1			3							6
Acacia stenophylla			1		3			6												1	11
Acanthospermum hispidulum						1							1								2
Ajuga australis								1													1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Alectryon oleiofolius					1	1				1		1									4
Allocasuarina inophloia															2			1			3
Allocasuarina leuhmanii					1			1			16	1	3	1	1			1		4	29
Alloteropsis semialata					1			2													3
Alphitonia excelsa											3		1		1						5
Alternanthera denticulata		1		1	3	2		1		1										2	11
Alternanthera nana								2			1									2	5
Alternanthera nodiflora		2								1			3								6
*Alternanthera pungens**		1			1																2
*Amaranthus viridis**										2										1	3
Amyema linophylla subsp. orientalis											1										1
Amyema quandang var. bancroftii		1			1					1	1				1						5
Ancistrachne uncinulata										1											1
Angophora floribunda					5			6													11
Angophora leiocarpa					1						3	1		1	3						9
Anielema silicifolia											1										1
Aristida acuta		1			1			1			1		1		2			1			8
Aristida calycina					2			2			5		2		6			2		1	20

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Aristida caput-medusae		2			3			1			10	1	2	1	7			3	2	4	36
Aristida gracilipes											1		1								2
Aristida leichhardtiana											1		1				1	2		1	6
Aristida ramosus					1			1									1				3
Arundinella nepalensis		1																			1
Asperula conferta				1	1			1												1	4
Bidens sp.													1								1
Boerhavia pubescens					1	1				2										3	7
Bonamia media								1													1
Boronia occidentalis											2				1	1		1			5
Bothriochloa bladhii		1	1	1	1	1															5
Bothriochloa decipiens		3			4			1		1		1	2							1	13
Bothriochloa sp. (GBS44/6)																				1	1
Brachychiton populnea					1			1													2
Brachyscome dentata																				1	1
Brachyscome sp. (indet.)		1						1		1	1			1							5
Brunoniella acaulis		1								1	2		3		3			1	1		12
Bulbine bulbosa				1																	1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Bulbine sp. (GBQ93/1)																				1	1
Bulbine sp. (GBS54/1)					1																1
Calandrinia sp. (GBS82/3)		1																			1
Callitris endlicheri											1										1
Callitris glaucophylla					4		1	1			15		3	3	5	1	1	2	2	1	39
Calotis cuneata		1			1					2			2		2						8
Calotis sp. (GBS5/4)											1										1
Capparis mitchellii										1											1
Carex appressa					1																1
Cassytha filiformis																1					1
Casuarina cristata		1	1			2						1									5
*Centella asiatica**		1			3			1											1		6
*Cestrum parqui**								1													1
Cheilanthes sieberi		2			2			2			5			1	5	2	1	1	2	2	25
Chloris divaricata		1			2	2		1		2			2						1	1	12
Chloris truncata		1			1	1				2	1	1	3					1		1	12
*Chloris virgata**		1						1													2
Chrysocephalum apiculata		2			3			2			2		1	1	2					4	17

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Chrysopetalum sp. (GBS53/4)																				1	1
Chrysopogon fallax		4			2			1			5									3	15
*Cirsium vulgare**					1																1
Commelina cyanea						1														1	2
Commelina diffusa											1										1
Commelina lanceolata		2			1	2				2	3		2		1					1	14
*Conyza bonariensis**																				1	1
*Conyza sp.**		1																			1
Corymbia bloxsomei					1			1			1			3							6
Corymbia clarksoniana					1						1										2
Corymbia tesselllaris					5			3			1										9
Corymbia trachyphloia											1				1						2
Crinum flaccidum																				1	1
Crotalaria novae-hollandaei								1													1
Cullen tenax					1	1															2
Cyanthillium cinereum					1			2			4		1					2			10
Cymbidium canaliculatum								1		1											2
Cymbidium suave											1				1						2

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Cymbopogon refractus		2						1		1	1		2	1	2					2	12
*Cynodon dactylon**		1	1		3			2		1										2	10
Cyperus aquatilis					2																2
Cyperus concinnus		1		1																	2
Cyperus fulvus					1	1														2	4
Cyperus gracilis		1			1					2			3		1				1		9
Cyperus polystachyus		1			1																2
*Cyperus rotundus**			1		1	1		1		1											5
*Dactyloctineum radulans**		1								1										1	3
Damasonium minor					2																2
Dampiera adpressa																				1	1
Desmodium campylocaulon					1			2							2			1		1	7
Desmodium sp. (indet.)											1		2								3
Desmodium varians					2	1		1													4
Dianella brevipedunculata														1	1						2
Dianella longifolia var. longifolia		1			2			2					1					1			7
Dichanthium sericeum subsp. sericeum		1			4			2			1	1								2	11
*Dichondra repens**													1								1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Digitaria amonophila					2	1														2	5
Digitaria brownii					1										1					1	3
Digitaria ramularis								2			1							1			4
Digitaria sp. (GBS74/1)				1																	1
*Dinebra retroflexa**		1																		1	2
Dodonaea biloba					1																1
Dodonaea lanceolata var. subsessilifolia												1						1			2
Dodonaea macrosanii											4		1		1	1	1	3			11
Drosera peltata															1	1					2
Drosera sp. (GBS101/1)							1														1
*Echinochloa cruss-gallii**		1								1										2	4
Eclipta procera				1	1	1		1												1	5
Einadia hastata		2	1			1				2	1										7
Einadia nutans															1						1
Eleocharis acuta		1		2	3															1	7
Eleocharis dulcis					1																1
Eleocharis pallens									1												1
Eleocharis plana					2																2

