17

TERRESTRIAL ECOLOGY

ENTER HERE

BACK TO CONTENTS

arrow energy
go further

17 Terrestrial Ecology

This chapter provides a summary of the terrestrial ecology assessment undertaken for the Project, The survey methodology used during the terrestrial ecology assessment is outlined, relevant legislation is considered, and the Project area's existing environmental values, as identified during a literature review and field surveys are discussed. This chapter also provides an assessment of the potential impacts of the Project on terrestrial ecology values and proposed mitigation measures. A detailed assessment of the potential impact on terrestrial ecology values for the Project area is presented in The Terrestrial Ecology Technical Report (Appendix P of this EIS). A cross reference to the locations where each of the requirements of the ToR has been addressed is given in Appendix B which references both the study chapters (Sections 1 through 34) and/or the Appendices (A through EE).

Matters of national environmental significance (MNES) identified within this chapter are expanded on and discussed in further detail in Appendix CC of this EIS. An assessment of the aquatic flora and fauna for the Project is provided in the Aquatic Ecology chapter (Section 16) of this EIS.

17.1 Legislative Context

Regulation of the environmental aspects of petroleum related activities is governed primarily by the Queensland *Environmental Protection Act 1994* (EP Act). A range of additional statutory mechanisms at both state and federal levels may be triggered during petroleum related activities. These mechanisms are detailed in the sections below.

17.1.1 Queensland Government

17.1.1.1 Environmental Protection Act 1994 (Qld)

Environmental authorisation for a petroleum related activity is regulated by the EP Act. The EP Act regulates Environmentally Relevant Activities (ERAs), including those relating to mining and petroleum through the development of EIS'. The *Environmental Protection Regulation 2008* provides a mechanism to enforce the EP Act and allows for an assessment of the risk that an ERA poses to Environmentally Sensitive Areas (ESAs). Details of ERAs for the petroleum industry are listed below:

- 'Level 1' Petroleum Activities, which are activities considered to have a high risk of causing significant environmental damage; and
- 'Level 2' Petroleum Activities, being activities considered to have low potential to cause environmental harm.

Arrow is preparing a voluntary EIS under the EP Act for the proposed Project. As outlined in the DERM (now EHP) Guideline *Assessment and approval process for environmental authorities for chapter 5A activities* (DERM 2011), petroleum activities considered as triggers for the EIS process include those that:

- Have a significant impact on Category A or B ESAs;
- Involve activities in a marine area;
- Involve activities less than 500 m from highest astronomical tide;

- Involve the construction of a new pipeline of more than 150 km under a petroleum authority;
- Include an ERA with an aggregate environmental score of greater than 165;
- Involve activities under a greenhouse gas injection and storage lease under the *Greenhouse Gas Storage Act 2009;* and
- Involve the construction of a petroleum refining or processing facility.

The classification of Category A, Category B or Category C ESAs is based on a ranking of environmental sensitivity.

Category A ESAs relevant to terrestrial ecology values include the following:

- All areas designated as national park under the *Nature Conservation Act 1992* (NC Act);
- Conservation parks;
- Forest reserves; and
- The Wet Tropics World Heritage area.

Category B ESAs relevant to terrestrial ecological values include the following:

- Areas designated under the NC Act as co-ordinated conservation areas, wilderness areas, world heritage management areas, areas of critical habitat under a conservation plan or areas subject to interim conservation orders;
- Conventions to which Australia is signatory including the 'Convention on the Conservation of Migratory Species of Wild Animals' and the 'Convention on Wetlands of International Importance (Ramsar Convention; Iran 1971);
- Feature protection areas (e.g. state forest park); and
- Regional ecosystems (REs) scheduled as 'endangered' (biodiversity status) by EHP.

Category C ESAs are not listed under the schedules of the Environmental Protection Regulations although they are provided within the *Draft Code of Environmental Compliance for Level 2 Petroleum Activities* (EPA, 2008a) forming part of the environmental compliance and conditioning framework. 'Category C' ESAs include state forests and REs with an 'of concern' biodiversity status. Level 2 petroleum activities must not cause impact to Category A or Category B ESAs. Authority for Level 1 petroleum activities may be granted in association with an approved EM Plan with impacts to Category A and Category B ESAs addressed within this plan or assessed within the EIS Framework.

17.1.1.2 Nature Conservation Act 1992 (Qld)

Actions relevant to the description of ecological values under the NC Act include the provision for eleven classes of protected areas ranging from:

- National parks (scientific);
- World heritage management and international agreement areas;
- National parks (Aboriginal land);
- Nature refuges;
- Coordinated conservation areas involving private property; and
- Seven classes of wildlife are defined by the *Nature Conservation (Wildlife) Regulation 2006* (NC Regulation);

- Extinct in the wild;
- Endangered;
- Vulnerable;
- Near threatened; and
- Least concern.

These classes collectively relate to native species and are protected wildlife. International and prohibited wildlife classes relate to non-native species and are not classified as protected wildlife. There are however restrictions on the release of international and prohibited wildlife into the wild.

17.1.1.3 Vegetation Management Act 1999 (Qld)

The *Vegetation Management Act 1999* (VM Act) is the planning initiative underlying regional management of vegetation in Queensland, including clearing of vegetation types (REs). The RE classification developed by Sattler and Williams (1999) is a hierarchical system formed by a three part code with the primary subdivision being bioregion, followed by land zone, then vegetation. The biogeographic region or bioregion is the primary level of classification for biodiversity values in Queensland, describing where the RE is found on a state wide basis. Land zones are geological and geomorphic categories that describe the major geologies and landforms of Queensland. The system is based primarily on geology, with geologic age considered an important determinant.

The Vegetation Management status of REs is based on their pre-clearing and remnant extent, and is gazetted under the VM Act and listed in the Regional Ecosystem Description Database (REDD) maintained by EHP. However, the Biodiversity Status of an RE is used in the designation of ESAs and relates to the condition of the RE in terms of level of disturbance and on-going threatening processes. The Biodiversity Status is described in line with the following:

'Endangered' RE: an RE that is prescribed under a regulation and has either:

- <10% of its pre-clearing extent remaining; or
- 10% to 30% of its pre-clearing extent remaining and the remnant vegetation remaining is less than 10,000 ha.

In addition to the above criteria, a RE is listed with a Biodiversity Status of 'endangered' if:

- Less ten percent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss; or
- Ten to thirty percent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- It is a rare RE subject to a threatening process.

'Of concern' RE: means an RE that is prescribed under a regulation and has either:

- Ten to thirty percent of its pre-clearing extent remaining; or
- More than thirty percent of its pre-clearing extent remaining and the remnant vegetation remaining is <10,000 ha.

In addition to the above criteria, a RE is listed with a Biodiversity Status of 'of concern' if 10-30% of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.

'Least concern' RE: means an RE that is prescribed under a regulation and has more than 30% of its pre-clearing extent remaining and the remnant vegetation remaining is more than 10,000 ha and the degradation criteria listed above for 'endangered' or 'of concern' REs are not met.

Essential habitat: the VM Act also has provision for the regulation of essential habitat for species of state significance. Essential habitat is vegetation in which a species that is endangered, vulnerable or near threatened has been known to occur. Clearing or disturbance to areas of essential habitat will require compensatory habitat measures to be developed.

Regrowth Vegetation Code: took effect on October 8, 2009 and regulates the clearing of high value regrowth (HVR) vegetation defined as regrowth vegetation that has not been cleared post 31 December 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.

The code applies three levels of protection for regrowth vegetation derived from:

- 'Endangered' REs;
- 'Of concern' REs; and
- 'Least concern' REs.

The code also applies protection to regrowth watercourse vegetation.

As defined under the EP Act, mining and petroleum activities undertaken on freehold or leasehold land are interpreted to be exempt from the vegetation management framework. However, these activities must account for impacts to biodiversity. The nature and quality of regrowth vegetation is assessed accordingly, with high value regrowth areas considered in the broader habitat management strategy and impact assessment process. At the time of writing, EHP are introducing Mature Regrowth mapping, which is expected to incorporate HVR mapping however all references to regrowth within this chapter are based upon HVR mapping.

17.1.1.4 Land Protection (Pest and Stock Route Management) Act 2002 (Qld)

The *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act) provides a framework and powers for improved management of weeds, pest animals and the stock route network. The Act provides for designation of threat classes to exotic species which:

- Degrade natural resources;
- Threaten conservation of biodiversity;
- Threaten remnant vegetation;
- Reduce rural production; and
- Interfere with human health and recreational activities.

Exotic species that pose threat under the listed categories are declared under one of the following three categories:

- Class 1 Pest: fauna or flora species that has potential to become a very serious pest in Queensland in the future.

- Class 2 Pest: fauna or flora species has already spread over substantial areas of Queensland, but its impact is considered sufficiently serious to warrant control.
- Class 3 Pest: fauna or flora species that is commonly established in parts of Queensland, but its control by landholders is not warranted unless the plant is impacting, or has potential to impact on a nearby ESA.

The mapping of flora species declared under the LP Act provides a measure of vegetation condition, particularly when applied to non-statutory assessment measures as described in Eyre *et al*. (2006).

17.1.2 Commonwealth Government

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for:

- Identification and listing of species and ecological communities as threatened;
- Development of conservation advice and recovery plans for listed species and ecological communities;
- Development of a register of critical habitat; and
- Recognition of key threatening processes.

If a proponent proposes to undertake an action that will have, or is likely to have, a significant impact on a MNES, it may be deemed a 'controlled action' under the EPBC Act. The Minister for DSEWPaC will decide whether assessment and approval is required under the EPBC Act, and what level of assessment by the commonwealth is appropriate.

17.1.3 Non-statutory Mechanisms

EHP's (formerly Environmental Protection Agency (EPA)) Biodiversity Assessment and Mapping Methodology (BAMM) provides for a consistent state wide approach for the assessment of biodiversity values at the landscape scale in Queensland (EPA, 2002a). The assessment is based largely on vegetation mapping data generated or approved by the Queensland Herbarium, and the methodology is used to generate Biodiversity Planning Assessments (BPAs) for each of Queensland's bioregions, the Brigalow Belt North BPA being relevant to the study area. These assessments are used by EHP staff, other government departments, local governments and/or members of the community to advise a range of planning or decision-making processes. Application of the methodology is used to identify areas of significance solely for biodiversity reasons, including threatened ecosystems or species, large tracts of habitat in good condition, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes.

The *Nature Conservation (Protected Plants) Conservation Plan 2000* (PPCP) outlines how clearing permits, licenses and exemptions can be issued to take protected plants. In Queensland, all plants that are native to Australia are "protected plants" under the NC Act. Under Section 89 of the NC Act, a licence, permit or authority (issued under the NC Act) or an exemption is required to 'take' protected plants. It is an offence to take protected plants including 'least concern' plants, other than under a licence, permit, authority or exemption under the NC Act. Section 29 of the PPCP outlines the restrictions on clearing permits. Arrow Energy and associated companies have an exemption under the PPCP to take plants listed as least concern.

Other non-statutory mechanisms include listings for Weeds of National Significance (WONS) that lists 20 species regarded as posing the greatest threat to a range of Australia's natural values and primary industries (Thorp and Wilson, 2012). Identifying WONS within the study area supplements the broader assessment of vegetation community bio-condition.

17.2 Assessment Methods

17.2.1 Desktop Literature and Database Review

17.2.1.1 Flora Methods

Available literature was reviewed and analysed. It included raw data derived from database searches, information held by agencies and/or individuals, and interpretive reports. Database searches from state and federal 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 be in the Project area. The major databases searched include the following:

- Queensland Herbarium's records system (Herbrecs) (EHP, 2012);
- EHPs REDD (DERM, 2009c);
- EHP WildNet;
- EPBC Protected Matters search tool;
- EHP's RE digital data (DERM, 2009a);
- EHP's HVR digital data (DERM, 2009d);
- Queensland Wetland Data (DERM, 2010a);
- Australia's Virtual Herbarium;
- BPA - Brigalow Belt North (EPA, 2008a); and
- Other literature includes personal communications with relevant personal, such as EHP staff; books; Biosecurity Queensland's predictive and annual pest mapping database (Biosecurity Queensland 2008b). Other sources include technical and impact assessment reports relevant to the Project area including: URS (2011a); and Aecom (2011).

17.2.1.2 Fauna Methods

A desktop review of ecological records, databases and literature relating to vertebrates was undertaken for the Project area (with a 25 km buffer). The major databases and relevant literature searched include the following:

- Queensland Museum collections database (QM);
- Birds Australia Atlas (BA);
- EHP WildNet (WN);
- EPBC Act Protected Matters search tool (EPBC Online);
- EcoSmart Ecology database (ES);
- BAMM;

- Other sources including personal communications with relevant personnel including EHP staff; books; technical reports; Biosecurity Queensland's predictive and annual pest mapping database (Biosecurity Queensland, 2008b);
- AARC (2004) Mckenzie Coal Project;
- AARC (2004) Broadlea Flora and Fauna Study;
- AARC (2008) Carborough Downs Flora and Fauna Study. prepared for McCullum Environmental;
- AARC (2009) North Goonyella flora and fauna works;
- BAAM (2010) Blackwater Power Station Project; Flora and Fauna Habitat Assessment, prepared by Biodiversity Assessment and Management Pty Ltd;
- ESM (2010), Terrestrial Ecological Assessment; Minyango Coal Project, prepared by Ecological Survey and Management for Hansen Bailey Pty Ltd;
- AARC (2011) Dry season terrestrial flora and fauna report; North Mackenzie Project. Prepared by AustralAsian Resource Consultants Pty Ltd for Jellinbah Group Pty Ltd;
- ESM (2011) Bow Energy Blackwater Transmission Line; Ecological Report, Prepared by Ecological Survey and Management;
- ESM (2011) Arrow Bowen Pipeline Terrestrial Fauna Assessment. Prepared by Ecological Survey and Management;
- Matrix Plus (2009) Millenium Coal Flora and Fauna Study, prepared for Peabody Resources;
- RLMS (2011) Environmental Management Plan; Petroleum Lease PL 388, prepared by RLMS for Bow Energy Ltd; and
- URS (2011b) Fauna CSG Field Survey, prepared for Bow Energy.

17.2.2 Habitat Suitability Assessment

Detailed mapping to predict possible habitats for endangered, vulnerable or near threatened (EVNT) species was not undertaken due to significant limitations in the existing dataset, the most problematic of which are described below;

- Field investigation associated with the floristic survey indicate the accuracy of the existing EHP digital dataset (DERM, 2009a) may be as little as 30%, limiting its use to all but the broadest ecological analysis;
- A significant proportion of existing EVNT records are located within non-remnant habitats; and
- Many EVNT records are not accompanied by accurate location coordinates (e.g. WildNet records).

Due to these limitations, mapping potential habitats for EVNT species could be particularly misleading. Rather, a map for ‘known’ EVNT habitats has been produced, which reflects the extent of RE polygons intersected by a record of an EVNT species. This approach is extremely conservative and EVNT habitats are likely to be much more widely distributed than indicated.

17.2.3 Aerial Photo Analysis

A representative area of vegetation within the Project area was selected for detailed mapping review. This area, defined as the 'detailed study area' coincided with an 800 km^2 area of sensitive vegetation to the north of Moranbah, which is subject to future well site development. A review and compilation of hard copy stereographic imagery, both recent and historical, from the Queensland Department of Natural Resources, Mines and Water aerial photographic library was completed to determine the most appropriate image base for vegetation mapping and assessment purposes with the detailed study area. Historical aerial photography was extensively utilised to determine the remnant and EPBC Act status of sensitive vegetation communities as well as broadly indicating past land management practices relevant to an assessment of vegetation condition. Certified RE mapping (DERM, 2009a) was referenced during all stages of stereoscopic assessment to provide a preliminary indication of the limitations of existing mapping as well as assisting the selection of field survey site locations.

17.2.4 Field Survey

17.2.4.1 Field Survey Site Selection

Results of the literature review and the aerial photographic interpretation were used to select patches of remnant and non-remnant vegetation for targeted fieldwork. These patches, which represented most REs known from the Project area, were selected based on an initial assessment of habitat sensitivity and perceived likelihood of exposure to threatening processes. Surveyed sites were thus located within:

- Ecosystems where limited information on condition or structure within the Project area is available;
- Areas identified as possessing, or potentially possessing significant or sensitive vegetation, flora and vertebrate fauna species; and
- Areas with representative examples of remnant vegetation which provide reference condition for a number of sensitive vegetation communities or REs.

The field investigation was conducted over an initial period of 11 days (between 17 and 27 October 2011). Conditions during the field survey were generally mild (26 to 30˚C) with overcast and windy conditions. The ground cover, particularly cover of perennial native grass species, was robust in the majority of field survey locations, a testament to the extent and duration of rainfall during the previous wet season. A second phase of field survey was completed in May (between May 4 and May 20), to allow for seasonal variations in floristic and faunal composition of habitats and species seasonality. The latter survey period is consistent with Neldner *et al.* (2004) as the optimal window for sampling in north Australian savannahs. Where available and relevant, the field survey was supplemented with data collected during unrelated previous works by 3d Environmental and/or EcoSmart Ecology.

