ENVIRONMENTAL IMPACT STATEMENT

RED HILL
MINING LEASE

Section 09
Terrestrial Ecology

Section 09 Terrestrial Ecology

9.1 Introduction

The Red Hill Mining Lease is located adjacent to the existing Goonyella, Riverside and Broadmeadow (GRB) mine complex in the Bowen Basin, approximately 20 kilometres north of Moranbah and 135 kilometres south-west from Mackay, Queensland.

BHP Billiton Mitsubishi Alliance (BMA), through its joint venture manager, BM Alliance Coal Operations Pty Ltd, proposes to convert the existing Red Hill Mining Lease Application (MLA 70421) to enable the continuation of existing mining operations associated with the GRB mine complex. Specifically, the mining lease conversion will allow for:

- An extension of three longwall panels (14, 15 and 16) of the existing Broadmeadow underground mine (BRM).
- A future incremental expansion option of the existing Goonyella Riverside Mine (GRM).
- A future Red Hill Mine (RHM) underground expansion option located to the east of the GRM.

The three project elements described above are collectively referred to as 'the project'.

9.1.1 Aims

The aim of the Terrestrial Ecology investigation was to identify the flora and fauna assemblages, vegetation communities, habitats, conservation, and ecological and environmental values in and adjacent to the project environmental impact statement (EIS) study area. The potential impacts from the project on these values were assessed. This investigation considers the occurrence of conservation significant flora, vegetation communities, and fauna within the EIS study area. The scope of work undertaken during this investigation included:

- review of existing terrestrial flora and fauna data within the EIS study area and environs;
- compile a description of the floristics and structure of the vegetation communities;
- describe the diversity of amphibians, birds, reptiles and mammals found on the site;
- identify the presence of conservation significant or poorly known species;
- describe the integrity of ecological processes and functionality, including habitats of rare and threatened species;
- identify habitat requirements for conservation significant or noteworthy species;
- describe the use of areas by migratory birds and terrestrial fauna;
- describe the overall biodiversity of the study area;
- describe the diversity and extent of weed and pest species, assess potential impacts on biodiversity values and determine appropriate mitigation strategies; and
- determine offset requirements.

Aquatic Ecology is discussed separately in **Section 10**.

9.1.2 Overview of Studies Undertaken

Terrestrial ecology studies as part of the EIS were undertaken by URS Australia Pty Ltd (URS) in 2005, 2006 (flora only), 2009 and 2011. The studies involved a literature review of existing ecological data including the identification of conservation significant flora and fauna species and vegetation communities. The review was followed by field surveys to verify findings. This report combines data from the literature reviews conducted prior to the 2005, 2006, 2009 and 2011 field studies.

For the purposes of this report, the area within the EIS study boundary, as defined in **Section 3**, will be referred to as the 'EIS study area'. The 'survey area' refers to the boundaries of each of the terrestrial ecology surveys for 2005, 2009 and 2011. The 'survey area' for these various studies extends beyond the EIS study area. Description of terrestrial ecology environmental values was confined to the EIS study area only, except to the extent that the project may impact on adjacent terrestrial ecological values.

Additional to the ecological studies, this report identifies the environmentally sensitive areas (ESAs) within the EIS study area and surrounding region. An impact analysis on these ESAs was undertaken and is presented in **Section 9.7**.

9.1.3 Regional Setting

9.1.3.1 EIS Study Area

The Moranbah area has a history of grazing and extraction of coal. These land uses have markedly altered the natural characteristics of the land with associated impacts to vegetation communities, habitat values and native fauna.

Site Characteristics

The ecological values of the EIS study area are considered typical for the altered Isaac River sub-catchment, with large areas of land historically cleared for grazing and cropping. Although some areas of remnant vegetation remain intact, most have been modified to some extent by historical and current land management practices. The most common modification is the removal of the shrub and ground layers and replacement with pasture grass species.

The EIS study area features areas of habitat displaying north-south connectivity identified as state and regional importance. The remnant woodland vegetation in the south-east of the EIS study area represents significant habitat connectivity within the corridor system at a state scale. Contiguous tracts of vegetation within the EIS study area, representing local connectivity of habitat, are primarily linked by riparian corridors associated with the local creek and river systems. Connectivity in the east is primarily provided by the Isaac River riparian corridor. The Isaac River corridor connects with a large significant tract of vegetation along the Burton Range, approximately 10 kilometres to the north-west of the project. The Burton Range represents a contiguous extent of woodland approximately 18 kilometres long, varying in width from between one and five kilometres.