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Eleocharis pusilla					1																1
Eleonurus scaber													1								1
*Emilea sonchifolia subsp. sonchifolia**													1		2						3
Enneapogon sp. (indet.)															1						1
Entolasia stricta																		1			1
Enychleana tomentosa					1					1											2
Epaltes australe		3			1	1				1	1		2		1						10
*Eragrostis curvula**		2				1					1									2	6
Eragrostis interruptus		1																			1
Eragrostis lacunaria		2								1	1		2							1	7
Eragrostis parviflora										1					1				1	1	4
Eragrostis shultzii		2			2					1	1		3		1				1	1	12
Eragrostis sororia		2			1			1			3				4			2		2	15
Eragrostis sp. (GBS16/2)					2			2												1	5
Eragrostis sp. (GBS53/3)						1														1	2
Eremophila debilis						1				1			1								3
Eremophila desertii										1											1
Eriochloa crebra					1	1		1												1	4

SPECIES NAME	**Regional Ecosystems**																				
	11.3.1	**11.3.2**	**11.3.3**	**11.3.3c**	**11.3.4**	**11.3.17**	**11.3.18**	**11.3.25**	**11.3.27**	**11.4.3**	**11.5.1**	**11.5.1a**	**11.5.20**	**11.5.21**	**11.7.4**	**11.7.5**	**11.7.6**	**11.7.7**	**11.10.1d**	**Non-R**	**Total Records**
Eriochloa procera		2																		1	3
Eriachne obtusa										1			1		4						6
Eucalyptus camaldulensis					1			2													3
Eucalyptus coolabah			1	1				1													3
Eucalyptus crebra					2	1					14		2		4		1	1	2	2	29
Eucalyptus crebra x E. populnea																				1	1
Eucalyptus elegans											10				1		1	1		4	17
Eucalyptus exserta															4			1		1	6
Eucalyptus fibrosa subsp. nubila																1	1	2			4
Eucalyptus populnea	1	5			6	2	1				3	2	1							5	26
Eucalyptus rubiginosa															1						1
Eucalyptus tereticornis		3			13		1	8			1			1							27
Eucalyptus woollsiana						1				2		1	4						1	1	10
Eulalia aurea		1		1	1	1					2			1	2		1	2		4	16
Euphorbia dallachaina		1			2			1					1							1	6
Eustrephus latifolius					3			2											1		6
Evolvulus alsinoides					1						3				3				2	1	10
Fimbristylis dichotoma		3			3			1		1	6		1	1	3	1	1			4	25

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Gahnia aspera					1						4		1		2		1	3			12
Galactica tenuiflora					1	1					1										3
Geijera parviflora					2	1															3
Glycine tabacina					3						1										4
*Gomphrena celesioides**		3				2				1			1							2	9
Goodenia delicata		1		1	2			1			3		2	1	3		1	2		3	20
Goodenia disperma											3				2			2		1	8
Goodenia gracilis																		1			1
Goodenia paniculata											1										1
Goodenia rotundifolia																				1	1
*Gossypium hirsutum**					3			1													4
Grevillea striata											1										1
Hakea purpurea											1			1	1	1					4
Harrisa martini (Decl. Class 2)*		1			1	2							1		1						6
*Heliotropium ovalifolium**		1																			1
Heteropogon contortus					2			1											1	1	5
Heteropogon triticeus								2													2
Hibbertia cistoides															1			1			2

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Hibbertia sp. (GBS20/1)					1																1
Homoranthus melanostictus											1			2							3
Hypericum gramineum					1																1
*Hypochaeris radicata**						1															1
Imperata cylindrica					4			3													7
Indigofera pratensis																			1		1
Ipomoea phlebia				1																1	2
Jacksonia scoparia											1										1
Juncus continuus		1		1		1		1	1	1			1								7
Juncus sp. (indet.)					1																1
Juncus usitatus								1													1
Kunzea opposita														1	1	2					4
Lepidosperma laterale															1						1
Leptospermum polygalifolium					1			2													3
Leucopogon mitchellii											5			2	2			3			12
Leucopogon sp. (GBS10/2)															1	1	1	1			4
Leucopogon sp. (GBS22/2)															1			1			2
Leucopogon sp. (indet.)															1						1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Lobelia concolor		1			1					1	1									1	5
Lomandra filiformis											1							1			2
Lomandra laxa											1		3		2				1		7
Lomandra leucocephala subsp. leucocephala					1						3		2	1				1		1	9
Lomandra longifolia					8			5							1						14
Lomandra sp. (indet.)		1																			1
Lysicarpus angustifolius															2						2
*Macroptileum atropurpurea**					1																1
Maireana microphylla		1								2	2		1							1	7
Malvaceae (GBQ55/1)								1													1
Marsilea drumondii		1	1		3	1		2		1										3	12
Marsilea hirsuta		1		1	1																3
*Megathyrsus maximus var. maximus**								2													2
*Megathyrsus maximus var. pubiglumis**					3	1															4
Melaleuca decora					1						5										6
Melaleuca nodosa																		1		1	2
Melaleuca uncinata																2					2

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
*Melinus repens**											1										1
Mirbelia pungens																1					1
Mitrasacme sp. (GBS61/2)		1			1						1				1						4
Murdannia graminea		3		1							2		1	1						1	9
Neptunia gracilis				1	1															1	3
Oldenlandia galioides											1										1
Opuntia stricta (Class 2)*								1		1	1									1	4
Opuntia tomentosa (Class 2)*		4			1					1	2		2	1	1				1	2	15
Oxalis perennans		3	1	1	4	2		3		2					1						17
Ozothamnus diosmifolius											1										1
Panicum decompositum		1			2			1			5		2		2	1		3		1	18
Panicum effusum					1						1		1		1						4
Panicum queenslandicum		1			1								1		1	1				2	7
Parsonsia lanceolata										1									1		2
Paspalidium constrictum											1										1
Paspalidium distans						1					2		2		1	1				1	8
Paspalidium jubilifera																				1	1
Paspalidium sp. (GBS13/1)					2	1		2			2							2			9