17.2.4.2 Vegetation Community Mapping

The detailed assessment was restricted to the detailed study areas where mapping revision was undertaken utilising stereo-photographic images over an area approximating 800 km^2 at a spatial scale of 1:40,000. Polygons were delineated down to 0.5 ha, particularly where EPBC Act listed communities were confirmed to be present. Outside the detailed study area, RE mapping at a scale of

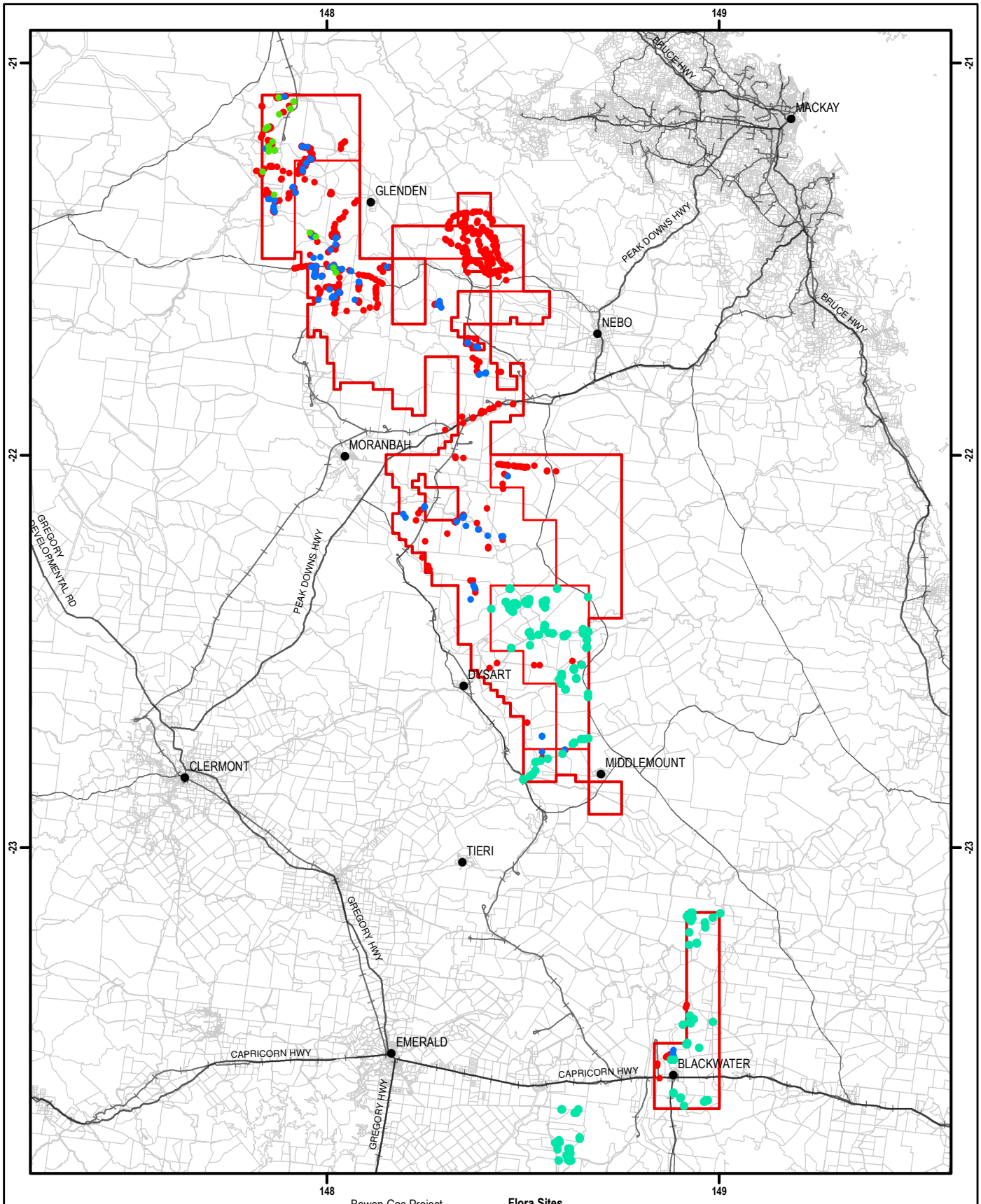
1:100,000 (DERM, 2009a) was utilised as a basis for biodiversity assessment and preliminary sensitivity assessment. It is considered that from detailed assessment of mapping areas, sufficient information would be obtained to allow assumptions in regard to the utility of the existing certified RE mapping to be made and management requirements identified. The sampling scale for remnant vegetation in the detailed study area equates roughly to 1:50,000.

17.2.4.3 Flora Methods

Field survey methods followed Queensland Herbarium standards as identified in Neldner *et al*. (2005) using a combination of formalised secondary, tertiary and quaternary level sampling procedures, as well as informal site observation. Benchmark site data collection followed methods outlined by DERM (2011c). Benchmark and secondary sites were chosen in habitats that presented good examples of a particular vegetation community or RE, particularly where ground strata was particularly diverse and diagnostic (e.g. natural grasslands). Tertiary sites were utilised to confirm the structural attributes of site vegetation in habitats that had previously been assessed by secondary method in other locations. Quaternary sites were established for the primary purpose of RE validation, often in locations where ground searches for EVNT species were undertaken.

Details of secondary, tertiary and quaternary survey methodologies are provided within the Terrestrial Ecology Technical Report (Appendix P) of this EIS.

Six hundred and thirty-two floristic survey sites are recorded across the Project area comprising 102 secondary, 20 tertiary and 510 quaternary sites, a large number of these sites collated from previous recent studies. The majority of the sites were collected from within the Project area, however some sites external to the Project area were included, as they provide a useful reference to a number of significant habitat types. Full benchmark site data was collected from 10 of the secondary survey sites to assist with future habitat offsetting requirements. In addition, 47 tertiary survey sites and 81 quaternary sites were recorded within the Project area in studies undertaken by URS (2011a). These sites are also considered to contribute to the assessment. The location of floristic survey sites is shown in Figure 17-1. A summary of survey sites including structural and floristic information is provided in the Terrestrial Ecology Technical Report (Appendix P) of this EIS.



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BOWEN GAS PROJECT EIS

FLORA SURVEY LOCATIONS

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Figure: 17-1

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17.2.4.4 Fauna Methods

Assessment of faunal habitat values and species presence was undertaken in representative habitats across the Project area concurrently with the floristic survey team. At each survey location a number of non-trapping survey methods were used, and habitats were evaluated for their potential for EVNT species. This data was used to refine mapping and highlight any trends between vegetation community and EVNT fauna species potential. At each location, the assessments described below were undertaken.

17.2.4.4.1 Habitat Assessment

Habitat assessments were used to evaluate important ecological features that contribute to fauna values including, but not limited to:

- Quality and type of ground cover, such as thick grass, woody debris, rocks and soil cracks;
- Abundance of hollows;
- Abundance of food resources such as fruit, flowers and seeds;
- Abundance of suitable roosting and sheltering habitat, including caves and fissures;
- Water sources or possibility for pooling surface water (e.g. gilgai);
- Canopy cover, extent and height;
- Vegetation structure, density and complexity;
- Disturbance regimes; and
- Edge effects.

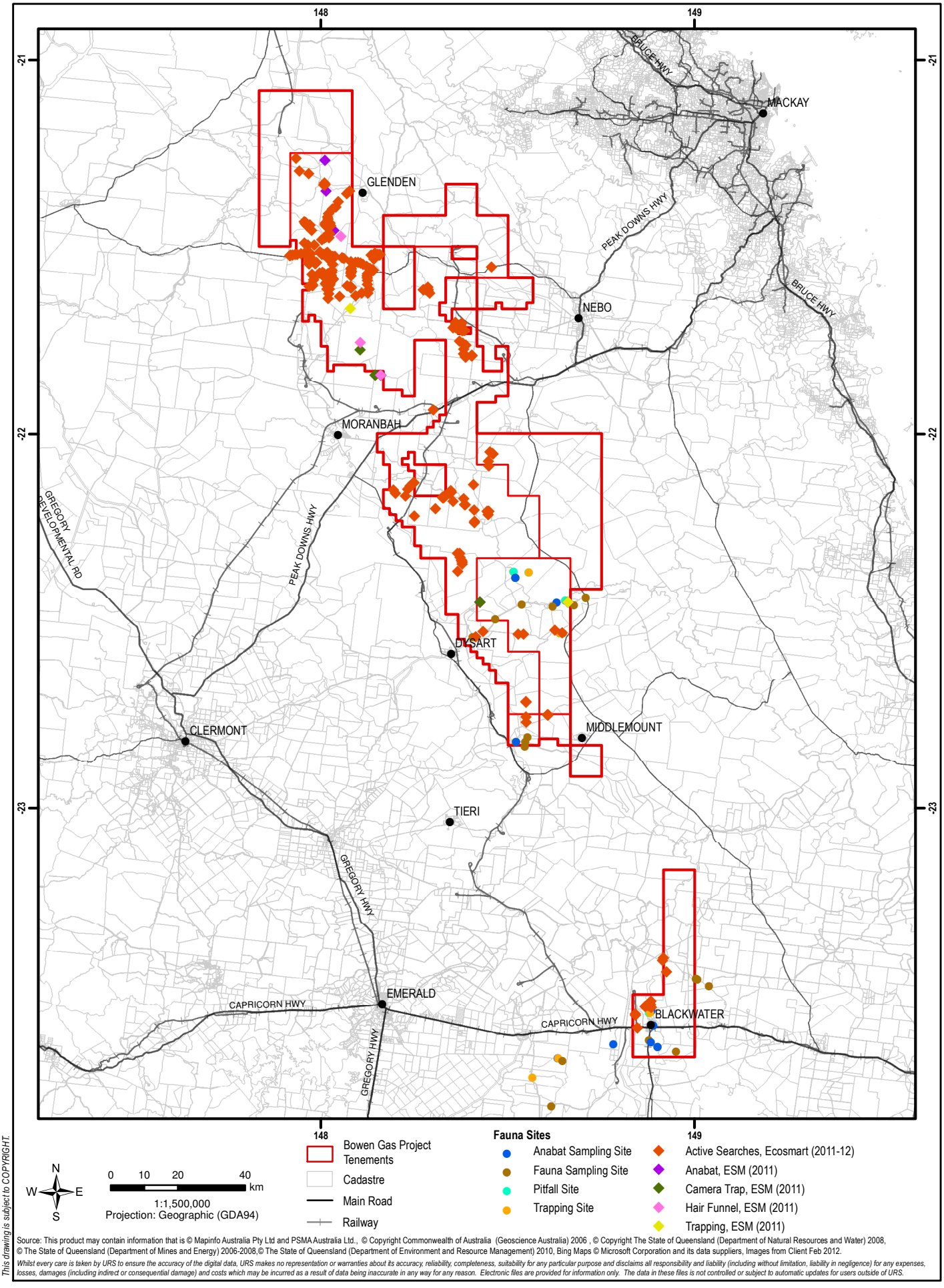
An assessment on the value of the habitat for individual EVNT fauna species was made on the basis of the above observations and known EVNT habitat requirements.

Bird surveys were conducted using both aural and visual survey methods to determine the species present. Habitats which might be utilised by EVNT species (e.g. wetlands and dams) were specifically investigated.

Habitat searches for amphibians, small mammals, and reptiles included log / rock rolling, inspecting exfoliating bark and raking through leaf litter. Scats, tracks and traces, including droppings and claw marks were recorded. This method is particularly useful for assessing the presence of koalas.

Incidental observations were made in relation to terrestrial vertebrates throughout the survey. Locations where potentially important fauna values were recognised were geospatially recorded for later use in impact assessment and mapping.

A total of 334 sites have been assessed for fauna composition including 260 sites subject to active fauna searches during this study with a further 39 sites subject to formalised trapping techniques and 35 sites subject to fauna observation recorded in recent associated studies (EMS, 2011; URS, 2011b). The location of fauna survey and trapping sites in the Project area are shown in Figure 17-2. It should be noted that sites identified as ‘active search’ generally utilised all, or a number of the above techniques dependent on the habitat type and particular species targeted.



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FAUNA SURVEY LOCATIONS

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Figure: 17-2

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17.2.4.5 Data Analysis and Species Likelihood Assessment

Data from the desktop review and field based survey for both flora and fauna was analysed and a list of threatened species, ecological communities and sensitive REs considered relevant or potentially relevant to the Project was compiled. A 'likelihood of occurrence' assessment was undertaken based on available records, known species and habitat distribution, and habitat suitability. For those species or habitats considered known or likely to occur within the Project area, profiles were constructed from available information detailing:

- Known distribution or extent, both within the study area and broader region;
- Specific ecology including habitat requirements and preferences;
- Specific risks or threats to the species or habitat; and
- Any specific information obtained from the desktop or field survey in regard to habitat condition and population trends.

Profiles, presented in the Terrestrial Ecology Technical Report (Appendix P of this EIS) form the basis for impact assessment.

17.2.5 Impact Assessment Methods

The assessment of ecological impacts undertaken in this study draws from both extensive desktop investigation as well as the targeted field assessments. It should be noted that although quantification of impacts is not provided, this qualitative assessment defines the sensitivity of ecological values within the Project area, predicts the significance of impacts to those values prior to implementation of management procedures (preliminary impact), and predicts the significance of impacts following thorough implementation of recommended management actions (residual impact).

17.2.5.1 Approach to Impact Significance Assessment

The approach used to assess impact significance considers the sensitivity of the ecological value to impact (both direct and indirect impact) as well as the predicted magnitude of the impact. The implementation of this approach aims to reduce the subjectivity of standard risk assessment procedures, which consider impact likelihood and impact consequence. The approach adopted is conservative in nature and assumes:

1. That the identified impacts will occur; and
2. Proven mitigation measures will be utilised and applied successfully.

Mitigation measures which have not been tested or are not known to be successful are indicated where appropriate when they are applied to individual species or habitat (see the Terrestrial Ecology Technical Report (Appendix P of this EIS)). Scope is allowed to identify those species, which are considered by their ecology and habit, to be amenable to a particular mitigation method (e.g. translocation) even though the effectiveness of this mitigation method has not been practically tested.

17.2.5.1.1 Sensitivity of Ecological Values

The sensitivity of ecological values considers a number of criteria including but not limited to:

- The legislative status (conservation status) of an ecological value;
- The intactness of an ecological value;
- The rarity of an ecological value;
- The resilience of an ecological value to cope with change;
- The ability of an ecological value to recover from an impact; and
- The potential for any losses of the ecological value to be replaced with an equivalent example.

Communities and species protected by legislation have been determined to be declining in either extent or abundance, and further loss of any population is contrary to fundamental conservation principles. Sensitivity definitions provided in Table 17-1 therefore have a bias towards the sensitivity of populations rather than individuals. However, some scope has been included to assess those individual species that appear to be abundant in Queensland despite their status.

Table 17-1 Sensitivity ranking definitions

Sensitivity Ranking	Descriptor
Not Sensitive	No short-term or long-term Project impacts are likely to adversely affect the population / community, or the population / community may benefit from the Project (e.g. coloniser species) and is resilient to changes in habitat structure or condition. The species is not considered threatened under state or federal legislation. Impacted habitats may have a low degree of intactness due to previous disturbance regimes.
Low Sensitivity	The community / species is not listed as threatened under legislation and has a high resilience to Project related impacts. Short-term impacts may occur but are unlikely to cause local extinction. The community / species is resilient to change, able to quickly recover, and no long-term impact is expected on abundance, extent or integrity. Impacted habitats may be have a low degree of intactness due to previous disturbance regimes. or The species is not listed as threatened under legislation and has a moderate resilience to disturbance. Short-term impacts (over one to two generations) may lead to a loss of abundance or extent, but are unlikely to cause local extinction. The species can recolonise or recruit and only minor long-term impacts are expected on the abundance, extent and integrity of the community / population. The community / species is well represented in the bioregion and state (not applicable to critically endangered, endangered or vulnerable values).
Moderate Sensitivity	The species is listed as near threatened or threatened under relevant state or federal legislation but has a moderate resilience to disturbance. Short-term impacts (over one to two generations) may lead to a loss of abundance or extent, but are unlikely to cause local extinction. The species can recolonise or recruit and only minor long-term impacts are expected on the abundance, extent and integrity of the community / population. The community / species is rare or uncommon but widely distributed throughout the state, or may be common and largely restricted to the bioregion.
High Sensitivity	The species is listed as threatened under state or federal legislation and has a 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 community / population. The community / species regenerates / recolonises with difficulty after disturbance. The community / species is rare but widespread outside the Project area within the broader bioregion. Habitats typically demonstrate a high degree of intactness or integrity.

Sensitivity Ranking	Descriptor
	or The species is listed as threatened under state or federal legislation and has a moderate resilience to disturbance. Short-term impacts may lead to a loss of abundance or extent, but are unlikely to cause local population extinction. The species is able to recolonise or recruit and only minor long-term impacts are expected on the abundance, extent and integrity of the community / population. The community / species may occur outside the Project area, but core populations and/or known distribution are heavily centred on the Project area. Habitats typically demonstrate a high degree of intactness or integrity.
Extreme sensitivity	The species / population is listed as threatened, endangered or critically endangered under state or federal legislation and has low resilience to disturbance. Impacts may or are likely to lead to the long-term extinction of a local community / population. Natural recruitment or colonisation would not replace or restore the community / population within several generations. Habitats typically demonstrate a high degree of intactness and may represent benchmark condition in reference to examples of the habitat across its broader range.

17.2.5.1.2 Magnitude of Impact

The magnitude of an impact on a specific ecological value has been assessed in accordance with:

- The geographical extent of an impact, with particular reference to:
  - The relative importance of a habitat to the survival of a population; and
  - The proportion of an ecological value relative to its local, bioregional, state-wide or national extent.
- The duration of an impact whether it be short term (months), medium term (years) or long term (decades); and
- The severity of an impact, being the degree of change from existing condition considered in relation to the impact extent.

Summary definitions of impact magnitude are provided in Table 17-2 below.

Table 17-2 Impact Magnitude Ranking Definitions

Magnitude Ranking	Description
Extremely Low Magnitude	The impact is restricted to a local population and impacts do not extend beyond the direct impact footprint. The impact will be difficult to detect when the source of impact is removed.
Low Magnitude	The impact is restricted to a local population and impacts do not extend beyond the area of direct impact. The impact will be detectable although recovery will occur in the short term (months) without the risk of long term impacts to the local population.
Moderate Magnitude	The impact may extend beyond the immediate boundary of disturbance although is contained within a regional population. Impacts are short term and it is feasible to manage local impacts with species / population specific management protocols or actions.
High Magnitude	An impact extends beyond the area of a local population and may affect an entire bio-regional population or species. Impacts are medium to long term and impact management procedures do not rapidly reverse the impact.

Magnitude Ranking	Description
Extremely High Magnitude	An impact extends to an entire population or group of populations whether this be at a national, regional or local level. Impact management procedures have not been tested or provide limited impact amelioration and there is limited potential for the population to recover once the disturbance has been removed.

17.2.5.1.3 Significance of Potential Impacts

The significance of an ecological impact is derived from the risk matrix, provided in Table 17-3, being 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 17-4.