The majority of the EIS study area is located on relatively flat or slightly undulating lands at elevations between 250 and 325 metres above sea level (**Section 5.3.1**). Woodlands dominated by *Eucalyptus* or *Acacia* species cover part of the area with the remainder vegetated by non-remnant grasslands (as pasture) and shrubby regrowth. Areas of native grassland are present. In the drier areas *Eucalyptus populnea* (poplar box), *E. cambageana* (Dawson gum), *Corymbia tessellaris* (Moreton Bay ash) and

Acacia harpophylla (brigalow) generally dominate the canopy, with a sparse mid layer and ground cover of tussocky introduced grasses. Black soil grassland areas with *Lysiphyllum* species occur, while other areas are dominated by sandy, clayey or stony soils. Isolated low laterite hills vegetated with *Acacia* species occur in the south-east and west of the EIS study area.

Natural waterways on the site include the Isaac River and its tributaries, including Goonyella, Eureka, Fisher, and Platypus creeks and 12 Mile Gully. All streams on the site are ephemeral with flow only evident following significant rain events. The Isaac River is a significant watercourse in the region, flowing south to enter the Fitzroy River system.

The primary existing land use within the EIS study area is cattle grazing. As a result, the general ecology of the area has been significantly modified. Modifications include the proliferation of the exotic *Pennisetum ciliare** (buffel grass) to the general exclusion of native groundcover species; impacts from cattle (trampling of ground cover vegetation); loss of mid-story vegetation shrubby diversity; soil erosion; compaction; and disturbance and fouling of natural water bodies. The presence of artificial water supplies, such as dams, provide habitat and resources for fauna groups including waterbirds and frogs, and enhances the conditions for exotic fauna such as cane toads and feral pigs.

9.1.3.2 Bioregion

Queensland's bioregions are based on landscape patterns that reflect geology and climate, as well as floral and faunal assemblages at a broad scale and are used as the fundamental framework for the planning and conservation of biodiversity (Young *et al.* 1999).

The EIS study area is located within the Brigalow Belt bioregion, which has experienced rapid and extensive loss of habitat. Major impacts upon vegetation of the Brigalow Belt include tree clearing, high grazing pressure, and the proliferation of exotic species such as the *Opuntia** spp. (prickly pear). Additionally, the introduced pasture species *Pennisetum ciliare** (buffel grass) dominates much of the open landscape. As a consequence of habitat modification, many flora and fauna species in this bioregion have undergone severe range reductions and localised extinctions have occurred for several fauna species (Young *et al.* 1999).

Vegetation clearing has occurred on most of the lowland landscapes. Areas with more rugged topography associated with the sandstone and metamorphic ranges remain relatively undisturbed (Young *et al.* 1999).

9.1.3.3 Sub-Region

The Brigalow Belt bioregion contains 36 sub-regions that delineate significant differences in geology and geomorphology (Young *et al.* 1999). The EIS study area is situated within the Northern Bowen Basin subregion. The landscape of this province is predominantly undulating country dominated by *Acacia harpophylla* (brigalow) communities on clay soils and *Eucalyptus crebra* (narrow-leaved ironbark) and *E. populnea* (poplar box) open woodland communities on the shallower texture-contrast soils. Areas of sandstone are dominated by both narrow-leaved ironbark and bloodwoods (*Corymbia* spp.). Streams are often fringed by *E. raveretiana* (black ironbox) (Sattler and Williams 1999).

9.1.4 Legislative Context

The following legislation and policies are relevant to terrestrial ecology values and ESAs within the EIS study area:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Nature Conservation Act 1992* (NC Act);
- *Land Protection (Pest and Stock Route Management) Act 2002* (LP Act);
- *Vegetation Management Act 1999* (VM Act);
- *EPBC Act Environmental Offsets Policy October 2012;*
- *Queensland Government Environmental Offsets Policy 2008*; and
- Department of Environment and Heritage Protection (EHP) (formerly the Department of Environment and Resource Management (DERM)) *Biodiversity Offset Policy (Version 1, 30 October 2011)* (BOP).

An outline of the above legislation and guidelines is provided in **Appendix K1**.

9.2 Assessment Methodology

9.2.1 Flora and Fauna Literature Review Methodology

A desktop review of ecological data and literature was undertaken to characterise the ecological values and identify the potential presence of conservation significant species, habitats and vegetation communities within the survey area. The objectives of the desktop study included:

- the review of relevant biodiversity databases and conservation reports for the survey area and surrounding region;
- an assessment of the broad floral and faunal conservation values of vegetation communities present in the survey area;
- the identification of the potential presence of conservation significant flora and fauna species and vegetation communities; and
- supporting design and targeting of field surveys.

9.2.1.1 Data Sources

Existing data on flora and fauna within the survey area was compiled through acquisition and review of the following key references:

- EHP Herbarium Database (HERBRECS) (NRM 2013b);
- EHP 1:100,000 Regional Ecosystem (RE) mapping v.6.0b (Queensland Herbarium 2011);
- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) online Environment Protection and Biodiversity Conservation (EPBC) Matters of National Environmental Significance (MNES) database (DSEWPaC 2012a);
- EHP Wildlife online database (EHP 2012e);

- Queensland Museum fauna records (Queensland Museum 2011);
- Birds Australia database (Birds Australia 2011);
- EHP Essential Habitat mapping (EHP 2012d);
- EHP Ecomap ESA mapping (EHP 2009); and
- species distribution maps from current field guides.