SPECIES NAME	Regional Ecosystems																			
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Paspalidium sp. (GBS59/1)		1	1	1	2					2		1	1		1						10
Paspalidium sp. (indet.)					1										1		1				3
*Paspalum dilatatum**					1	2					1									1	5
Paspalum distichum					1																1
Paspalum vaginatum		1		1																	2
*Pennisetum ciliare**					1						1										2
Perotis rara		1						2												1	4
Persicaria sp. (indet.)					1																1
Petalostigma pubescens											2										2
Phragmites australis								1													1
*Phyla canescens**		3	2	1	5	2		4					1							5	23
Phyllanthus virgatus		2	1		1	2		3		1	4		1		3			3		5	26
*Physalis angulata**		1				2														1	4
Pimelea neoanglica											1			1		1					3
Pittosporum angustifolia					1	1						1	2								5
Pittosporum sp. (indet.)													1		1						2
Platysace lanceolata																		1			1
Pleurocarpaea sp. (GBS3/5)					1						3			1	3	2	1	2			13

SPECIES NAME	Regional Ecosystems																			
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Pomax umbellata											1				1						2
*Portulaca oleracea**						1				2										3	6
Portulaca sp. (GBS42/5)					1																1
Portulaca sp. (GBS44/2)																				1	1
Portulaca sp. (indet.)*		1																			1
Prostanthera cryptandroides subsp. euphrasioides															1			1			2
Prostanthera sp. (GBS1/8)															1						1
Psydrax sp. (indet.)											1		1								2
*Richardia brasiliensis**								1													1
Rostellularia adscendens		1			1			2							1						5
Rubus sp. (indet.)*								1													1
Rumex brownii		1			3	1		2		1										1	9
Rumex stenoglottis					2	1															3
Rynchnosia minima					1																1
Salsola kali						1														3	4
Santalum lanceolatum																			1		1
Scleria sp. (GBS59/6)					1																1
Scleria sp. (indet.)					1																1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Scleria sphacelata											1				3			2			6
Scleroleana sp. (indet.)		2								2											4
*Scoparia dulcis**		1																			1
Senna clavigera					1																1
Setaria sp. (indet.)		2				2															4
*Sida acuta**		1			3	2		2													8
Sida rohlenae subsp. rohlenae					2										1			2			5
Sida sp. (GBS85/2)											1				1						2
Sida subspicata					2					1											3
Sigesbeckia orientalis		1			1																2
Solanum ellipticum										1	3				1						5
*Solanum nigrum subsp. nigrum**										1					1						2
Solanum parvifolium subsp. parvifolium										1	2		1		1						5
*Sonchus oleraceus**										2											2
*Sorghum helapense**					1																1
Sporobolus creber		3			1					1	2		1		1				1	2	12
Sporobolus sp. (GBS16/7)					2			2													4
Sprorobolus sp. (GBS16/1)								1													1

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Stackhousia intermedia															1						1
Stylidium eriorhizum															2						2
Tetragonia tetragonioides						1															1
Themeda triandra											4		1								5
Tragus australiana		1								1			1							1	4
Tricoryne anceps		1						1			1				1					1	5
Tricoryne elatior											1			1	1			2			5
Triglochin procera				1	2																3
Triodia scariosa											1			2	1	1					5
Tripogon loliformis											1										1
*Urochloa mosambicensis**					1			1													2
Urochloa panicoides					1					1									1		3
Ventilago viminalis					1					1											2
*Verbena aristigera**		2			4	1		2		1										2	12
Verbena gaudichaudiana						1															1
*Verbena incompta**					1																1
*Vicia monantha subsp. monantha**					1																1
Wahalwellya subxerophila		1		1	1	2				2											7

SPECIES NAME	Regional Ecosystems																				
	11.3.1	11.3.2	11.3.3	11.3.3c	11.3.4	11.3.17	11.3.18	11.3.25	11.3.27	11.4.3	11.5.1	11.5.1a	11.5.20	11.5.21	11.7.4	11.7.5	11.7.6	11.7.7	11.10.1d	Non-R	Total Records
Wahlenbergia communis		1			3			2			2									1	9
Wahlenbergia gracilis		1			2	1							1							1	6
Westringea cheelii											1					1	1				3
*Xanthium occidentale**					3	2		3													8
Xanthorrhoea johnsonii					2						1			1							4
Xylomelum cunninghamianum														1							1
Zornia muriculata subsp. angustata					1						2				1					1	5

Appendix K. SREIS Survey Fauna (Vertebrate) Species List

AMPHIBIANS **N = 20**

FAMILY		Status**		Arrow Site (survey areas)				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
LIMNODYNASTIDAE								
Limnodynastes fletcheri	Long-thumbed frog	LC		X			X	
Limnodynastes salmini	Salmon striped frog	LC		X			X	
Limnodynastes tasmaniensis	Spotted marshfrog	LC		X	X		X	
Limnodynastes terraereginae	Scarlet-sided pobblebonk	LC		X			X	
Neobatrachus sudellae	Meowing Frog	LC		X				
Platyplectrum ornatum	Ornate Burrowing Frog	LC		X			X	
HYLIDAE								
Cyclorana alboguttata	Green-striped Frog	LC		X			X	
Cyclorana brevipes	Short-footed Frog	LC					X	
Cyclorana novaehollandiae	New Holland Frog	LC		X			X	
Cyclorana verrucosa	Rough Collared Frog	NT					X	
Litoria caerulea	Green Tree Frog	LC		X			X	
Litoria fallax	Eastern Sedgefrog	LC		X			X	
Litoria latopalmata	Broad Palmed Rocketfrog	LC		X	X	X	X	
Litoria peronii	Emerald-spotted Tree Frog	LC		X			X	
Litoria rubella	Ruddy Treefrog	LC		X			X	
MYOBATRACHIDAE								
Crinia parinsignifera	Beeping Froglet	LC					X	
Pseudophryne major	Great Brown Broodfrog	LC		X			X	
Uperoleia laevigata	Eastern Gungan	LC					X	
Uperoleia rugosa	Chubby Gungan	LC					X	
BUFONIDAE								