17.2.5.2 Impact Management

Mitigation measures are applied to alleviate Project impacts to ecological values as well as reduce the magnitude of ecological impact. As many impacts may reinforce each other or accumulate, a variety of impact mitigation measures may be recommended for management of a particular ecological value. It must be noted that the effectiveness of chosen mitigation measures must be certain prior to application. Without evidence providing certainty for the effectiveness of a proposed mitigation technique, the precautionary principle is applied and the lowest level of mitigation effectiveness is assumed. Further research to test the effectiveness of a potential mitigation measure must be undertaken prior to implementation. In many situations, complete removal of all environmental impact may not be possible and some residual impact will remain after implementing the mitigation measures. Whilst avoidance is the preferred mitigation measure in all cases, it may be the only practical mitigation measure where the impact of an activity is assessed to be of ‘high‘ or ‘extremely high‘ significance.

17.2.5.3 Residual Impact Significance Estimation

Residual impact evaluation identifies those impacts associated with the broad impacts of the Project construction, operational phases and decommissioning. It considers impacts known to be associated with the Project, or may draw from case studies associated with similar operations. The residual impact evaluation considers impacts remaining following implementation of management / mitigation procedures. Therefore, the residual impact assessment is based on the assumption that the sensitivity of the ecological value does not change, but the magnitude of the impact does. Reducing ecological impact by avoiding important habitat (i.e. infrastructure placed in low quality habitat) is the most effective mitigation measure. In the majority of cases, if sensitive habitats are avoided altogether, other mitigation measures will not be necessary. Habitat avoidance is therefore identified as a mitigation measure independent of other mitigation measures, although in reality a variety of methods are likely to be used through operational stages of the Project.

Table 17-3 Significance Assessment Matrix for Terrestrial Ecology

		Ecological Sensitivity				
		Extremely Sensitive	**Highly Sensitive**	**Moderately Sensitive**	**Low Sensitivity**	**Not Sensitive**
Impact Magnitude	**Extremely High Magnitude**	Extremely High	Extremely High	High	Moderate	Moderate
	High Magnitude	Extremely High	High	Moderate	Moderate	Low
	Moderate Magnitude	High	Moderate	Moderate	Low	Low
	Low Magnitude	Moderate	Moderate	Low	Low	Insignificant
	Extremely Low Magnitude	Moderate	Low	Low	Insignificant	Insignificant

Table 17-4 Impact Significance Ranking Definitions

Significance Ranking	Descriptor
Insignificant	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.
Extremely High Significance	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. Avoidance is considered the only effective mitigation

17.3 Existing Environment and Ecological Values

17.3.1 Vegetation Communities and Regional Ecosystems

17.3.1.1 Overview of Landscape and Vegetation

Geologically, the Project area is diverse. Its northern portion is characterised by a series of variably dissected lateritic plateaus, underlain by Carboniferous age basalt. Between escarpments, the basalt manifests as broad undulating plains formed with cracking clay soils (vertosols). Southwards towards Moranbah, the basalts give way to deeper Cainozoic clays, silts and sands and the breakaways are higher, more pronounced and formed by quartzose sandstones. In the southern portion of the study area, to the south of Dysart and Blackwater, the clay plains are broader, more extensive and the lateritic breakaway plateaus more widely dispersed. The characteristically broad, discontinuous floodplains and associated tributaries of the Isaac River in the north and Mackenzie River in the south provide a source for the major alluvial landforms in the Project area. In the far south of the Project area, towards Blackwater, the relictual sandstone plateau of the Blackdown Tableland intrudes, although insignificantly, into the study area.

Only 40% of vegetation in the Project area retains remnant status. The majority of this remnant vegetation persists on the breakaway scarps, escarpments and plateaus that are historically less amenable to land development. Open forests of lancewood (*Acacia shirleyi*) characterise the steeper breakaways and escarpments although mix with eucalypt dominant woodland and open forest comprising species, which include ironbark (*Eucalyptus crebra*, and *Eucalyptus xanthoclada*), Gympie messmate (*Eucalyptus cloeziana*), brown bloodwood (*Corymbia trachyphloia*), spotted gum (*Corymbia citriodora*) and Clarkson's bloodwood (*Corymbia clarksoniana*). Small patches of vine thicket are also associated with breakaway areas, as well as basaltic landforms in the northern portion of the Project area.

The brigalow forest that was once characteristic of clay plains in the Project area has suffered severely the impacts of land clearing, fragmentation and attrition, as it has for the broader Brigalow Belt North Bioregion. With the exception of a few better-preserved remnants, brigalow now persists in the landscape as scattered fragments and disturbed regrowth. Severe fragmentation has also affected eucalypt woodland habitats associated with clay plains. However, better-preserved vestiges can still be located on a number of properties in the northern and central portions of the study area where land disturbance has not been excessive.

In a better state of preservation are habitats associated with basaltic landforms that are extensive to the north of Moranbah. The basaltic plains form the substrate to an extensive, relatively intact belt of natural grassland and woodland habitat. The natural sparseness of trees in the landscape has assisted the preservation of these habitats, meaning that mechanical clearing of trees was not necessary. The native pastures were also particularly amenable to grazing and did not require intervention or introduction of exotic species to be productive. Gradual and pervasive alteration of these habitats is however an ongoing process with exotic grasses including Indian couch (*Bothriochloa pertusa*), buffel grass (*Pennisetum ciliare*) and purple pigeon grass (*Setaria incrassata*)

becoming established in areas that have been subject to more pronounced grazing pressure and recent disturbance.

17.3.1.2 EPBC Act Threatened Ecological Communities

A search of the EPBC Act database (DSEWPaC, 2012) (database extract included in the Terrestrial Ecology Technical Report (Appendix P of this EIS)) for the Project area indicates the potential presence of the following five threatened ecological communities (TECs):

1. *Brigalow (*Acacia harpophylla *dominant and co-dominant)* (endangered) (herein referred to as the Brigalow Ecological Community);
2. *Natural grasslands of the Queensland Central Highlands and Northern Fitzroy Basin*. (endangered) (herein referred to as the Natural Grasslands Ecological Community);
3. *Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions* (endangered) (herein referred to as the Semi-evergreen Vine Thicket Ecological Community);
4. Weeping Myall Woodlands (endangered); and
5. *Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions* (endangered) (herein referred to as the Coolibah – Black Box Woodland Ecological Community).

Of these communities, the Brigalow Ecological Community, Natural Grasslands Ecological Community and the Semi-evergreen Vine Thicket Ecological Community are confirmed through field survey as being present in the Project area. The Weeping Myall Ecological Community possibly occurs although has not been confirmed and the Coolibah – Black Box Woodland Ecological Community is considered unlikely to occur based on its known distribution. The extent, distribution and condition of these communities are discussed briefly below with detailed information for each ecological community provided in the Terrestrial Ecology Technical Report (Appendix P of this EIS). Spatial representation of these communities based on DERM (2009a) is provided in Figure 17-3 with distribution in the detailed study area provided in Figure 17-4.

Brigalow Ecological Community (endangered): relatively common in the study area. Based on existing mapping (DERM 2009a), 21,799 ha of this habitat occurs in the Project area. The ecological community is represented in the Project area by REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16. The habitat also includes advanced brigalow regrowth communities determined as being older than 15 years old as per guidelines of Environment Australia (2001b). High Value Regrowth containing endangered REs (as per DERM, 2009c) may be included within this classification, although field observation questions the reliability of this dataset for the purpose.

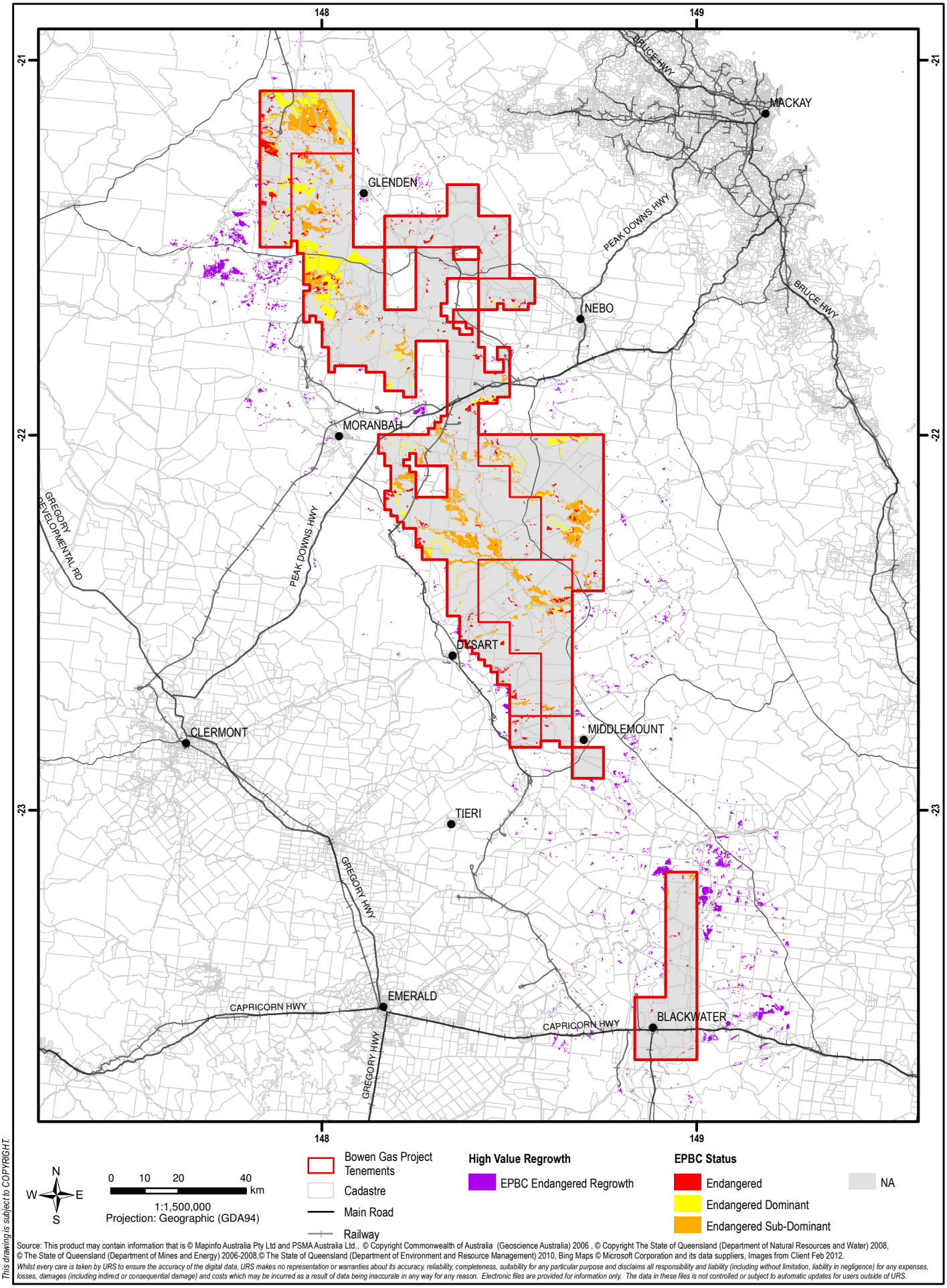
Natural Grasslands Ecological Community (endangered): This is an extensive habitat occupying 18,032 ha in the Project area based on mapping provided by DERM (2009a). The most extensive occurrence runs in a broad east-west trending belt between Glenden and Moranbah in the north of the Project area, however fragmented remnants persist throughout the landscape in the broader study area. As per TSSC (2008a), the habitat can be described within two conditions classes; 'best quality' and 'good quality', with 'best quality' habitats being relatively common in the less fragmented field investigation areas. Mapping provided by DERM (2009a) regularly represents natural grasslands as a heterogeneous mix of grassland and woodland habitats (a mix of REs 11.8.11 and 11.8.5). These

habitats have been differentiated in the detailed study area (see Figure 17-4) to provide more a useful spatial representation of ecological constraints.

Semi-Evergreen Vine Thicket Ecological Community (endangered): Relatively extensive areas of vine thicket habitat are mapped in certified RE mapping in the northern portion of the Project area, where they are represented by REs 11.5.15, 11.8.3 and 11.8.13 (DERM, 2009a). Field examination confirmed the presence of these habitats, although they are by no means as extensive as represented in the certified mapping. A considerable portion of habitat currently represented as RE11.8.13 (DERM, 2009a) was found to occupy lateritic escarpments and be consistent with RE 11.7.1x1, a non-EPBC Act significant community. Despite this, good quality examples of vine thicket were surveyed on basaltic terrains north of Newlands Mine consistent with RE 11.8.3.

Weeping Myall Woodlands (endangered): The distribution of the Weeping Myall Woodland Ecological Community as provided by the Department of Environment, Water, Heritage and the Arts (DEWHA, 2009c) (now DSEWPaC) ranges from 100 km north of Clermont, southwards with the eastern-most limit of the ecological community co-inciding roughly with the western boundary of the Project area. With the exception of a small area extending to approximately 75 km north of Blackwater, the ecological community is not expected to occur within the Project area. Field survey within 'at risk' areas did not locate the ecological community although it there is potential for it to occur as small patches within REs 11.3.2 and 11.3.28 (TSSC, 2008d). Further scrutiny of these REs, particularly RE11.3.2, which is known to occur in the Project area, is required when working within areas potentially hosting the ecological community.

Coolibah – Black Box Woodlands Ecological Community (endangered): restricted to the Brigalow Belt South Bioregion (TSSC, 2011). This bioregion forms an extremely minor intrusion into the south-western portion of the Project area where habitats are associated with the slopes of the Blackdown Tableland. Hence, in the absence of floodplain vegetation, the Coolibah – Black Box Ecological Community is not expected to occur within the Project area.



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BOWEN GAS PROJECT EIS

EPBC VEGETATION COMMUNITIES (EHP DATA)

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Figure: 17-3

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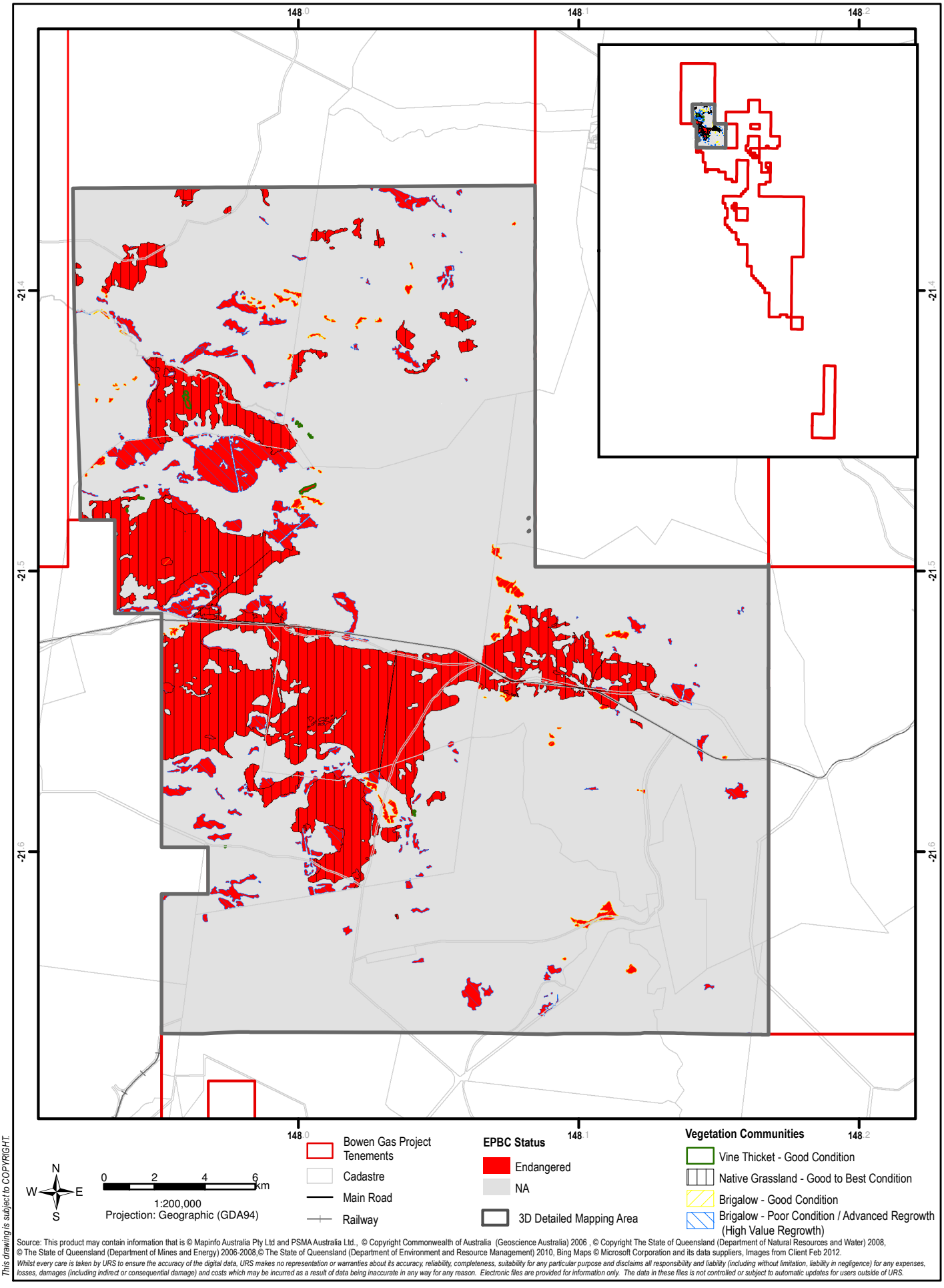

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BOWEN GAS PROJECT EIS

EPBC VEGETATION COMMUNITIES (3D DATA)

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Figure: 17-4

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17.3.1.3 Regional Ecosystems

17.3.1.3.1 *Accuracy of the Existing Regional Ecosystem Mapping (DERM, 2009a)*

Of the 632 floristic survey sites established within the Project area, only 224 (or 35%) correspond with the mapped RE in the certified data (DERM, 2009a), allowing for heterogeneous polygons that may contain up to four RE components. There may be a number of reasons contributing to this inaccuracy including the spatial scale of the DERM data (1:100,000 scale). It does however indicate the inherent danger in reliance on the DERM dataset for fine scale planning purposes. A revision of mapping in the detailed study area, produced and field surveyed at 1:50,000 scale, provides a much more reliable base for ecological planning (see Figure 17-4). It does not however negate the need for further ground survey when locating infrastructure in the detailed survey area. Mitigations to alleviate the risks associated with mapping inaccuracies are provided in the subsequent sections.

17.3.1.3.2 Regional Ecosystems in the Project Area

Based on certified RE mapping (DERM, 2009a), remnant vegetation totals 306,371 ha (40% of the Project area). This comprises 32,071 ha with a biodiversity status of ‘endangered’, 95,186 ha with a biodiversity status of ‘of concern’ and 178,276 ha with a biodiversity status of ‘no concern at present’. The balance of 461,021 ha of non-remnant vegetation comprises mostly cleared pastoral and grazing land. A total of 78 REs (excluding RE sub-types) are mapped within the Project area including representation of 18 ‘endangered’ REs (biodiversity status) with 20 listed as ‘of concern’. Two threshold REs (being those in danger of falling below 30% of their pre-clearing extent) are also recognised. No ‘critically limited’ REs as per DERM (2011a) are known to occur in the Project area.

REs within the Project area are discussed further in the Terrestrial Ecology Technical Report (Appendix P of this EIS) and a summary of those ecosystems significant to impact assessment is provided in Table 17-5. Spatial representation of the biodiversity status of REs in the Project area based on DERM (2009a) is provided in Figure 17-5. REs with an ‘of concern’ or ‘endangered’ biodiversity status are considered susceptible to degradation and are governed by the EP Act and associated regulations.

Table 17-5 Regional Ecosystems Present or Potentially Present within the Project Area

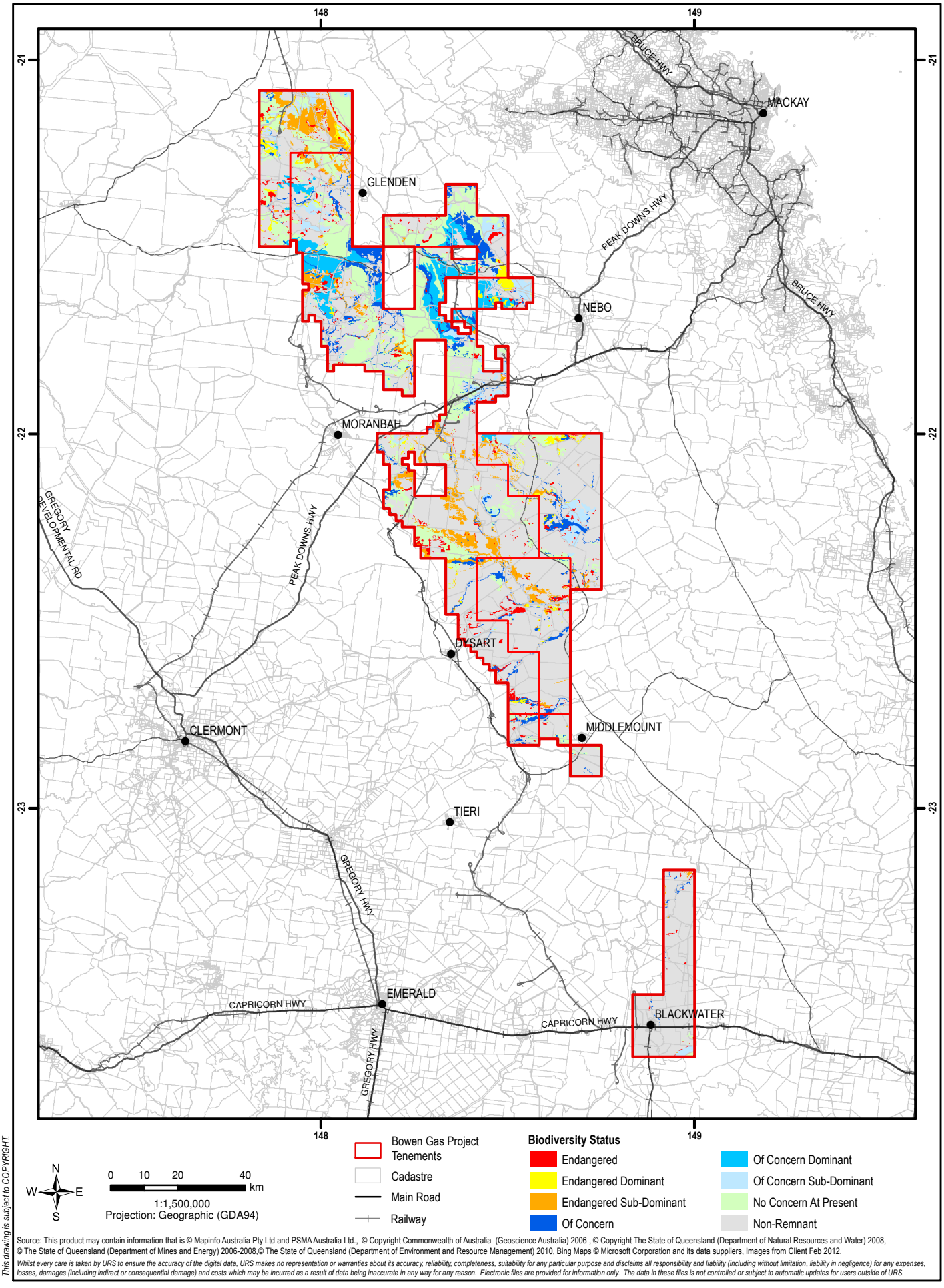
RE	Bio Status	VM Act Status	EPBC Act Status	EPBC Comm.*	Study Area DERM	Detailed Study Area (3d ENV)	Detailed Study Area (DERM)	Area in Bioregion**	Area in National Park**	Area in Cons. Reserve**	Area in State Forest and Forest Reserve**
11.3.1	E	E	E	1	4,061	11	100	80,679	9,920	105	207
11.3.11	E	E	E	3	24	0	2	2,416	572	0	29
11.3.21	E	E	E	2	461	0	0	54,459	150	3	43
11.4.1	E	E	E	3	24	0	0	2,312	1,333	0	55
11.4.7	E	E	E	1	4	0	0	20,886	137	0	140
11.4.8	E	E	E	1	1,822	0	33	71,909	2,452	174	4,347
11.4.9	E	E	E	1	9,083	0	397	96,425	4,426	558	3,633
11.4.13	E	LC	NA	NA	3,996	0	0	12,128	0	0	1
11.5.15***	E	LC	E	3	1,193	<1	429	14,995	0	66	1,726
11.5.16	E	E	E	1	190	81	0	3,027	0	0	78
11.5.17	E	E	NA	NA	72	0	0	1,473	7	0	307
11.8.13	E	E	E	3	2,211	24	843	6,327	140	5	238
11.8.15	E	E	NA	NA	370	0	254	1,906	0	0	0
11.9.1	E	E	E	1	1,360	0	0	55,195	4,471	0	2,460
11.9.4	E	E	E	3	686	0	0	33,883	6,686	25	2,866
11.9.5	E	E	E	1	5,236	254	605	168,841	20,800	240	11,002
11.9.10	E	OC	NA	NA	1,235	0	0	83,507	6,166	51	756
11.11.18	E	E	E	3	43	0	0	4,518	3	0	54
11.3.2	OC	OC	NA	NA	25,114	571	6,444	528,081	8,119	45	39,437
11.3.3	OC	OC	NA	NA	1,983	13	0	282,541	5,807	358	269
11.3.4	OC	OC	NA	NA	7,445	341	647	186,652	3,260	94	16,364

RE	Bio Status	VM Act Status	EPBC Act Status	EPBC Comm.*	Study Area DERM	Detailed Study Area (3d ENV)	Detailed Study Area (DERM)	Area in Bioregion**	Area in National Park**	Area in Cons. Reserve**	Area in State Forest and Forest Reserve**
11.3.6	OC	LC	NA	NA	496	0	0	29,336	1,977	0	1,136
11.3.7	OC	LC	NA	NA	2,718	0	0	59,550	1,212	111	79
11.3.25	OC	LC	NA	NA	14,904	615	1594	515,267	7,527	450	21,427
11.3.27	OC	LC	NA	NA	946	0	14	49,875	613	1,366	197
11.3.36	OC	OC	NA	NA	97	0	0	8,200	67	0	0
11.4.2	OC	OC	NA	NA	3,641	0	168	34,728	471	0	364
11.4.4	OC	LC	E	2	1,642	0	0	24,917	0	0	0
11.4.11***	OC	OC	E	2	<1	0	0	23,372	200	0	0
11.5.18	OC	OC	NA	NA	243	0	26	3,894	0	0	303
11.7.1	OC	LC	NA	NA	312	2	0	78,759	2,359	0	4,062
11.8.3***	OC	OC	E	3	1,033	0	0	26,458	2,584	184	641
11.8.11	OC	OC	E	2	13,827	9,581	10,700	176,127	727	0	203
11.8.14	OC	OC	NA	NA	40	0	0	519	0	0	0
11.9.3	NCAP	LC	E	2	2,103	0	0	151,166	207	0	35
11.9.7	OC	OC	NA	NA	18,873	552	923	109,286	650	0	2,824
11.9.13	OC	OC	NA	NA	1,215	0	90	20,332	243	0	5,710
11.10.8	OC	OC	NA	NA	656	36	0	8,375	992	19	1,012
11.11.13	OC	OC	NA	NA	0	0	0	53,290	1,073	0	27
11.11.16	OC	OC	NA	NA	0	0	0	23,254	421	0	1,169
11.3.9	NCAP	LC	NA	NA	0	0	0	64,239	168	0	930
11.3.10	NCAP	LC	NA	NA	53	0	0	168,912	1,343	0	14

RE	Bio Status	VM Act Status	EPBC Act Status	EPBC Comm.*	Study Area DERM	Detailed Study Area (3d ENV)	Detailed Study Area (DERM)	Area in Bioregion**	Area in National Park**	Area in Cons. Reserve**	Area in State Forest and Forest Reserve**
11.3.12	NCAP	LC	NA	NA	3	0	0	28,957	124	0	0
11.3.35	NCAP	LC	NA	NA	263	0	0	111,178	1,143	0	381
11.3.37	NCAP	LC	NA	NA	69	0	0	30,497	469	0	14
11.5.2	NCAP	LC	NA	NA	2,053	0	0	191,075	6,583	0	47,793
11.5.3	NCAP	LC	NA	NA	52,085	3,787	7,096	388,531	4,243	0	10,230
11.5.8	NCAP	LC	NA	NA	1,457	0	0	63,037	825	0	100
11.5.9	NCAP	LC	NA	NA	6,808	5,263	0	243,365	4,014	0	27,464
11.5.12	NCAP	LC	NA	NA	1,203	1,916	555	56,261	199	0	447
11.7.2	NCAP	LC	NA	NA	11,743	460	424	371,031	4,486	0	25,221
11.7.3	NCAP	LC	NA	NA	1,128	0	0	91,623	629	0	0
11.7.4	NCAP	LC	NA	NA	775	0	0	224,015	458	0	72,934
11.7.5	NCAP	LC	NA	NA	4	0	4	63,003	1,401	0	25,011
11.7.6	NCAP	LC	NA	NA	0	808	0	338,165	1,442	0	176,863
11.8.4	NCAP	LC	NA	NA	426	0	0	1,518	45,859	0	7,528
11.8.5	NCAP	LC	NA	NA	21,046	2,883	4,771	348,922	25,068	0	5,013
11.9.2	NCAP	LC	NA	NA	18,415	34	898	145,973	16,315	0	3,618
11.9.3	NCAP	LC	NA	NA	2,104	0	0	160,125	208	0	35
11.9.9	NCAP	LC	NA	NA	19,705	1,128	1,003	122,100	4,102	0	10,405
11.10.1	NCAP	LC	NA	NA	2,255	0	0	879,932	101,382	0	277,597
11.10.3	NCAP	LC	NA	NA	3,569	0	2,713	333,577	25,538	0	27,730
11.10.4	NCAP	LC	NA	NA	12,375	1,996	2,511	472,687	74,085	0	49,160

RE	Bio Status	VM Act Status	EPBC Act Status	EPBC Comm.*	Study Area DERM	Detailed Study Area (3d ENV)	Detailed Study Area (DERM)	Area in Bioregion**	Area in National Park**	Area in Cons. Reserve**	Area in State Forest and Forest Reserve**
11.10.5	NCAP	LC	NA	NA	70	0	0	26,864	22,074	0	3,161
11.10.7	NCAP	LC	NA	NA	8,564	0	213	282,627	8,368	0	41,189
11.10.12	NCAP	LC	NA	NA	4,032	0	0	47,725	32	0	3,022
11.10.13	NCAP	LC	NA	NA	0	2,729	0	391,474	72,839	0	137,144
11.11.1	NCAP	LC	NA	NA	5,245	0	0	161,592	10,675	0	38,469
11.11.9	NCAP	LC	NA	NA	353	0	0	54,609	700	0	397
11.12.1	NCAP	LC	NA	NA	1,592	0	0	854,829	23,989	0	41,017
11.12.2	NCAP	LC	NA	NA	25	0	0	190,781	1,264	0	7,493
11.12.3	NCAP	LC	NA	NA	705	0	0	53,793	1,596	0	3,459
11.12.4	NCAP	LC	NA	NA	151	0	0	56,853	10,994	0	4,311

All areas in hectares (ha)
Bio Status: E = Endangered; OC = Of Concern, NCAP=No Concern at Present, **VM Act Categories:** E = Endangered; OC = Of Concern, LC=Least Concern,
EPBC Act Categories: E = Endangered; NA = Not Applicable.
* EPBC Act community description listed as per 17.3.1.2**.**
** Data sourced from Accad *et al* (2008).
*** Threshold REs (In danger of falling below 30 % pre-clearing extent).



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BIODIVERSITY STATUS (EHP DATA)

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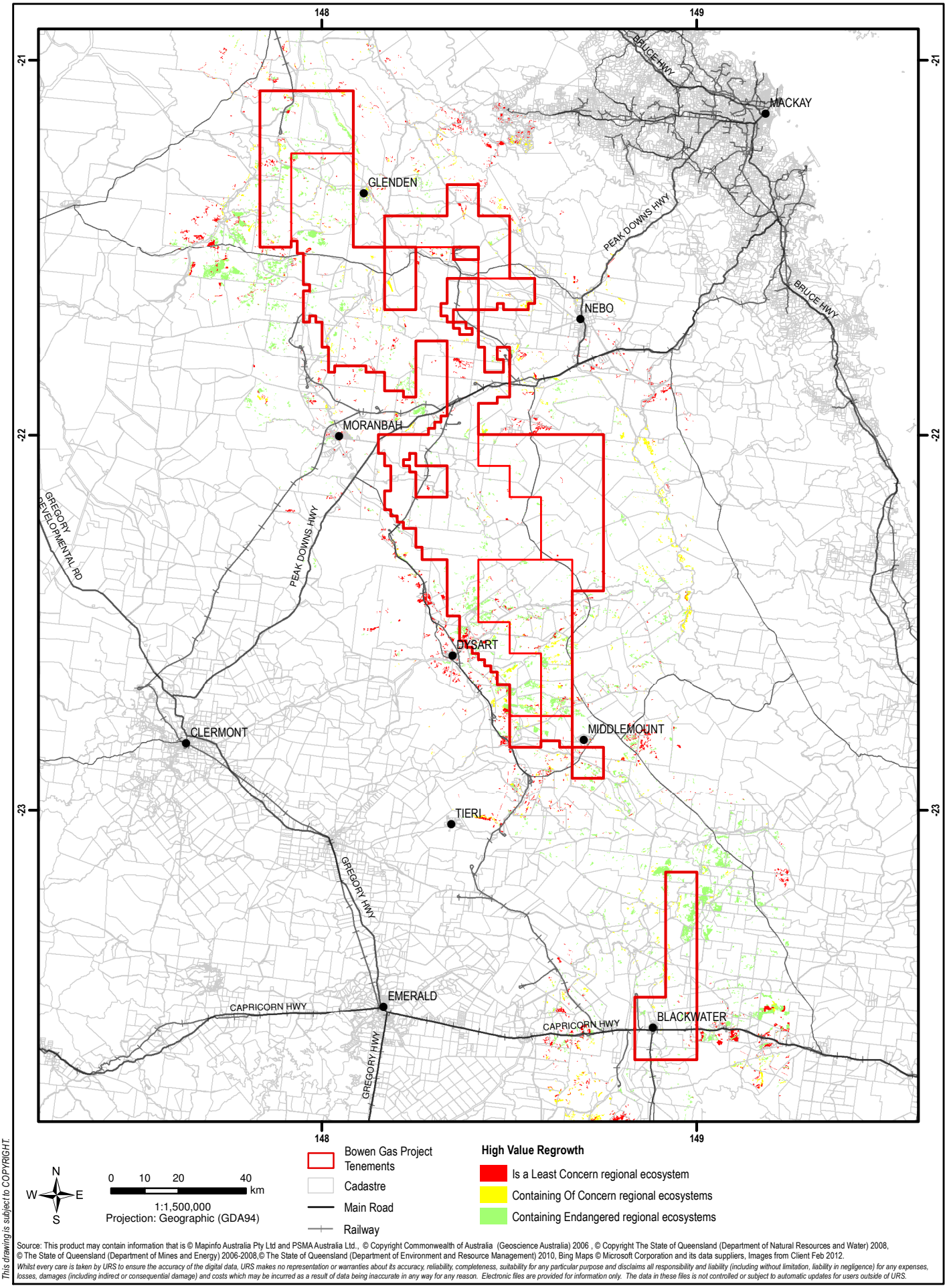
17.3.1.4 Non-remnant and Regrowth Habitats with Conservation Value

High Value Regrowth (HVR) mapping (DERM, 2009d) is shown in Figure 17-6. Across the Project area, HVR containing 'endangered' REs is shown as a scattering of minor fragments and slivers amongst more extensive areas of regrowth containing 'of concern' and 'least concern' REs. Ground examination of areas mapped as HVR containing 'endangered' REs suggests that the HVR mapping can be used as a general guide to regrowth distribution only. In ground locations examined, many of these regrowth habitats are poorly developed, often with a development age of less than five years, or comprising stunted, widely spaced and often dead shrubs.