	Rhinella marina	Cane Toad	I		X				

**Species listings under EPBC Act and NC Act, LC = Least Concern, I = Introduced ; NT = Near Threatened, V = Vulnerable; E = Endangered

REPTILES **N = 30**

FAMILY			**Status****		**Site**				
	Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
GEKKONIDAE									
	Gehyra dubia	Dubious Dtella	LC		X		X	X	X
	Heteronotia binoei	Bynoe's Gecko	LC		X		X	X	
DIPLODACTYLIDAE									
	Diplodactylus vittatus	Wood Gecko	LC		X			X	
	Nebulifera robusta	Robust Velvet Gecko	LC		X				
	Strophurus taenicauda	Golden-tailed Gecko	NT		X				
PYGOPODIDAE									
	Paradelma orientalis	Brigalow Scaly-foot	V	V	X				
	Pygopus schraderi	Eastern Hooded Scaly-foot	LC		X				
AGAMIDAE									
	Diporiphora australis	Tommy Roundhead	LC		X				
	Intellagama lesueurii	Eastern Water Dragon	LC		X			X	
	Pogona barbata	Eastern Bearded Dragon	LC		X				
VARANIDAE									
	Varanus gouldii	Sand Goanna	LC		X		X	X	
	Varanus tristis	Freckled Monitor	LC		X				
	Varanus varius	Lace Monitor	LC		X				

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
SCINCIDAE								
Anomalopus leuckarti	Two-clawed Worm-skink	LC		X				
Carlia munda	Shaded-litter Rainbow-skink	LC		X				
Carlia pectoralis	Open-litter Rainbow-skinks	LC		X				
Cryptoblepharus metallicus	Metallic Snake-eyed Skink	LC		X				
Cryptoblepharus pulcher	Elegant Snake-eyed Skink	LC		X				
Ctenotus allotropis	Brown-blazed Wedgesnout Ctenotus	LC		X				
Ctenotus robustus	Eastern Striped Skink	LC		X				
Ctenotus taeniolatus	Copper-tailed Skink	LC		X				
Eulamprus quoyii	Easter Water Skink	LC		X				
Lerista fragilis	Eastern Mulch-slider	LC		X				
Lerista timida	Timid Slider	LC		X				
Lygisaurus foliorum	Burnett's Skink	LC		X			X	X
Menetia greyii	Common Dwarf Skink	LC		X				
COLUBRIDAE								
Tropidonophis mairii	Keelback	LC		X				
ELAPIDAE								
Cryptophis nigrescens	Eastern Small-eyed Snake	LC		X				
Parasuta dwyeri	Dwyer's Snake	LC					X	
Vermicella annulata	Bandy Bandy	LC					X	

**Species listings under EPBC Act and NC Act, LC = Least Concern, V = Vulnerable

BIRDS **N = 135**

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
PHASIANIDAE								
Coturnix pectoralis	Stubble Quail	LC		X			X	
ANATIDAE								
Anas gracilis	Grey Teal	LC		X			X	
Anas superciliosa	Pacific Black Duck	LC		X			X	
Aythya australis	Hardhead	LC		X				
Chenonetta jubata	Australian Wood Duck	LC		X			X	
Cygnus atratus	Black Swan	LC					X	
Dendrocygna eytoni	Plumed Whistling Duck	LC		X			X	
Malacorhynchus membranaceus	Pink-eared Duck	LC					X	
PODICIPEDIDAE								
Tachybaptus novaehollandiae	Australasian Grebe	LC		X			X	
COLUMBRIDAE								
Geopelia cuneata	Diamond Dove	LC		X				
Geopelia humeralis	Bar-shouldered Dove	LC		X				
Geopelia placida	Peaceful Dove	LC		X		X		
Ocyphaps lophotes	Crested Pigeon	LC		X			X	X
Phaps chalcoptera	Common Bronzewing	LC		X				
PODARGIDAE								
Podargus strigoides	Tawny Frogmouth	LC		X			X	
AEGOTHELIDAE								

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
Aegotheles cristatus	Australian Owlet Nightjar	LC		X				
Eurostopodus mystacalis	White-throated Nightjar	LC		X			X	
APODIDAE								
Hirundapus caudacutus	White-throated Needletail	LC	Mig	X			X	
ANHINGIDAE								
Anhinga novaehollandiae	Australasian Darter	LC		X			X	
PHALACROCORACIDAE								
Microcarbo melanoleucos	Little Pied Cormorant	LC		X				
PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican	LC					X	
ARDEIDAE								
Ardea modesta	Eastern Great Egret	LC	Mig	X				
Ardea pacifica	White-necked Heron	LC		X			X	
Egretta novaehollandiae	White-faced Heron	LC		X			X	
Nycticorax caledonicus	Nankeen Night-heron	LC		X				
THRESKIOMITHIDAE								
Platalea flavipes	Yellow-billed Spoonbill	LC					X	
Platalea regia	Royal Spoonbill	LC					X	
Threskiornis spinicollis	Straw-necked Ibis	LC		X			X	
ACCIPITRIDAE								