A more precise representation of disturbed brigalow habitats that meet the requirements of HVR within the detailed study area has previously been provided in Figure 17-4 with HVR habitats for brigalow represented in the category 'Brigalow – Poor Condition / Advanced Regrowth'.



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BOWEN GAS PROJECT EIS

HIGH VALUE REGROWTH (EHP DATA)

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Figure: 17-6

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17.3.2 Terrestrial Flora

17.3.2.1 Flora Species Diversity

The indicative flora list for the study area presented in the Terrestrial Ecology Technical Report (Appendix P of this EIS) is based on searches of EHP databases (Wildlife Online, CORVEG, HERBRECS) and field surveys carried out in October 2011 and May 2012.

The flora of the study area is considered well known with a highly diverse vascular flora of 770 taxa recorded within or in close proximity to the study area. The flora represents approximately 7.8% of the known 9,890 species of Queensland flora listed as per Bostock and Holland (2010). It comprises 14 EVNT species (deemed to be known from or likely to occur within the Project area), 17 regionally significant species and 117 species of non-native flora (15% of total flora). Twelve species are declared under the LP Act, although many of these are known from single or widely scattered records often on roadsides or in town areas. Four EVNT flora species were recorded during the field survey.

17.3.2.2 Endangered, Vulnerable or Near Threatened Flora Species

Search results from all available datasets retrieved a total of 63 species listed as EVNT under federal and state legislation which may occur or potentially occur within the study area. This included 17 species of national significance under the EPBC Act and 49 species of state significance under the NC Act.

Further analysis of the HERBRECS data (EHP, 2012) supported by review of relevant literature and field surveys indicates that 51 species are considered unlikely to occur in the Project area due to low precision records and lack of suitable habitat. Consequently, 12 species listed as either ‘endangered’, ‘vulnerable‘ or ‘near threatened‘ under federal and state legislation may potentially occur within the Project area.

A summary of the number of EVNT flora species is provided below with reference to Table 17-6**,** which lists those EVNT species with potential to occur (known, likely, possible, and unlikely) in the study area (based on desktop analysis and field survey). Profiles for all EVNT species considered known, likely, or possible including notes on habitat, and distribution are provided in the Terrestrial Ecology Technical Report (Appendix P of this EIS). The location of EVNT species derived from the HERBRECS database (EHP, 2012), field survey, and a number of independent sources is provided in Figure 17-7.

EPBC Act species

- Four known (one endangered, three vulnerable);
- Two possible (two vulnerable); and
- Twelve unlikely (two endangered, ten vulnerable).

NC Act species

- Eleven known (one endangered, three vulnerable, six near threatened);
- Two likely (one endangered, one near threatened);
- Six possible (one endangered, five vulnerable); and

- Forty-four unlikely (eight endangered, fourteen vulnerable, twenty-two near threatened).

Table 17-6 Summary of EVNT Flora Likelihood of Occurrence in Project Areas Based on Database Searches

Status	Known	Likely	Possible	Unlikely
EPBC Act				
Endangered	*Digitaria porrecta*	-	-	*Cycas ophiolitica* *Macrozamia platyrhachis*
Vulnerable	*Dichanthium queenslandicum* *Dichanthium setosum* *Eucalyptus raveretiana*	-	*Aristida annua* *Croton magneticus*	*Acacia ramiflora* *Cadellia pentastylis* *Daviesia discolor* *Hakea trineura* *Leucopogon cuspidatus* *Logania diffusa* *Omphalea celata* *Quassia bidwillii* *Taeniophyllum muelleri*
NC Act				
Endangered	*Solanum elachophyllum*	*Capparis humistrata*	*Solanum adenophorum* *Trioncinia retroflexa*	*Acacia ramiflora* *Cycas ophiolitica* *Kunzea sp. (Dicks Tableland A.R.Bean 3672)* *Macrozamia platyrhachis* *Sannantha papillosa* *Solanum graniticum* *Trioncinia patens*
Vulnerable	*Eucalyptus raveretiana* *Euphorbia sarcostemmoides* *Dichanthium queenslandicum*	-	*Aristida annua* *Cyperus clarus* *Croton magneticus*	*Cadellia pentastylis* *Daviesia discolor* *Dryopteris sparsa* *Graptophyllum ilicifolium* *Hakea trineura* *Huperzia tetrastichoides* *Huperzia varia* *Logania diffusa* *Neisosperma kilneri* *Ozothamnus eriocephalus* *Plectranthus graniticola* *Polianthion minutiflorum* *Trigonostemon inopinatus*
Near Threatened	*Macropteranthes leiocaulis* *Cerbera dumicola* *Digitaria porrecta* *Desmodium*	*Peripleura scabra*	-	*Acacia arbiana* *Acacia gittinsii* *Acacia spania* *Acronychia eungellensis* *Actephila sessilifolia*

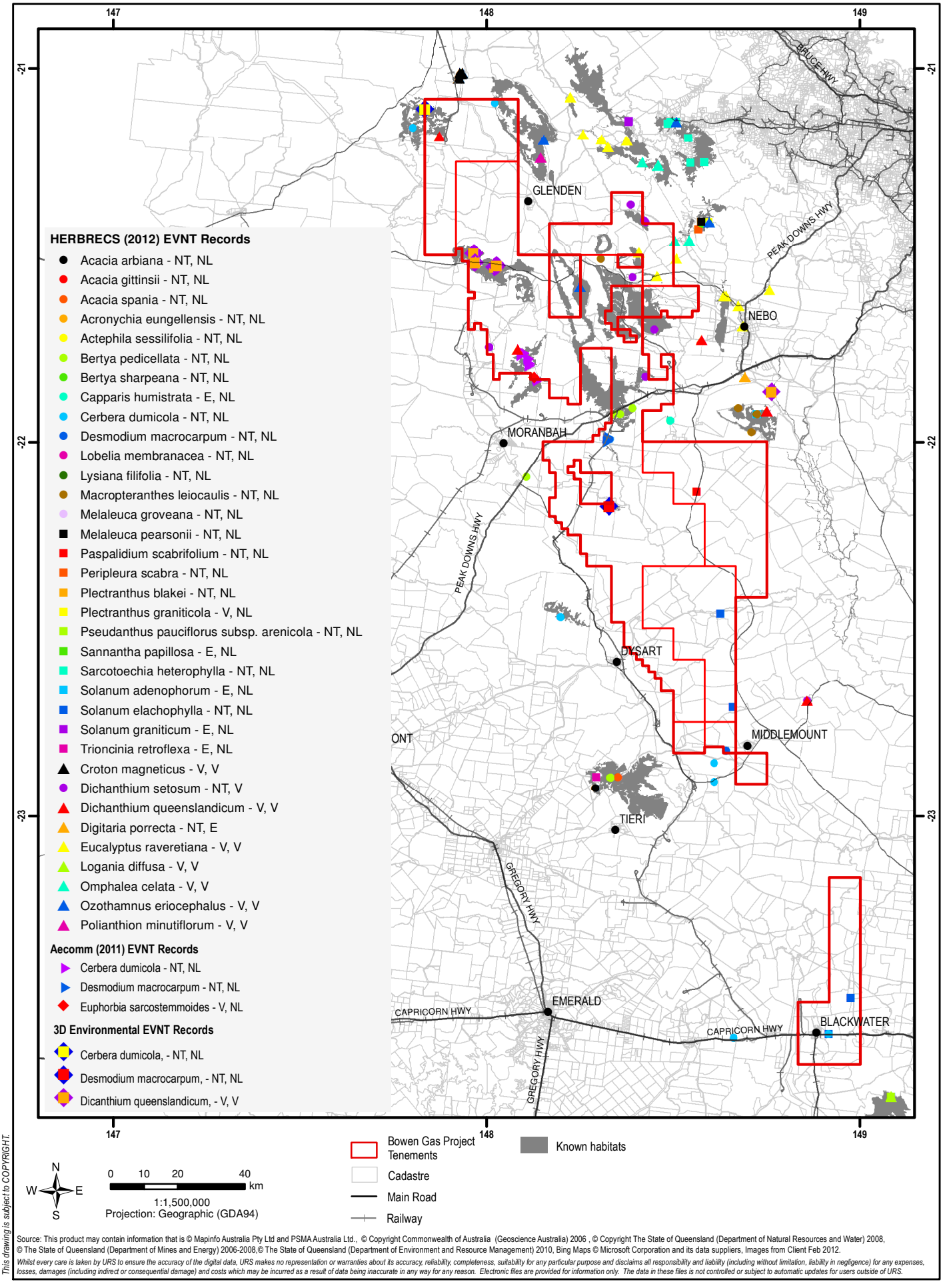
Status	Known	Likely	Possible	Unlikely
	macrocarpum *Bertya pedicellata* *Paspalidium scabrifolium*			*Argophyllum nullumense* *Asplenium normale* *Bertya sharpeana* *Carex rafflessiana* *Choricarpia subargentea* *Elaphoglossum callifolium* *Eulophia bicallosa* *Lobelia membranacea* *Lysiana filifolia* *Macropteranthes fitzalanii* *Melaleuca groveana* *Melaleuca pearsonii* *Pseudanthus pauciflorus subsp. arenicola* *Rhodamnia pauciovulata* *Rourea brachyandra* *Sarcotoechia heterophylla*

17.3.2.3 Habitats for EVNT Flora Species

The accuracy constraints inherent in the attribution of certified RE mapping dataset (DERM 2009a) means that its utility for predictive habitat mapping for flora species is limited. Hence, habitat mapping is applied in its broadest sense for species previously recorded in the Project area. Figure 17-7 shows individual RE polygons from the certified mapping data which are known to host populations of EVNT flora species. This mapping is conservative in nature, as it is based on current knowledge of the distribution of threatened species in the Project area.

17.3.2.4 Bioregionally Significant Species

A range of generic criteria may be applied to define or classify significant non-EVNT or bioregionally significant flora species. These include regional endemicity, isolated distribution, disjunction, reaching limits of geographical range, or special scientific, cultural and commercial interest species. Preliminary analysis of HERBRECS (EHP 2012) data coupled with field survey indicates that 17 bioregionally significant species are known to occur within the Project area, as described in the Terrestrial Ecology Technical Report (Appendix P of this EIS).



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BOWEN GAS PROJECT EIS

EVNT FLORA SPECIES RECORDS (HERBRECS) AND KNOWN HABITAT

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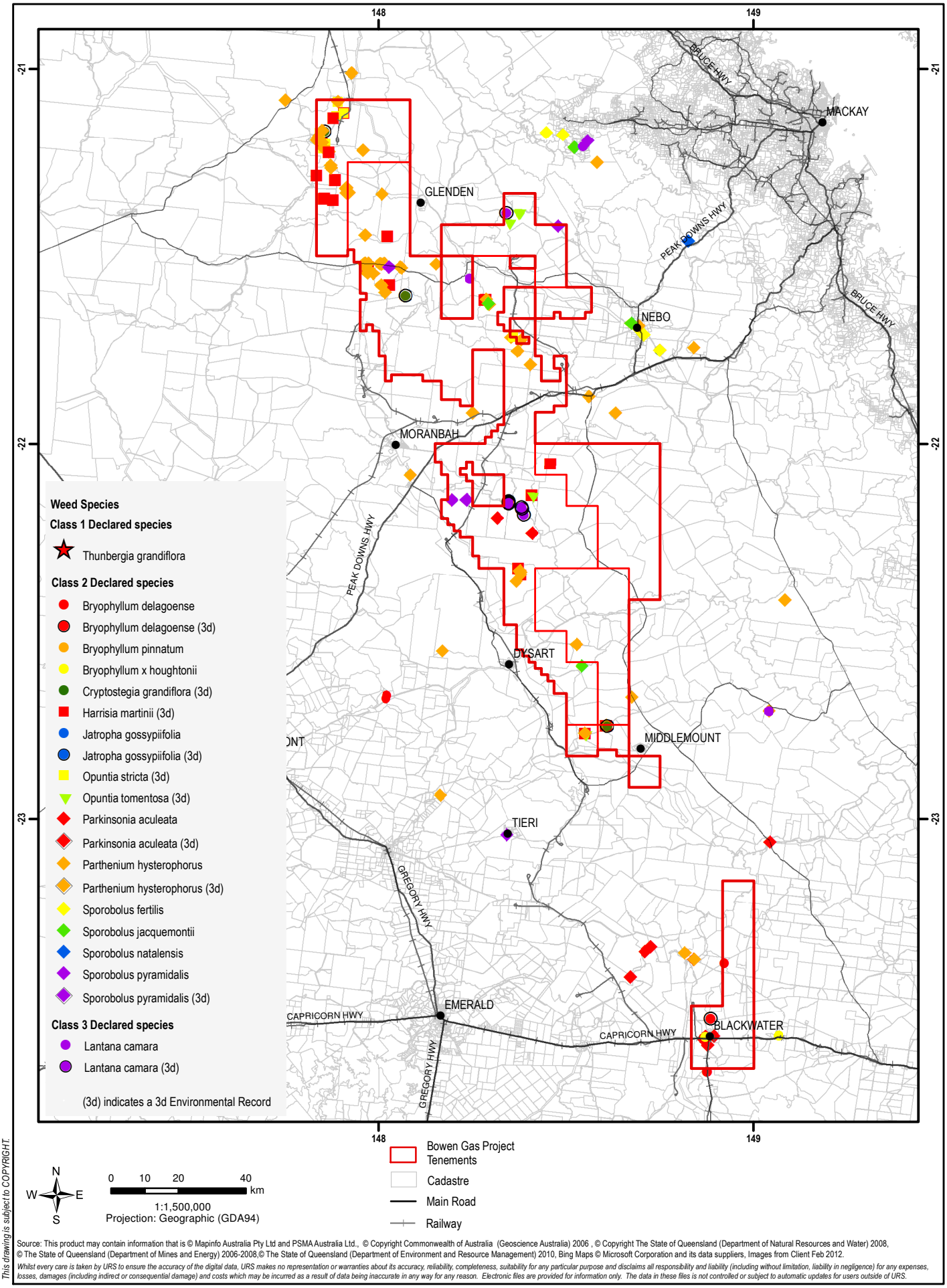
17.3.2.5 Pest Plants

Of the 117 species of non-native flora recorded in the HERBRECS database, 10 are declared under the LP Act. A full list of declared flora species extracted from database searches and field surveys is provided in Table 17-7. Under the LP Act, landowners must take reasonable steps to keep their land free of Class 2 pests. Point locations for exotic species are represented in Figure 17-8. A high proportion of infested ecosystems are classed as Category B or Category C ESAs on fertile clay soils and alluvial landforms, highlighting the requirement for stringent management control in the vicinity of these areas.

Table 17-7 Summary of Declared Weeds and Weeds of National Significance Known to Occur in Study Area from Database Searches and Field Survey

Pest Class	Common Name	Scientific Name
Class 2	Velvet pear	*Opuntia tomentosa*
Class 2	Prickly pear	*Opuntia stricta*
Class 2	Harissia cactus	*Harissia martinii*
Class 2	Mother of millions	*Bryophyllum delagoensis / Bryophyllum x houghtonii*
Class 2, WONS	Bellyache bush	*Jatropha gossypiifolia*
Class 2	Rats tail grass	*Sporobolus fertilis / Sporobolus pyramidalis*
Class 2, WONS	Rubber vine	*Cryptostegia grandiflora*
Class 2, WONS	Parthenium	*Parthenium hysterophorus*
Class 2, WONS	Parkinsonia	*Parkinsonia aculeata*
Class 3, WONS	Lantana	*Lantana camara*

An assessment of the potential for a range of exotic species to proliferate in the study area as a result of Project activities is provided in the Terrestrial Ecology Technical Report (Appendix P of this EIS). The assessment includes those that are known to occur in the study area, or are considered to possess considerable potential for introduction based on climate and habitat suitability.



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BOWEN GAS PROJECT EIS

DECLARED WEED SPECIES RECORDS IN STUDY AREA

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Figure: 17-8

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17.3.2.6 Overall Condition of Vegetation

The Project area encompasses a number of landscapes, ranging from the laterite jump-ups, sandstone escarpments, basaltic plains, broad sedentary clay and loam plains and riverine flood plains centred on catchments of the Isaac and Mackenzie Rivers. Land use impacts vary across the landscape, largely dependent on the fertility of the underlying substrate.

Ecosystem types on soils of low fertility, typically those REs associated with land zones 7 and 10, form the largest and most continuous tracts of vegetation in the Project area and these generally retain excellent condition with intact ecological values.

The existing vegetation of the Project area in the Isaac – Comet Downs Province is highly degraded, comprising areas mixed with regrowth, and suffering the impacts of widespread selective removal or ringbarking of canopy trees. Native ground covers throughout floodplain vegetation of the Mackenzie River and Blackwater Creek has been extensively altered with pervasive invasion of buffel grass (*Pennisetum ciliare)* and a range of exotic grass and herb species. Severe infestation of noogoora burr (*Xanthium occidentale*) is noted on the majority of drainage lines in the south of the Project area mixed with parthenium (*Parthenium hysterophorus)* which has invaded adjacent floodplain vegetation. Vestiges of *Eucalyptus coolabah* woodland (RE 11.3.3) on the floodplain of Blackwater Creek, mixing with RE 11.3.25, represent the best-preserved floodplain vegetation in the far southern portion of the study area. The habitats demonstrate a diverse shrub layer and riparian vegetation provides an important habitat linkage for fauna within an otherwise fragmented landscape.

Further details on vegetation condition are provided in the Terrestrial Ecology Technical Report (Appendix P of this EIS)

17.3.3 Terrestrial Fauna

The desktop study revealed a total of 599 vertebrate species have been recorded from the study area and surrounds including 41 frogs, 131 reptiles, 334 birds and 94 mammals. This list includes species that are unlikely to occur due to the search area extending to habitats associated with the Blackdown Tableland and Connors Range. Thirty-three EVNT species under the NC Act or EPBC Act are included within the database search results. The ecological requirements of these species are discussed in more detail within the Terrestrial Ecology Technical Report (Appendix P of this EIS).

Habitat quality is a major influence on fauna diversity and abundance, the bulk of habitats inspected during the current survey were degraded through processes such as fragmentation, grazing and weed infestation (e.g. buffel grass). Buffel grass is a particular threat to existing values within the Brigalow Belt North Bioregion. It has invaded many small remnant patches and affects habitat structure, reduces diversity and modifies fire regimes (Jackson 2005; Franklin and Molina-Freaner, 2009). While there is some evidence of grazing in the majority of localities sampled, Spring Creek Station in the vicinity of Coppabella had good examples of relatively undisturbed fauna habitats, including deeply gilgaid brigalow patches (RE 11.4.9) and palustrine wetlands.

17.3.3.1 Fauna Communities

17.3.3.1.1 Amphibians

A total of 41 amphibian (frog and toad) species have been recorded within the study area or adjacent surrounds from database searches. This is likely to include a large number of species associated with rainforest ranges (i.e. Connors Range), which were included within the search area buffer. Only one EVNT listed species is recorded from the Project area, the rough collared frog (*Cyclorana verrucosa).* However, it is probable that these records reflect a misidentification (see the Terrestrial Ecology Technical Report (Appendix P of this EIS)).

No rain fell during the most recent surveys, and the lack of rainfall is likely to have affected frog activity (and hence detection), with only nine species recorded. Amphibians were most commonly associated with wet habitats such as gilgias, swamps and creeklines. The most common species were *Limnodynastes tasmaniensis* and *Limnodynastes salmini.* Metamorphs of these species were found in large numbers around swamps and gilgai areas. Thirteen (approximately 32%) of the 41 known species are burrowing, remaining underground for extended periods until substantial rainfall causes the pooling of surface water. These conditions were not experienced during surveys. The species that would be abundant and widespread species following rainfall include: green-striped burrowing frog (*Cyclorana alboguttata*), and eastern snapping frog (*Cyclorana novaehollandiae*).

One introduced amphibian species, the cane toad (*Rhinella marina*), has been recorded from the study area. This species is not declared under the LP Act, but has the potential to cause significant environmental harm. The biological effects of this species is now a listed Key Threatening Process under the EPBC Act.

17.3.3.1.2 Reptile

A total of 131 reptile species were recognised in the database search as occurring within the Project area or surrounds. Nine of these species are listed under the EPBC Act, three of which are known or likely to occur within the Project area:

- Ornamental snake (*Denisonia maculata*);
- Brigalow scaly-foot (*Paradelma orientalis*); and
- Stripe-tailed delma (*Delma labialis*).

These species are discussed in more detail within the Terrestrial Ecology Technical Report (Appendix P of this EIS). The six remaining EVNT species are not considered likely to occur within the Project area (see the Terrestrial Ecology Technical Report (Appendix P of this EIS)). Thirty species of reptile were recorded during the most recent, survey including members of all five Australian lizard families, four of the six snake families and one of the four turtle families.

Skinks were the most abundant reptiles recorded during the field survey and were predominantly ground dwelling or fossorial in habit. Skinks were commonly found in areas with a high level of ground cover (e.g. fallen logs, leaf litter and rocks) but were less common in areas with low debris levels (e.g. grasslands). Snakes were similarly associated with high levels of ground cover with some species

most often found under fallen logs. Geckoes were more commonly located on vertical surfaces typically associated with loose bark.

Most species recognised from the Project area are listed as 'least concern' under legislation, being widespread and/or relatively common. Nine species (6.8%) of reptile identified in either database searches or field survey are considered threatened (EVNT fauna) although six of these are not considered likely to occur with the Project area (see the Terrestrial Ecology Technical Report (Appendix P of this EIS)). One non-EVNT priority (Back on Track) species, the short-necked worm-skink (*Anomalopus brevicollis)*, is known from the Project area and was recorded in the vicinity of floristic survey site OI15 on the footslopes of the Burton Range.

17.3.3.1.3 Birds

At present, 334 bird species have been recorded within the study area with 132 recorded in the current survey. As some birds are vagrants, seasonal migrants or subject to sporadic influxes, species abundance is likely to vary greatly at a seasonal level. Exceptionally abundant species include pied butcherbird (*Cracticus nigrogularis)*, Australian magpie (*C. tibicen)*, laughing kookaburra (*Dacelo novaeguineae)*, sulphur-crested cockatoo (*Cacatua galerita)*, galah (*Eolophus roseicapillus)*, brown falcon (*Falco berigora)*, white-throated gerygones (*Gerygone albogularis)*, black-faced woodswallow (*Artamus cinereus)*, noisy miner (*Manorina melanocephala)*, yellow-throated miner (*M. flavigula*) and willie wagtail (*Rhipidura leucophrys)*. These species are tolerant of severe habitat disturbance and are often located in open grazing areas.

Waterfowl were often observed on the larger dams and wetlands that contained high water levels, particularly at Iffley Station. Woodlands and riparian vegetation supported a large diversity of birds, particularly smaller species that forage below and within the canopy. Grasslands and open landscapes were the least diverse, but certain species such as brown quail (*Coturnix ypsilophora)*, golden-headed cisticola (*Cisticola exilis*) and tawny grassbirds (*Megalurus timoriensis*) were more common in these habitats.

17.3.3.1.4 Mammals

Ninety-four mammal species are known to occur within the study area, with 18 species recorded on the current survey. Many native mammals are absent from, or very uncommon within, modified landscapes such as grazing or agricultural areas. While some species, including the eastern grey kangaroo (*Macropus giganteus*) and the white-striped mastiff bat (*Tadarida australis*) will often forage in cleared areas, they still require some remnant or advanced regrowth vegetation for shelter. Most mammal species will be associated with large, intact vegetation patches. Within remnant vegetation, the abundance and diversity of small and medium ground-dwelling species is often affected by ground strata condition. Mammal diversity and abundance is typically lower in areas where the soil structure has been affected, and debris or native grasses have been reduced by grazing or fire.

In contrast to ground-dwelling mammals, impacts on ground strata have little effect on arboreal species such as the common brushtail possum (*Trichosurus vulpecula*), greater glider (*Petauroides volans*), and bats including the near threatened little pied bat (*Chalinolobus picatus*). Rather, these species rely on old-growth vegetation with trees of sufficient age to be senescing, thereby producing

roosting hollows in a variety of sizes. Fire and heavy logging activities may reduce the occurrence of such hollows.

Exotic predators and evidence of their presence was commonly observed; pigs, deer, and cats were observed within the Project area and are far more common within modified artificial landscapes or fragmented habitats. Roads and tracks can act as conduits for predatory species, enabling easier penetration into previously unmodified areas.

Due to the above factors, key mammal areas within the Project area are likely to be associated with large vegetation patches such as Burton Range, Kerlong Range, state forests, conservation reserves and other selected areas of private land that have not experienced grazing, fire or heavy logging.

17.3.3.2 Fauna Habitats

A diverse range of habitat types are present within the Project area, however the majority of the landscape has been modified for agricultural purposes. Retained vegetation is often affected by tree thinning, the introduction of ungulates (hooved herbivores, particularly cattle grazing), the spread of exotic weeds and disturbances to water bodies. Whilst large areas of the Project area have been significantly affected by these changes, some areas have remained less disturbed and retain a high diversity and abundance of native fauna. Fauna habitats are described in detail within the Terrestrial Ecology Technical Report (Appendix P of this EIS).

17.3.3.3 Threatened Fauna Species

A total of 33 EVNT fauna species under the NC Act and/or the EPBC Act have been recorded from the study area, including one amphibian, four reptiles, nineteen birds and eight mammals (Table 17-8). The relevance of EVNT species to the Project area was evaluated based on the number of records, record date, species habits (e.g. highly mobile / nomadic), their habitat and known ranges, to produce a list of known, possible or unlikely species. Species were excluded if considered to be transient (i.e. few records and highly mobile such as the red goshawk *Erythrotriorchis radiatus*) or unlikely (e.g. historic records, which no longer represent extant populations such as the western quoll *Dasyurus geoffroii geoffroii).* These species have little relevance to the Project and justification for their removal from the impact assessment process is detailed in the Terrestrial Ecology Technical Report (Appendix P of this EIS).

Remnant habitats in the Project area that are known to host EVNT fauna are shown in Figure 17-9. This mapping is produced through intersection of available records of EVNT fauna species (i.e. the desktop database supplemented by field observation) with the certified RE mapping (DERM, 2009a), highlighting individual RE polygons in which EVNT species have been recorded. A summary of species known, possible or unlikely to occur within the Project area is provided below.

EPBC Act species

- Five known (vulnerable);
- Two possible (one endangered, one vulnerable);
- Ten unlikely (four endangered, six vulnerable); and
- One presumed extinct.

NC Act species

- Eight known (four vulnerable, four near threatened);
- Three possible (two vulnerable, one near threatened);
- Eighteen unlikely (three endangered, four vulnerable, 11 near threatened);
- Two presumed extinct / extinct.

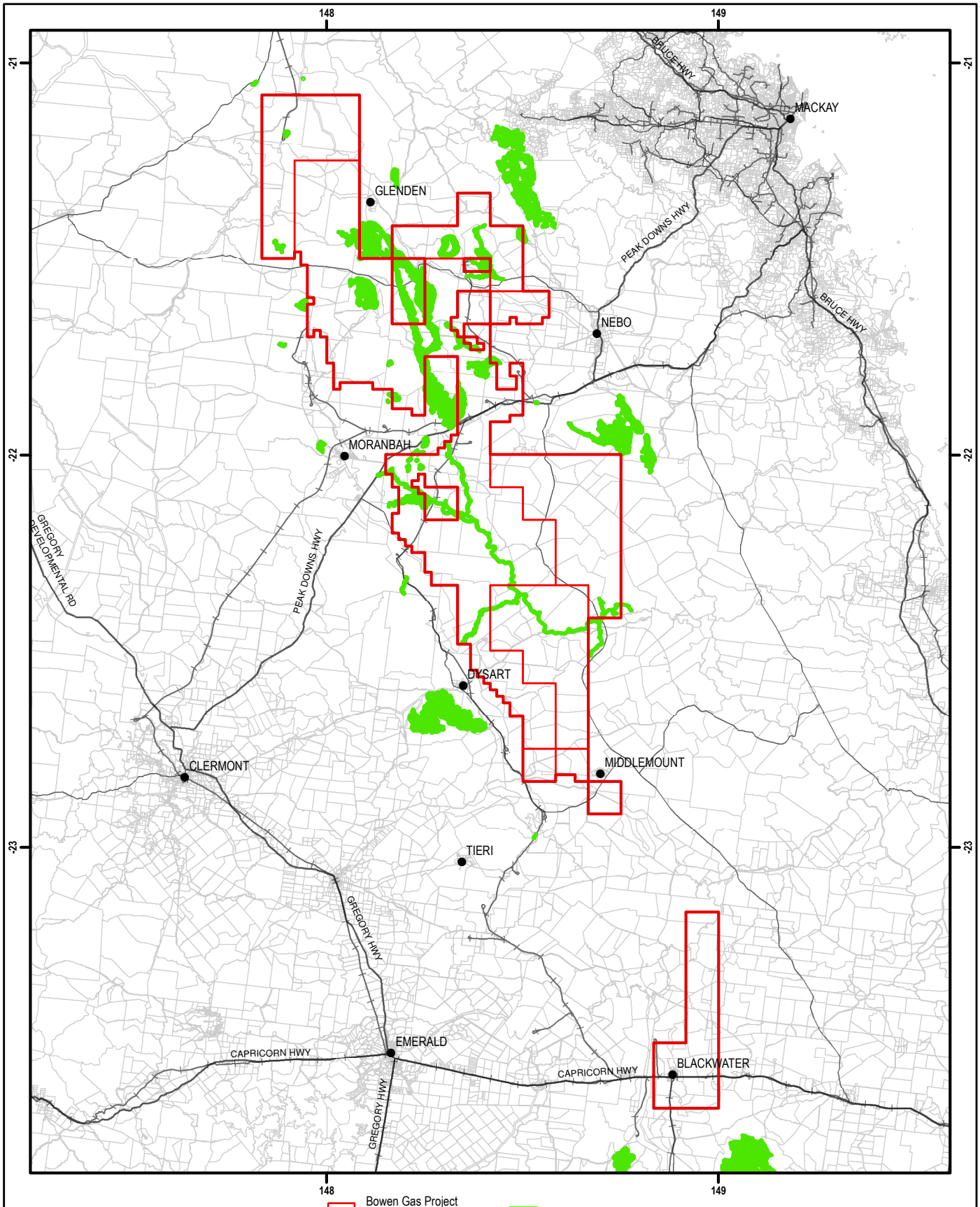
Table 17-8 Summary of EVNT Fauna Likelihood of Occurrence in Project areas Based on Database Searches

Status	Known	Possible	Unlikely
EPBC Act			
Presumed Extinct			*Psephotus pulcherrimus* paradise parrot
Endangered		*Dasyurus hallucatus* northern quoll	*Anthochaera phrygia* regent honeyeater *Poephila cincta* black-throated finch *Lathamus discolor* swift parrot *Bettongia tropica* northern bettong
Vulnerable	*Denisonia maculata* ornamental snake *Paradelma orientalis* brigalow scaly-footscaly-foot *Delma labialis* stripe-tailed delma *Geophaps scripta scripta* squatter pigeon *Phascolarctos cinereus* koala	Nyctophilus corbeni south-eastern long-eared bat	*Erythrotriorchis radiatus* *Pedionomus torquatus* plains wanderer *Rostratula australis*** Australian painted snipe *Turnix melanogaster* black-breasted button-quail *Dasyurus geoffroii geoffroii* western quoll *Onychogalea fraenata* bridled nailtail wallaby
NC Act			
Presumed Extinct / Extinct			*Psephotus pulcherrimus* paradise parrot *Dasyurus geoffroii geoffroii* western quoll
Endangered			*Anthochaera phrygia* regent honeyeater Poephila cincta black-throated finch Lathamus discolor swift parrot

Status	Known	Possible	Unlikely
Vulnerable	Denisonia maculata ornamental snake *Paradelma orientalis* brigalow scaly-foot *Delma labialis* stripe-tailed delma *Geophaps scripta scripta* squatter pigeon	Jalmenus eubulus pale imperial hairsteak *Nyctophilus corbeni* south-eastern long-eared bat	Calyptorhynchus lathami glossy black-cockatoo *Pedionomus torquatus* plains wanderer *Turnix melanogaster* black-breasted button-quail *Rostratula australis* Australian painted snipe *Ninox strenua* powerful owl
Near Threatened	*Acanthophis antarcticus* common death adder *Nettapus coromandelianus* cotton pygmy-goose *Ephippiorhynchus asiaticus* black-necked stork *Chalinolobus picatus* little pied bat	*Melithreptus gularis* black-chinned honeyeater	*Cyclorana verrucosa* rough collared frog *Lerista allanae* greater robust fine-lined slider *Strophurus taenicauda* golden-tailed gecko *Accipiter novaehollandiae*** grey goshawk *Erythrotriorchis radiatus*** red goshawk *Lophoictinia isura*** square-tailed kite *Neophema pulchella* turquoise parrot *Tadorna radjah* radjah shelduck *Aerodramus terrareginae* Australian swiftlet *Turnix melanogaster* black-breasted button-quail *Bettongia tropica* northern bettong *Kerivoula papuensis* golden-tipped bat

** Transient Species

Habitat requirements and ecology of the 13 EVNT fauna species assessed as known from, or possibly occurring in, the Project development are outlined in the Terrestrial Ecology Technical Report (Appendix P of this EIS).



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KNOWN HABITATS FOR EVNT FAUNA SPECIES

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Figure: 17-9

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17.3.3.4 Migratory Fauna Species

A total of 14 migratory bird species, as listed under the EPBC Act, have been recorded from the study area (Table 17-9). Migratory wetland species include latham's snipe (*Gallinago hardwickii)*, eastern great egret (*Ardea modesta)*, cattle egret (*Ardea ibis)*, cotton pygmy-goose and Australian painted snipe. Eastern great egrets are abundant and common on farm dams within the Project area and will also occur in flooded paddocks, billabongs, creeks and on the Isaac River. Latham's snipe may inhabit similar waterways to eastern great egrets, but is generally more common in larger waterways with abundant semi-aquatic vegetation. Cattle egrets, which may occur in open paddocks and waterways, are uncommon within the study area. Cotton pygmy-geese, which typically inhabitat permanent waters with abundant floating vegetation, are locally common, but patchy. Two notable aggregations were recorded from Lake Elphinstone and a farm dam on Iffley Station where, on the latter, over 50 individuals were observed.

Table 17-9 Migratory Species known from Study Area

Common Name (Scientific name)	Notes
Fork-tailed swift (*Apus pacificus*)	Nomadic; vagrant.
Great egret, white egret (*Ardea alba sensu lato*)	Common throughout study area and bioregion
Eastern great egret (*Ardea modesta*)	Commonly found on shallow waterbodies
Cattle egret (*Ardea ibis*)	Found around waterways and in paddocks
White-bellied sea-eagle (*Haliaeetus leucogaster*)	Found around waterways and larger waterbodies (including artificial dams)
White-throated needletail (*Hirundapus caudacutus*)	Nomadic; uncommon
Rainbow bee-eater (*Merops ornatus*)	Common throughout Project area and bioregion
Black-faced monarch (*Monarcha melanopsis*)	Possible in semi-evergreen vine-thickets or riparian vegetation; uncommon
Spectacled monarch (*Monarcha trivirgatus*)	Possible in semi-evergreen vine-thickets or riparian vegetation; uncommon
Satin flycatcher (*Myiagra cyanoleuca*)	Vagrant / uncommon
Rufous fantail (*Rhipidura rufifrons*)	Possible in semi-evergreen vine-thickets or riparian vegetation; uncommon
Latham's snipe, japanese snipe (*Gallinago hardwickii*)	Found around waterbodies
Cotton pygmy-goose (*Nettapus coromandelianus*)	Typically permanent waterbodies with floating aquatic vegetation; locally common, but patchy.
Australian painted snipe (*Rostratula australis*)	Found around waterbodies; vagrant

17.3.3.5 Exotic Pest Fauna

A total of 12 feral terrestrial vertebrate species have been recorded from the study area. These include seven listed as Class 2 declared animals under the LP Act. Class two declared animals are feral species established in Queensland that have, or may have, a substantial negative economic, environmental or social impact. Table 17-10 lists all known feral terrestrial vertebrate species from the study area. Four pest species are known to pose significant risks to biodiversity: the feral dog / dingo, fox, cat and cane toad.