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
Accipiter fasciatus	Brown Goshawk	LC				X		
Aquila audax	Wedge-tailed Eagle	LC		X			X	
Elanus axillaris	Black-shouldered Kite	LC		X				
Haliaeetus leucogaster	White-bellied Sea-eagle	LC	Mig	X				
Haliastur sphenurus	Whistling Kite	LC		X			X	
Milvus migrans	Black Kite	LC		X				
FALCONIDAE								
Falco berigora	Brown Falcon	LC		X				
Falco cenchroides	Nankeen Kestrel	LC		X			X	
Falco longipennis	Australian Hobby	LC					X	
RALLIDAE								
Fulica atra	Eurasian Coot	LC		X				
Tribonyx ventralis	Black-tailed Native-hen	LC		X				
BURHINIDAE								
Burhinus grallarius	Bush Stone-curlew	LC		X				
CHARADRIIDAE								
Elseyornis melanops	Black-fronted Dotterel	LC		X			X	
Erythrogonys cinctus	Red-kneed Dotterel	LC					X	
Vanellus miles	Masked Lapwing	LC		X			X	
SCOLOPACIDAE								
Gallinago hardwickii	Latham's Snipe	LC	Mig				X	

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
LARIDAE								
Chlidonias hybrida	Whiskered Tern	LC		X				
CACATUIDAE								
Cacatua galerita	Sulphur-crested Cockatoo	LC			X		X	
Cacatua sanguinea	Little Corella	LC			X		X	
Calyptorhynchus funereus	Yellow-tailed Black-cockatoo	LC		X				
Calyptorhynchus lathami	Glossy Black-cockatoo	V		X				
Eolophus roseicapilla	Galah	LC		X	X		X	
Nymphicus hollandicus	Cockatiel	LC		X	X		X	
PSITTACIDAE								
Alisterus scapularis	Australian King Parrot	LC						X
Aprosmictus erythropterus	Red-winged Parrot	LC		X	X		X	X
Glossopsitta pusilla	Little Lorikeet	LC		X		X	X	
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	LC		X			X	
Trichoglossus haematodus	Rainbow Lorikeet	LC		X			X	
Platycercus adscitus	Pale-headed Rosella	LC		X			X	
Psephotus haematonotus	Red-rumped Parrot	LC			X			
CUCULIDAE								
Cacomantis variolosus	Brush Cuckoo	LC		X				
Centropus phasianinus	Pheasant Coucal	LC		X			X	
Chalcites basalis	Horsefield's Bronze-cuckoo	LC		X				
Chalcites osculans	Black-eared Cuckoo	LC		X				
Eudynamys orientalis	Eastern Koel	LC					X	

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
STRIGIDAE								
Ninox boobook	Southern Boobook	LC		X			X	
TYTONIDAE								
Tyto javanica/novaehollandiae	Eastern Barn/Masked Owl	LC		X				
Tyto javanica	Pacific Barn Owl	LC		X				
HALCYONIDAE								
Dacelo novaeguineae	Laughing Kookaburra	LC		X			X	
Todiramphus sanctus	Sacred Kingfisher	LC		X			X	
MEROPIDAE								
Merops ornatus	Rainbow Bee-eater	LC	Mig	X	X	X		
CORACIIDAE								
Eurystomus orientalis	Dollarbird	LC		X		X	X	
CLIMACTERIDAE								
Cormobates leucophaea	White-throated Treecreeper	LC		X		X		
MALURIDAE								
Malurus cyaneus	Superb Fairy-wren	LC		X			X	
Malurus lamberti	Variegated Fairy-wren	LC		X			X	
Malurus melanocephalus	Red-backed Fairy-wren	LC		X				
ACANTHIZIDAE								

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
Acanthiza apicalis	Inland Thornbill	LC		X		X	X	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	LC		X				
Acanthiza nana	Yellow Thornbill	LC		X		X	X	X
Acanthiza reguloides	Buff-rumped Thornbill	LC				X		
Acanthiza uropygialis	Chestnut-rumped Thornbill	LC		X				
Gerygone albogularis	White-throated Gerygone	LC		X			X	
Gerygone fusca	Western Gerygone	LC		X				
Pyrrholaemus sagittatus	Speckled Warbler	LC		X		X	X	X
Smicrornis brevirostris	Weebill	LC		X	X	X	X	X
PARDALOTIDAE								
Pardalotus punctatus	Spotted Pardalote	LC		X				
Pardalotus striatus	Striated Pardalote	LC		X	X		X	
MELIPHAGIDAE								
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	LC		X				
Entomyzon cyanotis	Blue-faced Honeyeater	LC		X	X			X
Lichenostomus virescens	Singing Honeyeater	LC		X				
Lichenostomus chrysops	Yellow-faced Honeyeater	LC		X		X	X	
Lichenostomus leucotis	White-eared Honeyeater	LC		X	X	X		
Lichenostomus melanops	Yellow-tufted Honeyeater	LC		X				
Lichmera indistincta	Brown Honeyeater	LC		X				
Manorina flavigula	Yellow-throated Miner	LC		X				
Manorina melanocephala	Noisy Miner	LC		X	X	X	X	X
Melithreptus albogularis	White-throated Honeyeater	LC		X				
Melithreptus brevirostris	Brown-headed Honeyeater	LC		X		X		
Melithreptus gularis	Black-chinned Honeyeater	NT		X				

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
Myzomela sanguinolenta	Scarlet Honeyeater	LC		X				
Philemon corniculatus	Noisy Friarbird	LC		X		X	X	
Plectorhyncha lanceolata	Striped Honeyeater	LC		X		X		
Ptilotula penicillatus	White-plumed Honeyeater	LC		X				
POMATOSTOMIDAE								
Pomatostomus temporalis	Grey-crowned Babbler	LC		X			X	X
NEOSITTIDAE								
Daphoenositta chrysoptera	Varied Sittella	LC		X		X		
CAMPEPHAGIDAE								
Coracina maxima	Ground Cuckoo-shrike	LC					X	
Coracina novaehollandiae	Black-faced Cuckoo-shrike	LC		X			X	
Coracina papuensis	White-bellied Cuckoo-shrike	LC		X				
Coracina tenuirostris	Cicadabird	LC		X		X		
PACHYCEPHALIDAE								
Colluricincla harmonica	Grey Shrike-thrush	LC		X		X	X	X
Pachycephala rufiventris	Rufous Whistler	LC		X		X	X	
ORIOLIDAE								
Oriolus sagittatus	Olive-backed Oriole	LC		X				
ARTAMIDAE								
Artamus personatus	Masked Woodswallow	LC		X				
Artamus superciliosus	White-browed Woodswallow	LC		X		X		

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
Cracticus nigrogularis	Pied Butcherbird	LC		X			X	
Cracticus tibicen	Australian Magpie	LC		X		X	X	
Cracticus torquatus	Grey Butcherbird	LC		X	X	X	X	
Strepera graculina	Pied Currawong	LC		X			X	
RHIPIDURIDAE								
Rhipidura albiscarpa	Grey Fantail	LC		X		X		
Rhipidura leucophrys	Willie Wagtail	LC		X			X	
CORVIDAE								
Corvus coronoides	Australian Raven	LC		X		X		
Corvus orru	Torresian Crow	LC		X	X		X	X
MONARCHIDAE								
Grallina cyanoleuca	Magpie-lark	LC		X	X	X	X	X
Myiagra inquieta	Restless Flycatcher	LC		X				
Myiagra rubecula	Leaden Flycatcher	LC		X				
CORCORACIDAE								
Struthidea cinerea	Apostlebird	LC		X	X		X	X
PETROICIDAE								
Eopsaltria australis	Eastern Yellow Robin	LC		X	X	X		X
Microeca fascinans	Jacky Winter	LC		X				
Petroica goodenovii	Red-capped Robin	LC		X				
CISTICOLIDAE								
Cisticola exilis	Golden-headed Cisticola	LC			X			

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA 2**	**SA7**	**SA8**	**SA9**	**SAF**
MEGALURIDAE								
Cincloramphus mathewsi	Rufous Songlark	LC		X				
Cincloramphus cruralis	Brown Songlark	LC					X	
HIRUNDINIDAE								
Hirundo neoxena	Welcome Swallow	LC		X				
Petrochelidon nigricans	Tree Martin	LC						X
NECTARINIIDAE								
Dicaeum hirundinaceum	Mistletoebird	LC		X		X		
ESTRILDIDAE								
Taeniopygia bichenovii	Double-barred Finch	LC		X				
MOTACILLIDAE								
Anthus novaeseelandiae	Australasian Pipit	LC		X				

**Species listings under EPBC Act and NC Act, LC = Least Concern, V = Vulnerable, NT = Near Threatened, I = Introduced, Mig = Migratory

MAMMALS **N = 28**

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
TACHYGLOSSIDAE								
Tachyglossus aculeatus	Echidna	LC						X
DASYURIDAE								
Planigale maculata	Common Planigale	LC		X				

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
Sminthopsis murina	Common Dunnart	LC					X	
PHASCOLARCTIDAE								
Phascolarctos cinereus	Koala	LC	V				X	
PETAURIDAE								
Petaurus norfolcensis	Squirrel Glider	LC					X	
ACROBATIDAE								
Acrobates pygmaeus	Feathertail Glider	LC					X	
PHALANGERIDAE								
Trichosurus vulpecula	Common Brushtail Possum	LC					X	
POTOROIDAE								
Aepyprymnus rufescens	Rufous Bettong	LC					X	
MACROPODIDAE								
Macropus giganteus	Eastern Grey Kangaroo	LC		X		X	X	X
Macropus parryi	Pretty-faced Wallaby	LC						X
Macropus rufogriseus	Red-necked Wallaby	LC				X	X	X
Wallabia bicolor	Swamp Wallaby	LC					X	
EMBALLONURIDAE								
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	LC		X				
MOLOSSIDAE								
Austronomus australis	White-striped Free-tail Bat	LC		X				

FAMILY		Status**		Site				
Scientific Name	**Common Name**	**NCA**	**EPBC**	**SA2**	**SA7**	**SA8**	**SA9**	**SAF**
Mormopterus beccarii	Beccari's free-tailed bat	LC		X				
Mormopterus ridei	Eastern Little Free-tailed Bat	LC		X				
Mormopterus sp. 3	Free-tailed Bat	LC		X				
VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat	LC		X				
Chalinolobus picatus	Little Pied Bat	NT		X				
Nyctophilus corbeni	South-eastern Long-eared Bat		V	X				
Nyctophilus gouldii	Gould’s Long-eared bat	LC		X				
Scotorepens balstoni	Western Broad-nosed Bat	LC		X				
Scotorepens greyii	Little Broad-nosed Bat	LC		X				
Vespadelus vulturnus	Little Forest Bat	LC		X				
CANIDAE								
Canis lupus dingo/familiaris	Dingo/Dog	I		X		X	X	
FELIDAE								
Felis catus	Feral Cat	I					X	
LEPORIDAE								
Lepus europaeus	European Brown Hare	I		X			X	
SUIDAE								
Sus scrofa	Feral Pig	I			X	X	X	