Table 17-10 Pest Vertebrate Species Recorded from the Study Area

Common Name (Scientific Name)	LPA classification
Cane toad (*Rhinella marina*)	Not Declared
Feral dog / dingo (*Canis lupus*)	Class 2
European fox (*Vulpes vulpes*)	Class 2
Feral cat (*Felis catus*)	Class 2
European rabbit (*Oryctolagus cuniculus*)	Class 2
Feral pig (*Sus scrofa*)	Class 2
House sparrow (*Passer domesticus*)	Not Declared
Common myna (*Sturnus tristis*)	Not Declared
Common starling (*Sturnus vulgaris*)	Not Declared
European hare (*Lepus capensis*)	Not Declared
Black rat (*Rattus rattus*)	Not Declared
House mouse (*Mus musculus*)	Not Declared
Chital deer (*Axis axis*)	Class 2

17.3.4 Protected Estate

Protected estate within and in the vicinity of the Project area is limited and includes national parks, conservation parks, nature refuges as regulated by the NC Act and state forests as regulated by the Queensland *Forestry Act 1959.* Generally, within these areas the historical impacts of prior land management practice affecting habitat value have been less intense. Further, they are the largest intact habitat blocks remaining in an otherwise fragmented landscape. Larger, more structurally complex patches typically contain high species diversity and abundance (Olsen *et al.* 2005; Lindenmayer and Fischer 2006). Protected estate within or adjacent to the Project area is described below**:**

- Homevale National Park and Homevale Resources Reserve extend into the north-east of the Project area;
- Arthurs Bluff State Forest, contiguous with the Blackdown Tableland National Park extends into the far southern portion of the Project area;
- Dipperu National Park / Scientific Reserve is marginal to the central-eastern portion of the Project area;
- Taunton National Park / Scientific Reserve, which includes a nationally significant population of bridled nailtail wallaby (*Onychogalea fraenata*), is located 25 km from the south-eastern portion of the Project area; and
- Blackwater Brigalow Conservation Park is located 5 km from the south-western margins of the Project area, near Blackwater.

17.3.5 Important Wetlands

Lake Elphinstone is not located within the Project area although it occupies an enclave that the Project area surrounds. Hence, it must be considered as being potentially influenced by the Project. Lake Elphinstone is listed on the Directory of Important Wetlands and is recognised as significant at a national and state level due to being a bioregional example of a semi-permanent freshwater lake (Environment Australia, 2001a). The Lake is recognised as:

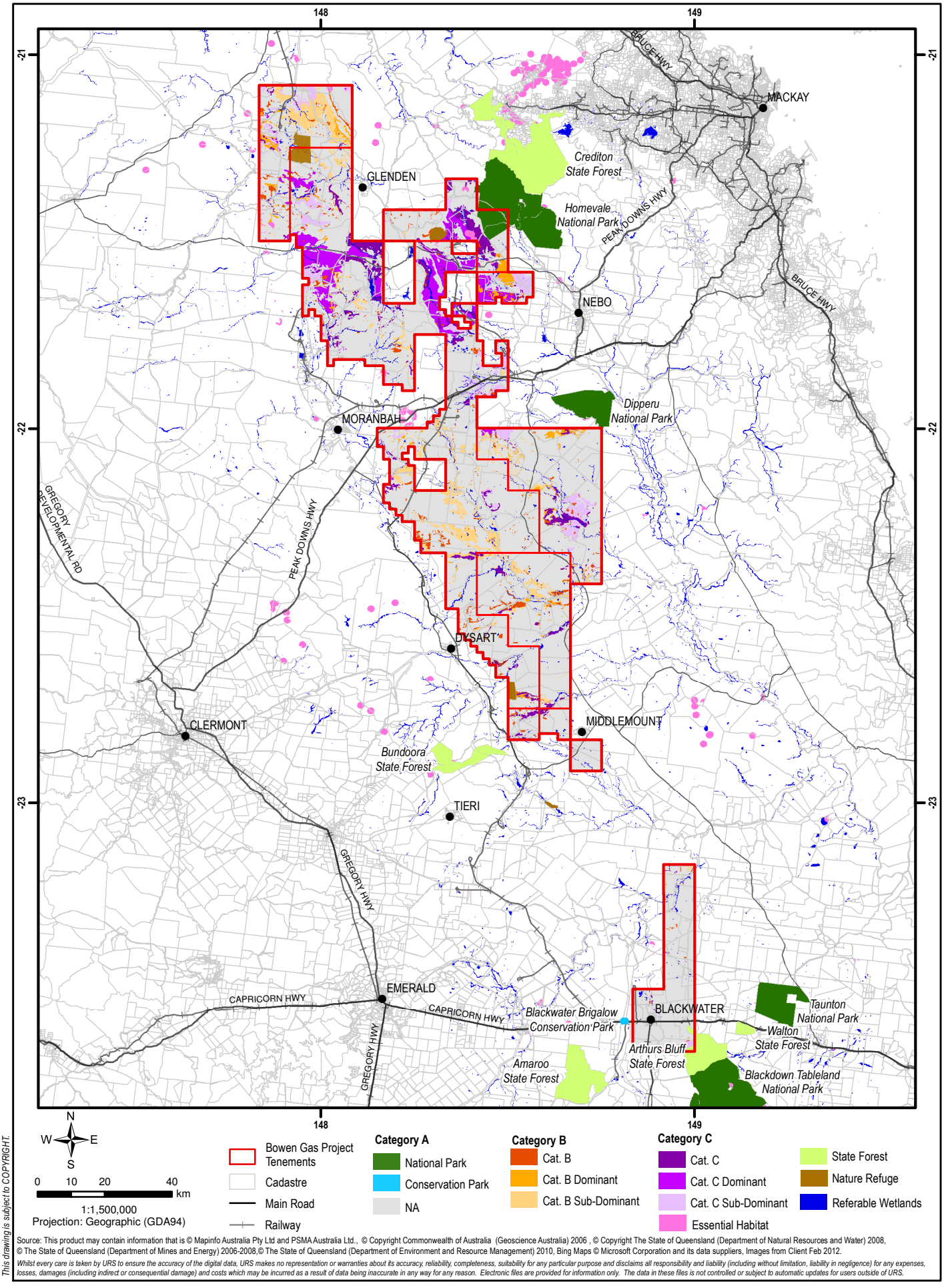
- A good example of a wetland type occurring within a biogeographic region in Australia;
- A wetland that plays an important ecological or hydrological role in the natural functioning of a major wetland system / complex;
- A wetland that is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail;
- Supporting a host of aquatic vertebrates and several EVNT species (e.g. black-necked stork, cotton pygmy-goose, squatter pigeon); and
- Supporting many waterbird species protected under CAMBA (China-Australia Migratory Bird Agreement), JAMBA (Japan-Australia Migratory Bird Agreement) and ROKAMBA (Republic of Korea – Australia Migratory Bird Agreement).

17.3.6 Essential Habitat

Essential Habitat, mapped by EHP under the BPA framework (EPA, 2002a), is used in the decision making process for vegetation clearing applications under the VM Act. It represents those areas considered essential for the maintaining populations of priority taxa (that includes threatened and non-threatened species of regional significance) and is generally defined from known records. Expert knowledge may be used to identify specific areas providing habitat factors critical to the concerned species. Essential Habitat is considered known when:

- The taxon is present (based on accurate records);
- There are indications of reproduction, or where a significant number of individuals are present, or important resources; and
- Important movement corridors for breeding and/or non-breeding (including migratory) individuals have been identified.

Essential Habitat is considered possible where there exists suitable habitat of a size capable of supporting one or more breeding units, and important resources (such as nest sites, roost caves, major food sources) are present, or the area is proximal to populations, or may act as a potentially important corridor. An un-attributed layer of Essential Habitat locations has been provided by EHP for the purpose of this study (refer to Figure 17-10). As previously identified, Essential Habitat is considered a Category C ESA and is regulated by the EP Act.



arrow energy go further

BOWEN GAS PROJECT EIS

ENVIRONMENTALLY SENSITIVE AREAS

URS

TERRESTRIAL ECOLOGY

Figure: **17-10**

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17.3.7 Environmentally Sensitive Areas

ESAs applicable to the Project are addressed in detail within the ESAs chapter (Section 18) of this EIS. A summary of ESAs is provided below.

17.3.7.1 Sensitive Areas by Tenure

Category A ESAs, as defined in the EP Regulation, and codes of compliance for mining and petroleum tenures are shown in relation to the Project area in Figure 17-10. Homevale National Park is the only Category A ESA directly overlapping with the Project area. Category A ESAs in the vicinity of the Project area include:

- Dipperu National Park (Scientific);
- Blackwater Brigalow Conservation Park;
- Blackdown Tableland National Park; and
- Taunton National Park (Scientific).

Category C ESAs apply to regulation of Level 2 petroleum industries although specific conditions may apply when conducting Level 1 ERAs within these areas. Category C ESAs derived from tenure include the following:

- Resources reserves;
- Nature refuges; and
- State forests.

A number of state forests fringe the Project area, including Arthur's Bluff State Forest, Crediton State Forest, Amaroo State Forest, Walton State Forest and Bundoora State Forest. Arthur's Bluff State Forest, located in the far south of the Project area, is the only state forest area that directly overlaps. A number of gazetted nature reserves on freehold land are also present within the Project area. Category C ESAs assigned by tenure are represented in Figure 17-10.

Sensitive Areas by Vegetation / Habitat

ESAs may be assigned by vegetation classification or a unique habitat attribute or value. The only Category B ESAs recognised in the Project area are REs with a biodiversity status of 'endangered'. Category C ESAs may be attributed to a number of ecological values. These values are listed below:

- Referable wetlands;
- REs with an 'of concern' biodiversity status; and
- Essential habitat.

Certified RE mapping (DERM, 2009a) may considerably exaggerate the extent of Category B and Category C ESAs due to the representation of heterogeneous polygons where 'endangered' or 'of concern' vegetation is mixed with vegetation that is listed as 'no concern at present'. Figure 17-10 shows the distribution of Category B and Category C ESAs based on certified RE mapping (DERM, 2009a) with dominant and sub-dominant categories represented to identify differing levels of ecological constraint. Figure 17-10 also shows the location of referable wetlands and essential habitat.

17.4 Issues and Potential Impacts

Potential direct and indirect impacts on the terrestrial ecology values from Project activities are summarised below.

17.4.1 Direct Impacts from Land Clearing

Vegetation clearing may affect flora and fauna communities and species in several ways including:

- Mortality or injury of individuals as a direct result of clearing activities;
- The loss of habitat for flora and fauna species:
  - reduction of the abundance and distribution of species due to the above effects; and
  - displaced individuals that move to nearby vegetation are often unable to compete with resident animals and typically perish;
- Edge effects causing habitat degradation of habitat.

These impacts are discussed further below.

17.4.1.1 Direct Mortality

Fauna

Fauna mortality can potentially occur from clearing activities. Small terrestrial species in particular (small mammals, many reptiles and frogs) are highly susceptible to mortality during clearing.

Further, displaced individuals are less effective in competing with neighbours and their survival is also dubious. However, the degree of competition depends largely on the extent of an animal's home range that is modified and the individual's movement patterns. Minor modification within large home ranges will have less of an impact than the clearing of an individual's entire home range. Hence, higher mortality is expected for smaller, less mobile taxa.

Species with broad habitat requirements, or those that occur in abundant habitats, will be widely distributed throughout the Project area, and losses can therefore be estimated according to the extent of habitat loss. Clearing for linear infrastructure (such as roads and gathering lines) is expected to have a lower magnitude of impact on larger habitat patches compared to clearing for larger infrastructure, such as dams or integrated processing facilities (IPFs).

By contrast, clearing within habitats that are comparatively minor in extent, or within areas inhabited by species with restricted distributions, will affect a greater proportion of that areas fauna population. Hence, any clearing within rare or uncommon habitats such as native grasslands, brigalow or waterways will result in proportionally higher individual mortality and proportionally higher rates of habitat loss.

Flora

Direct mortality of flora species will be governed to a large degree by the final impact footprint for any proposed infrastructure with strategic site selection allowing the avoidance of high-value environmental areas. Secondary impacts may also result from damage to trees on the margins of clearing resulting from tree fall or impact from operating machinery.

17.4.1.2 Habitat Loss and Fragmentation

Project activities will result in some vegetation clearance, which leads to habitat loss and fragmentation resulting in:

- An altered landscape (and hence habitat) mosaic;
- Modification of large core unmodified habitats that may be structurally varied, have high habitat integrity and contain source populations of flora and fauna species;
- Loss of habitat for significant flora and fauna species, as listed under the NC Act and EPBC Act;
- Increased movement barriers, isolating populations or reducing movement rates (forming metapopulations);
- Impacts to significant wildlife corridors, including riparian areas fringing Mackenzie and Isaac River;
- Increased risk of some stochastic events (e.g. fire) having serious local deleterious consequences (e.g. local population extinction); and
- A reduction in the likelihood of some stochastic events (e.g. fire) having broad scale impacts.

17.4.1.3 Edge Effects

Edge effects refer to the changes in biological and physical conditions that occur at an ecosystem boundary (Lindenmayer and Burgman, 2005). A variety of edge effects can result from landscape modification, and may impact upon remaining ecological values:

- Ecological values can be impacted by loss of vegetation integrity along disturbed margins or within minor remnants. Canopy dieback and loss of vigour, particularly of the ground cover, may be associated with increased light; penetration, disease, altered surface water flow, dust or exotic weed invasion;
- There may be modifications to community interactions (e.g. increased competition, increased aggression and increased predation); and
- Degradation of riparian and in-stream habitats through increased sedimentation and changes to hydrological regime.

17.4.2 Pest Species

17.4.2.1 Pest Flora Species

The impact of Project development on populations of exotic weed species will be dependent on land management practices employed. Unmanaged, the Project has the potential to assist proliferation of a number of exotic plant species that may have potential for serious economic and social impact, as well

as devastating impacts on native vegetation and general biodiversity. This includes both the dispersal of currently occurring exotic plant species and introducing additional pest species from outside the Project area.

The factors that may considerably influence the spread of weeds throughout the Project area include soil disturbance, creation of linear corridors and creation of water bodies.

Pest flora species which have the greatest potential to proliferate from Project related activities are:

- Velvet pear (*Opuntia tomentosa*);
- Prickly pear (*Opuntia stricta*);
- Harissia cactus (*Harissia martini*);
- Mother of millions (*Bryophyllum delagoensis / Bryophyllum x houghtonii*);
- Bellyache bush (*Jatropha gossypiifolia*);
- Parthenium (*Parthenium hysterophorus*);
- Parkinsonia (*Parkinsonia aculeate*);
- Lantana (*Lantana camara*);
- Indian couch (*Bothriochloa pertusa*); and
- Buffel grass (*Pennisetum ciliare*).

17.4.2.2 Pest Fauna Species

Project related activities have the potential to increase pest fauna abundance throughout the life of the Project. In particular, pest abundance and distribution may increase due to the following:

- The creation of gas gathering lines and road corridors through existing contiguous vegetation may act as movement conduits (DEWHA, 2008b), facilitating pest species spread;
- Storage ponds around gas wells and associated with facilities can provide a stable water supply for feral animals increasing their abundance and distribution; and
- Putrescible waste dumps associated with increased human inhabitation can become a valuable food resource for a variety of pest species leading to an increase in their abundance.

Species which have the greatest potential to proliferate from Project related activities, and have the potential to affect native fauna values are:

- Cane toad (*Rhinella marina*);
- European red fox (*Vulpes vulpes*);
- Feral cat (*Felis catus*);
- Wild dogs (*Canis lupus*); and
- Feral pigs (*Sus scrofa*).

17.4.3 Potential Impacts to Environmentally Sensitive Areas

17.4.3.1 Category A ESAs

Potential exists for Category A ESAs to be impacted by Project activities. Homevale National Park intrudes into the north-eastern portion of the Project area and Dipperu National Park fringes the

Project area's eastern boundary. Unless appropriately managed (see recommendations set out in Section 17.5), the most significant threats posed arise from proliferation of pest flora and fauna impacting on natural values.

17.4.3.2 Category B ESAs

Category B ESAs within the Project area include REs 11.3.1, 11.3.11, 11.4.1, 11.4.8, 11.4.9, 11.4.13, 11.8.13, 11.9.1 and 11.9.5. These ecosystems are generally associated with fertile clay soils that are highly susceptible to both erosion and exotic species invasion. Infestations of prickly pear (*Opuntia stricta, O. tomentosa*) and harrisia cactus (*Harrisia martinii*) are prevalent in the majority of areas where these ecosystems were examined on the ground. Failure to follow weed hygiene protocols coupled with increased vehicular traffic may facilitate increases in the rate and extent of exotic species invasion into these communities.

Another Category B ESA, RE 11.5.17, is a wetland habitat that is scattered throughout the Project area with some relatively pristine examples observed on the Spring Creek Property. These habitats may be threatened by proliferation of exotic species (pest plants and animals), sedimentation, and release of saline water from production wells. The hydrology of these features is also not sufficiently understood to discount impact from groundwater draw-down which may increase the length of seasonal drying.

Additional potential impacts to Category B ESAs include direct clearing, fragmentation and edge effects.

17.4.3.3 Category C ESAs

Category C ESAs are designated due to the presence of an ‘of concern’ RE and are often associated with alluvial areas and subject to both erosion and exotic species invasion. Failure to follow weed hygiene protocols coupled with increased vehicular traffic may facilitate increases in the rate and extent of exotic species invasion (particularly parthenium, bellyache bush and mother of millions) into these communities.

Other Category C areas including essential habitat and wetland habitats may be subject to fragmentation through placement of Limited Petroleum Activities. This would have a deleterious impact on habitat values in these areas and dramatically increase the extent of cleared edges, facilitating both weed invasion and loss of habitat condition on the margins. Edge effects may have dramatic impacts on the viability of areas as habitats for threatened fauna and flora species.

Wetland values are potentially threatened by the long term processes of increasing sedimentation, weed invasion (e.g. hymenachne) and changes to surface and sub-surface hydrology. Water extraction, discharge of saline CSG water from well heads and general increased site access all have potential to impact the natural integrity of wetland systems.