**Species listings under EPBC Act and NC Act, LC = Least Concern, V = Vulnerable, I = Introduced, Mig = Migratory

Appendix L. EPBC Search (25 km Buffer)

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

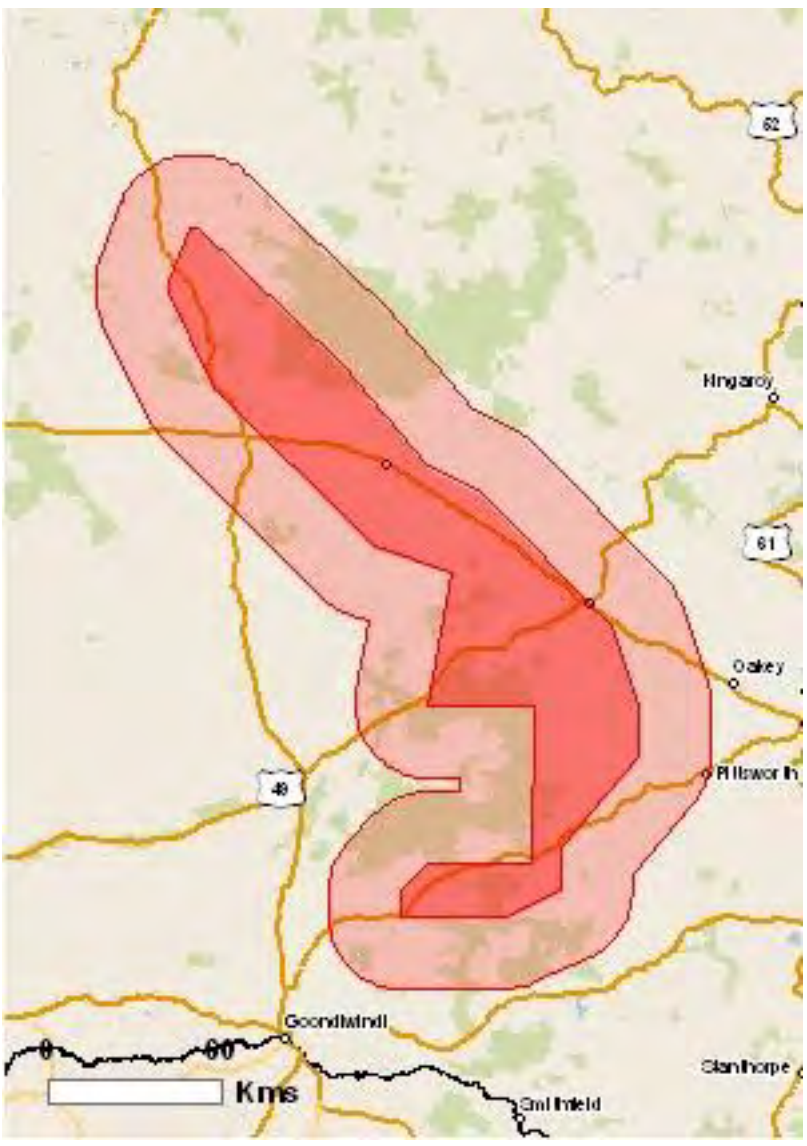
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

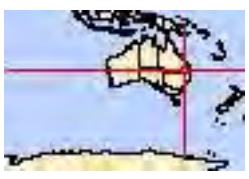
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 13/02/13 12:58:21



Coordinates

Buffer: 25.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	59
Listed Migratory Species:	19

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	20
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	24
State and Territory Reserves:	9
Regional Forest Agreements:	None
Invasive Species:	19
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (RAMSAR) [Resource Information]

Name	Proximity
Narran lake nature reserve	Upstream from Ramsar

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community likely to occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community likely to occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Black-throated Finch (southern) [64447]	Endangered	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Vulnerable	Species or species habitat likely to occur within area
Turnix melanogaster Black-breasted Button-quail [923]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Neoceratodus forsteri Australian Lungfish, Queensland Lungfish [67620]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll [331]	Endangered	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Nyctophilus corbeni South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland) [66645]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Species or species habitat likely to occur within area
Other		
Macrozamia conferta [64582]	Vulnerable	Species or species habitat likely to occur within area
Macrozamia machinii [64583]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Plants		
[Acacia curranii](#) Curly-bark Wattle [3908]	Vulnerable	Species or species habitat likely to occur within area
[Acacia handonis](#) Hando's Wattle, Percy Grant Wattle [14928]	Vulnerable	Species or species habitat likely to occur within area
[Acacia lauta](#) [4165]	Vulnerable	Species or species habitat likely to occur within area
[Acacia wardellii](#) [3916]	Vulnerable	Species or species habitat may occur within area
[Bothriochloa biloba](#) Lobed Blue-grass [3153]	Vulnerable	Species or species habitat likely to occur within area
[Cadellia pentastylis](#) Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
[Calytrix gurulmundensis](#) [24241]	Vulnerable	Species or species habitat likely to occur within area
[Commersonia argentea](#) a shrub [82761]	Vulnerable	Species or species habitat likely to occur within area
[Denhamia parvifolia](#) [18106]	Vulnerable	Species or species habitat likely to occur within area
[Dichanthium queenslandicum](#) King Blue-grass [5481]	Vulnerable	Species or species habitat likely to occur within area
[Digitaria porrecta](#) Finger Panic Grass [12768]	Endangered	Species or species habitat likely to occur within area
[Eucalyptus argophloia](#) Queensland White Gum, Queensland Western White Gum, Lapunyah, Scrub Gum, White Gum [19748]	Vulnerable	Species or species habitat likely to occur within area
[Eucalyptus virens](#) [10181]	Vulnerable	Species or species habitat likely to occur within area
[Haloragis exalata subsp. velutina](#) Tall Velvet Sea-berry [16839]	Vulnerable	Species or species habitat likely to occur within area
[Homopholis belsonii](#) [2406]	Vulnerable	Species or species habitat may occur within area
[Homoranthus decumbens](#) [55186]	Vulnerable	Species or species habitat known to occur within area
[Lepidium peregrinum](#) Wandering Pepper-cress [14035]	Endangered	Species or species habitat may occur within area
[Microcarpaea agonis](#) [64933]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Philotheca sporadica [64944]	Vulnerable	Species or species habitat likely to occur within area
Picris evae Hawkweed [10839]	Vulnerable	Species or species habitat likely to occur within area
Prostanthera sp. Dunmore (D.M.Gordon 8A) [84115]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis cobarensis Cobar Greenhood Orchid [12993]	Vulnerable	Species or species habitat likely to occur within area
Rhaponticum australe Austral Cornflower, Native Thistle [22647]	Vulnerable	Species or species habitat likely to occur within area
Streblus pendulinus Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Westringia parvifolia [4822]	Vulnerable	Species or species habitat likely to occur within area
Xerothamnella herbacea [4146]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Anomalopus mackayi Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat known to occur within area
Delma torquata Collared Delma [1656]	Vulnerable	Species or species habitat known to occur within area
Denisonia maculata Ornamental Snake [1193]	Vulnerable	Species or species habitat may occur within area
Egernia rugosa Yakka Skink [1420]	Vulnerable	Species or species habitat known to occur within area
Elseya belli Bell's Turtle, Namoi River Turtle, Bell's Saw-shelled Turtle [66690]	Vulnerable	Species or species habitat may occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat known to occur within area
Paradelma orientalis Brigalow Scaly-foot [59134]	Vulnerable	Species or species habitat known to occur within area
Rheodytes leukops Fitzroy River Turtle, Fitzroy Tortoise, Fitzroy	Vulnerable	Species or species