17.5 Avoidance, Mitigation and Management Measures

17.5.1 General Measures

Environmental protection for terrestrial ecology will be primarily achieved through design and site selection that results in avoidance of high-value environmental areas. Arrow will conduct the below measures to mitigate impacts on terrestrial ecology.

17.5.1.1 Planning and Design

Through the planning and design phase, areas of very high sensitivity will be avoided.

- Avoid all disturbance within Homevale National Park (Category A ESA) [B130].
- Where possible avoid disturbance within the following areas [B131]:
  - endangered EPBC Act TECs: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (RE 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall Woodlands (REs 11.3.2 and 11.3.28);
  - category B ESAs;
  - category C ESAs including Arthur's Bluff State Forest and gazetted nature reserves;
  - stock routes and state or regionally significant bioregional wildlife corridors;
  - essential habitat;
  - core habitat for EVNT species;
  - state forests and resource reserves; and
  - state-listed 'of concern' REs.
- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning
  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers).

17.5.1.2 Construction and Operations

Disturbance exclusion zones (or management buffers) will be established and managed during construction and operations to effectively protect ESAs. This may include the following actions:

- Manage impacts to Category A, B and C ESAs through implementation of management buffers. The buffers outlined below are indicative based on current regulatory conditions, however these may be subject to change in future. Buffers that will be implemented for the Project will be in line with the regulatory requirements at the time of implementation. Indicative buffers at this time include:
  - in areas mapped as high constraint a buffer of 100 m, measured from the bank edge, will be adopted during all phases of the Project, with a further 100 m constrained to low impact activities; and

- for areas mapped as moderate constraint, the following buffer zones, measured from the bank edge, will be adopted during all phases of the Project:
    - a riparian buffer of 50 m width on either side of first and second order streams; and
    - a riparian buffer of 100 m width on either side of third, fourth, fifth and higher order streams;

- Clearly mark buffers for sensitive areas that require avoidance;
- Develop site induction procedures to ensure that all worksite personnel, including contractors are made aware of the location of these sensitive habitats (and buffers) and are guided by qualified personnel when clearing is undertaken; and
- Demarcate ESA buffers and educate workers in regard to necessary site access protocols and requirements.

Table 17-11 Proposed Buffer Distances from ESA Boundaries

ESA Category	Proposed Activities within ESA	Proposed Activities within 200m of ESA	Proposed Activities within a Secondary Protection Zone *
Category A	None	Low-impact activities ***	Limited petroleum activities within 800 m of the primary protection zone.^
Category B: excluding REs with 'endangered' status	Low-impact Activities ***	Low-impact activities ***	Limited petroleum activities within 300 m of the primary protection zone. ^
Category B: regional ecosystems with an 'endangered' status	Limited petroleum Activities **	Limited petroleum Activities **	Only limited petroleum activities within 300 m of the primary protection zone. ^
Category C: excluding REs with an 'of concern' status, state forests and timber reserves	Low-impact Activities ***	Low-impact activities ***	Limited petroleum activities within 300 m of the primary protection zone. ^
Category C: regional ecosystems with an 'of concern' status, state forests and timber reserves	Limited petroleum Activities **	Limited petroleum Activities **	Limited petroleum activities within 300 m of the primary protection zone. ^

* Indicative ESA buffers (derived from the guidelines under the EP Act; Model Conditions for level 1 EAs for CSG Activities) Buffers that will be implemented for the Project will be in line with the regulatory requirements at the time of implementation.

** Limited petroleum activities are generally listed as a restricted set of activities defined within the EA. Limited petroleum activities generally include:

- Well sites less than 1 ha (and the infrastructure located on the well site) and multi-well sites;
- Geophysical surveys;
- Gathering / flow pipelines from a well head to the initial compression facility;
- Supporting access tracks; and
- Communication and power lines necessary for the undertaking of petroleum activities.

*** Low impact petroleum activities have been defined as: limited petroleum activities which do not result in the clearing of native vegetation, cause disruption to soil profiles through earthworks or excavation or result in significant disturbance to land. For example, soil surveys, topographic surveys, cadastral surveys, ecological surveys and traversing land by car or foot via existing access track or routes or in such a way that does not result in permanent damage to vegetation.

^ The primary protection zone is considered to be within 200 m of the ESA boundary.

17.5.1.3 Decommissioning

Prior to commencing ground disturbance activities, a rehabilitation plan will be developed that includes the following principles:

- Woody debris, logs and rocks should be retained for use in rehabilitation, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt [B161].
- Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be reinstated [B162].

17.5.2 Habitat Fragmentation and Isolation of Populations

The extent of vegetation removal will be minimised wherever possible. Impacts related to land clearing will be reduced through sensitive infrastructure design. Suitably qualified and experienced people[1] will be utilised to review conceptual designs to ensure site selection criteria are met. Mitigation and management measures to minimise the potential for habitat fragmentation include:

- Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136];
- Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133];
- Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134]; and
- Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135].

17.5.3 Habitat Loss or Degradation and Fauna Mortality

Mitigation and management measures to minimise the potential for habitat loss or degradation and fauna mortality are detailed below.

17.5.3.1 Habitat Loss

Mitigation and management measures to minimise the potential for habitat loss include:

- Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]:
  - vegetation mapping at a scale suitable for site-specific planning;

[1] Suitably qualified person means a person who has professional qualifications and experience relevant to the nominated subject matter

  - identification of core habitats for EVNT species; and
  - identification of site-specific sensitive areas (e.g. ESAs) that require avoidance or buffers);
- Retain habitat trees as a priority [B137];
- Avoid removing riparian vegetation when directional drilling and reduction of right of ways where practical [B138];
- Construct infrastructure within previously disturbed vegetation in preference to areas with higher biodiversity values [B139];
- Deviate access tracks and pipelines around sensitive vegetation where practicable [B140];
- Avoid construction activities in waterbodies frequented by migratory species [B141]; and
- Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142].

17.5.3.2 Habitat Degradation

Mitigation and management measures to minimise the potential for habitat degradation include:

- Implement noise control techniques in accordance with the noise and vibration commitments and standard industry noise suppression techniques [B146];
- All lighting should be directed into the infrastructure siting rather than dispersed into native vegetation when sites are adjacent to intact habitats [B147];
- Where possible, restrict traffic to designated access tracks [B148];
- Prohibit harassment of wildlife and the unauthorised collection of flora or fauna, unless directed by a suitably qualified and experienced person [B149];
- Fell trees away from existing vegetation not identified for removal where practicable [B150]; and
- Avoid damaging trees (e.g. through scraping of tree trunk or breaking of limbs by equipment) not identified by removal where practicable [B151].

Habitat Degradation (Pest Flora and Fauna)

A detailed pest management plan will be developed to mitigate and manage the potential spread of pest flora and fauna species [B152].

17.5.3.3 Fauna Mortality

Mitigation and management measures to minimise the potential for fauna mortality (including mortality of EVNT species) include:

- Where possible, avoid clearing known EVNT habitat (see Figure 17-9);
- Suitably qualified animal handler or ecologist to capture injured wildlife, where possible. Injured wildlife resultant from land clearing will be taken to a qualified veterinary surgeon where practical [B153];
- Develop speed limits on Project controlled roads with due consideration to reduce the potential for vehicle collisions with wildlife [B154];
- Undertake pre-clearing surveys to determine the likelihood of the species occurring [B155];

- Undertake partial rehabilitation of gathering lines and other linear infrastructure to reduce edge effects (including weed invasion) and maintain movement rates [B156];
- Undertake rehabilitation of available areas consistent with pre-clearing habitats, to increase the rate of recovery [B157];
- Undertake weed monitoring and targeted weed control measures within sensitive EVNT habitats (particularly threatened communities such as brigalow and native grasslands) [B158];
- Trenches should be inspected and monitored as per the APIA *Code of Environmental Practice* [B159];
- Reduce the impact of CSG water on soil structure and aquatic values, by designing and constructing wells in accordance with the *Code of Practice for Constructing and Abandoning CSG wells in Queensland* (DEEDI *et al.,* 2011) [B168]; and
- Design creek crossings to ensure that existing flow regimes are maintained [B143].

17.5.4 Edge Effects

Mitigation measures outlined above will assist in controlling impacts associated with edge effects.

17.5.5 Habitat Offsets

An offset package will be developed in consultation with EHP and DSEWPaC to address both State and Commonwealth offsetting requirements. Due to the uncertainty in the degree and nature of the environmental impacts, specific offset requirements should be identified during the course of the Project and discussed with regulating authorities.

For the residual impacts that cannot be avoided or mitigated an offset plan approved by the relevant government agencies will be implemented [B144]. A draft environmental offset strategy has been prepared by Arrow (see the Offset Strategy (Appendix DD) of this EIS) to guide the development of the offset plan.

17.6 Residual Impacts

The avoidance, mitigation and management measures outlined in Section 17.5 will avoid or reduce the potential Project impacts to terrestrial ecology values within the Project area. Areas designated as extremely high sensitivity will be avoided, thereby eliminating potential impact to these areas. For less sensitive environments within the Project area the significance of any residual impacts associated with the Project activities are detailed in the 17-12.

Table 17-12 Residual Impact Assessment for Threatened Flora / Fauna Species and Significant Ecological Communities and Ecosystems.

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
Activities associated with direct clearing of sensitive vegetation, , habitat fragmentation, edge effects and loss of habitat important to threatened flora / fauna								
Field Development • Production well design and installation; • Gathering infrastructure design and installation; • Access track design and installation; • Electricity supply design and installation; being a combination of grid based (overhead lines) network and local power generation near field facilities. **Facility Development** • Field compression facility (FCF), coal handling and gas processing facility (CPGF), IPF design and installation; • Water storage and treatment facility (at IPF) design and installation;	Moderate to High	Low to High	Low to High	Conduct pre-construction / pre-clearance surveys to identify any additional areas that need to be avoided. Include as a minimum [B132]: — vegetation mapping at a scale suitable for site-specific planning; — identification of core habitats for EVNT species; and — data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing and used until rehabilitation is complete [B163]. Aim to avoid disturbance within the following areas [B131]: — endangered EPBC Act TECs: Brigalow Ecological Community (REs 11.3.1, 11.9.1, 11.9.5, 11.4.8, 11.4.9 and 11.5.16); Natural Grasslands Ecological Community (REs 11.8.11); Semi-evergreen Vine Thicket Ecological Community (REs 11.5.15, 11.8.3 and 11.8.13); Weeping Myall	Extremely Low	Low	Extremely Low to Low	Low to Moderate

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
• Power generation facility and/or powerlines design and installation; • Sewerage treatment facility design and installation.				Woodlands (REs 11.3.2 and 11.3.28); — category B ESAs; — category C ESAs including Arthur's Bluff State Forest and gazetted nature reserves; — stock routes and state or regionally significant bioregional wildlife corridors; — essential habitat; — core habitat for EVNT species; — state forests and resource reserves; and — state-listed 'of concern' REs. Disturbance exclusion zones (or management buffers) will be established and managed during construction and operations to effectively protect ESAs. This may include the following actions [B145]: • Manage impacts to Category A, B and C ESAs through implementation of management buffers. The buffers outlined below are indicative based on current regulatory conditions, however these may be subject to change in future. The buffers that will be implemented for the project will be in line with the regulatory requirements at the time of implementation. Indicative				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
				buffers at this time include: — In areas mapped as high constraint a buffer of 100 m, measured from the bank edge, will be adopted during all phases of the Project, with a further 100 m constrained to low impact activities; and — For areas mapped as moderate constraint, the following buffer zones, measured from the high bank edge, will be adopted during all phases of the Project: o a riparian buffer of 50 m width on either side of first and second order streams; and o a riparian buffer of 100 m width on either side of third, fourth, fifth and higher order streams • Develop site induction procedures to ensure that all worksite personnel, including contractors are made aware of the location of these sensitive habitats (and buffers) and are guided by qualified personnel when clearing is undertaken. Develop threatened species management procedures as and when project activities are identified as likely to impact upon individuals [B187].				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
				Attempt to locate wells, gathering lines and access tracks within previous clearings or non-remnant vegetation if possible [B133]. Design infrastructure to avoid undisturbed tracts of remnant vegetation, where practical. Where collection and gathering infrastructure is to be placed within contiguous vegetation, collection networks should be designed to avoid dissection [B134]. Access track location should avoid the repeated isolation of small parcels of remnant vegetation from more continuous tracts [B135]. Minimise vegetation disturbance wherever practical. Corridors for linear infrastructure should be as narrow as practical, particularly when crossing linear corridors of vegetation (e.g. Isaac River and Suttor Creek). Areas cleared for field development should be as small as practical [B136]. Retain habitat trees as a priority [B137]. Avoid removing riparian vegetation by directional drilling and reduction of right of ways where practical [B138]. Construct infrastructure within previously disturbed vegetation in preference to				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
				areas with higher biodiversity values [B139]. Deviate access tracks and pipelines around sensitive vegetation where practicable [B140]. Avoid construction activities in waterbodies frequented by migratory species [B141]. Apply sensitive infrastructure design principles to avoid watercourse, drainage lines and riparian areas where practicable [B142]. Design creek crossings to ensure that existing flow regimes are maintained [B143]. • Preparation of biodiversity offsets (DSEWPaC, 2011; DERM, 2011b) for Commonwealth and State significant biodiversity values [B144].				
All activities associated with field development plus: **Field Operation and Maintenance** • Production well operation and maintenance; • Gathering infrastructure	Moderate to High	Extremely Low to High	Low to High	• 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 [B172]. • Where possible, restrict traffic to designated access tracks [B148]. • Install and maintain appropriate sediment	Extremely Low	Low	Extremely Low to Moderate	Low to Moderate

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
operation and maintenance; • Access track operation and maintenance; • Electricity supply operation and maintenance. **Facility Operation and Maintenance** • FCF, CPGF, IPF operation and maintenance; • Water storage and treatment facility (at IPF) operation and maintenance; • Power generation facility operation and maintenance; • Sewerage treatment facility operation and maintenance. **Decommission and Rehabilitation** • Production well decommission and				and erosion control structures at work sites [B160]. • Inspect management buffers and areas of avoidance to ensure boundaries are clearly delineated prior to clearing [B166]. • Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167]. • Trenches should be inspected and monitored as per the APIA *Code of Environmental Practice* (APIA 2009) code of practice. • Inspect at risk erosion and sediment control measures following significant rainfall events to ensure effectiveness of measures is maintained [B094]. • Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169]. • Develop monitoring programs that are site specific and based on the identified risk to the conservation or maintenance of a viable population [B185].				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
rehabilitation; • Gathering infrastructure decommission and rehabilitation; • Access track decommission and rehabilitation; • Electricity supply decommission and rehabilitation; • FCF, CPGF, IPF decommission and rehabilitation; • Water storage and treatment facility (at IPF) decommission and rehabilitation; • Power generation facility decommission and rehabilitation; • Sewerage treatment facility decommission and rehabilitation.				• Inspect food scrap bins and exclusion fences to ensure effectiveness [B170]. • Routinely inspect for pest flora and evidence of pest fauna species within Project disturbed areas [B217]. • Visually inspect physical form and monitor hydrology, turbidity and pH upstream and downstream of crossings immediately prior to, during and after construction of watercourse crossings [B216]. • Routinely monitor buffer zones and project footprint using satellite imagery [B215]. • Carry out routine monitoring of rehabilitation success [B183]. • Woody debris, logs and rocks should be retained for use in rehabilitation. Where practical, these should be piled along the edge of the cleared corridor. However, spreading these features over part or all of the corridor is preferred as it will provide refugia for crossing fauna. Systematic removal of surface debris should be avoided and cleared timber should never be burnt [B161]. • During rehabilitation works, care will be				

Activity	Unmitigated Impact Assessment			Mitigation Measures	Residual Impact Significance			
					Total Avoidance*		Others	
	Sensitivity	**Magnitude**	**Significance**		**Magnitude**	**Significance**	**Magnitude**	**Significance**
				taken when moving stockpiled logs and vegetation to avoid fauna mortality [B186]. • Plant species used for rehabilitation are specific to the original ecosystem and local provenance, wherever possible unless the area has been cropped or contains improved pasture to be reinstated [B162]. • Inspect rehabilitation areas after decommissioning for regrowth similar to the surrounding environment [B177]. • Reinstate self-supporting drainage lines [B176]. • Implement site planning, preparation and management requirements in accordance with a decommissioning and rehabilitation plan [B175].				

17.7 Inspection and Monitoring

Following the assessment of residual impact a monitoring program will be implemented to test the effectiveness of mitigation. A monitoring program will include details of management actions, a set of performance criteria, and reporting to document the outcomes of each management action.

Monitoring will be required to ensure compliance with performance criteria as might be necessary to ensure compliance with statutory requirements. Methods will be developed to monitor impacts on threatened species and communities and determine the effectiveness of mitigation measures such as the habitat rehabilitation. Priority for monitoring will be given to the highest risk species in the area of (or in the vicinity of) immediate impact.

Inspection and monitoring measures should include:

- Data collection, particularly of EVNT species identified during pre-clearing surveys, during trench checking or in other Project related activities, should be ongoing until rehabilitation is complete [B163];
- Monitoring programs should focus on those sensitive ecological values at risk of a high to extremely high level of residual impact [B164];
- Consider targeted monitoring effort conducted in co-operation with the proponents of overlapping projects. Particularly suited species to such monitoring include ornamental snake (*Denisonia maculata*), koala (*Phascolarctos cinereus*) and brigalow scaly-foot (*Paradelma orientalis*) [B165];
- Inspect management buffers and areas of avoidance to ensure boundaries are clearly delineated prior to clearing [B166];
- Monitor during and after clearing activities to ensure no unauthorised encroachment has occurred [B167];
- Trenches should be inspected and monitored as per the APIA *Code of Environmental Practice* [B159];
- Where EVNT species are identified in proposed development areas, consider mitigation measures such as translocation and/or propagation of flora species. Monitor progress of any translocation programs in accordance with the relevant translocation management plans [B169];
- Inspect food scrap bins and exclusion fences to ensure effectiveness [B170]; and
- In accordance with the Pest Management Plan routinely inspect for pest flora and evidence of pest fauna within Project disturbed areas [B171].