Name	Status	Type of Presence
Turtle [1761]		habitat may occur within area
[Tympanocryptis pinguicolla](#) Grassland Earless Dragon [66727]	Endangered	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Breeding likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus](#) White-throated Needletail [682]		Species or species habitat known to occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within area
[Monarcha melanopsis](#) Black-faced Monarch [609]		Species or species habitat known to occur within area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Breeding known to occur within area
[Rhipidura rufifrons](#) Rufous Fantail [592]		Species or species habitat known to occur within area
[Xanthomyza phrygia](#) Regent Honeyeater [430]	Endangered*	Species or species habitat likely to occur within area
Migratory Wetlands Species		
[Ardea alba](#) Great Egret, White Egret [59541]		Breeding likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
[Calidris ferruginea](#) Curlew Sandpiper [856]		Species or species habitat known to occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
[Limosa limosa](#) Black-tailed Godwit [845]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Defence - DALBY TRAINING DEPOT

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Himantopus himantopus Black-winged Stilt [870]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Vulnerable*	Species or species habitat likely to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
Barakula State Forest Area	QLD	Indicative Place
Bendidee National Park	QLD	Indicative Place
Dalby / Jandowae Roadside Remnant Grassland	QLD	Indicative Place
Dalby Cecil Plains Roadside Remnant Dichanthium sericeum Site	QLD	Indicative Place
Dalby Radio Tower Remnant Grassland	QLD	Indicative Place
Jondaryan East Roadside Remnant Grassland	QLD	Indicative Place
Jondaryan West Roadside Remnant Grassland	QLD	Indicative Place
Lake Broadwater Environmental Park	QLD	Indicative Place
Waaje Area	QLD	Indicative Place
Chinchilla Sands Local Fossil Fauna Site	QLD	Registered
Indigenous		
Fernbank Stone Arrangement	QLD	Registered
Kogan Stone Arrangement	QLD	Registered

Name	State	Status
Malleroo Stone Arrangement	QLD	Registered
Historic		
Club Hotel	QLD	Indicative Place
Jondaryan Post Office (former)	QLD	Indicative Place
Pittsworth Post Office	QLD	Indicative Place
All Saints Church	QLD	Registered
Boonarga Cactoblastis Memorial Hall	QLD	Registered
Dalby War Memorial and Memorial Park	QLD	Registered
Jimbour Station Homestead	QLD	Registered
Jondaryan Homestead Outbuildings	QLD	Registered
Jondaryan Woolshed	QLD	Registered
St Annes Anglican Church	QLD	Registered
Yandilla Street Group	QLD	Registered

State and Territory Reserves

[Resource Information]

Name	State
Ballara Park	QLD
Bendidee	QLD
Chinchilla Rifle Range	QLD
Irongate	QLD
Lake Broadwater	QLD
Lake Broadwater	QLD
Myall Park	QLD
Stones Country	QLD
Wondul Range	QLD

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Frogs		
Bufo marinus Cane Toad [1772]		Species or species habitat likely to occur within area
Mammals		
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Hymenachne amplexicaulis Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat may occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Lake Broadwater	QLD

Coordinates

-25.997 150.034,-26.429 150.482,-26.749 150.753,-26.832 150.919,-27.2499 151.332,-27.498 151.418,-27.664 151.414,-27.9481 151.1685,-28.082 151.1687,-28.1629 150.9945,-28.1646 150.6692,-28.0826 150.6688,-27.9977 150.751,-27.9962 151.0807,-27.5018 151.084,-27.5007 150.7525,-27.0823 150.8316,-26.9999 150.583,-26.5012 150.082,-26.1993 149.9363,-26.1646 149.935,-25.998 150.001,-25.997 150.034

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Sustainability, Environment, Water, Population and Communities
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111