In order to identify the range of flora and fauna species potentially present within the EIS study area and the broader region, reviews of the above data sources were conducted for the area as defined by the coordinates presented below. Prior to each survey period, new database searches were conducted. Only the most recent search results (2011) have been used in this report to ensure data used is current. The search areas used for each data source do not necessarily correlate to the EIS study area boundary due to the inherent search parameters for each database.

A description of these databases can be found in **Appendix K2**.

9.2.1.2 Search Areas

Latitudes and longitudes used for each search area (as described in **Section 9.2.1.1**) are provided below:

- a search of the HERBRECs database for the area bounded by the latitudes (decimal degrees): -21.6405 to -21.8692 and longitudes (decimal degrees): 148.0584 to 147.8635 retrieved on 21 January 2011;
- records for REs found within the area bounded by the latitudes (decimal degrees): -21.6405 to -21.8692 and longitudes (decimal degrees): 148.0584 to 147.8635 retrieved on 21 January 2011;
- an EPBC Act Protected Matters Report for a 10 km buffer around latitude -21.759, longitude 147.96902 (decimal degrees). Retrieved on 4 July 2012 and 12 June 2013;
- a Wildlife Online database search (Queensland EHP) for fauna and flora records bounded by the latitudes (decimal degrees) -21.644 to -21.889 and longitudes (decimal degrees) 147.866 to 148.054 retrieved on 21 January 2011;
- a Birds Australia database search for one degree square containing the latitudes 21° 38' and 21° 53' and longitudes 147° 52' and 148° 3' retrieved on 1 April 2011 (degrees, minutes);
- a Queensland Museum database search bounded by the latitudes 21° 38' and 21° 53' and longitudes 147° 52' and 148° 3' retrieved on 1 April 2011 (degrees, minutes); and
- Queensland EHP Ecomap ESAs for the latitudes and longitudes (decimal degrees):
  - Area 1 -21.759, 147.969;
  - Area 2 -21.384, 148.456;
  - Area 3 -21.644, 148.054;
  - Area 4 -21.384, 147.456;
  - Area 5 -21.644, 147.866;
  - Area 6 -22.266, 148.456;
  - Area 7 -22.266, 147.456; and
  - Area 8 -21.889, 147.866.

9.2.1.3 Existing Ecological Reports

The survey area has been extensively surveyed for flora, fauna, vegetation communities and biodiversity values. A review of 12 existing ecology study reports was undertaken to encapsulate all species that have previously been known to occur on site and are therefore potentially still present. The following reports were reviewed:

- WBM (1998 and 2000) dry and wet season fauna surveys of the GRM conducted in August 1998 and February 2000, respectively.
- WBM (2002) *A flora and fauna survey of the proposed 'Ramp Four' mining area at GRM*, conducted in February 2002.
- Ecoserve (2005a) *2005 Summer Season Flora and Fauna Surveys for Peak Downs Mine*. Prepared by Ecoserve Environmental Consultants.
- Ecoserve (2005b) *An Investigation of Flora, Fauna and Biodiversity Values associated with Brigalow Remnants along the Proposed Heyford Back Access Road*. Prepared by Ecoserve Environmental Consultants.
- Ecoserve and LAMR (2005) *A review of habitat values for biodiversity and conservation significance for the GRM conducted in 2005*. Prepared by Ecoserve Environmental Consultants and Landscape Assessment, Management and Rehabilitation Pty Ltd.
- Ecoserve (2006a) Draft - *Flora and Fauna Baseline Surveys for the BMA Isaac River Project*. Prepared by Ecoserve Environmental Consultants and Landscape Assessment, Management and Rehabilitation Pty Ltd.
- Ecoserve (2006b) *Draft - Preliminary Flora and Fauna Investigations – Land at Station Road, Moranbah.* Prepared for Shaun Ferris, BM Alliance Coal Operations Pty Ltd Project Development by Ecoserve Environmental Consultants and Landscape Assessment, Management and Rehabilitation Pty Ltd.
- Ecoserve (2006c) *Targeted vertebrate fauna surveys of selected remnant regional ecosystems on BMA GRM*. Prepared by Ecoserve Environmental Consultants.
- Ecoserve (2007) *A Review of Habitat Values for Biodiversity Species of Conservation Significance – Peak Downs Mine*. Prepared for BMA Peak Downs Mine by Ecoserve Environmental Consultants.
- Emmerton and Elsol (2007) *Peak Downs Mine Rehabilitation Monitoring August September 2006*. Prepared by B.R. Emmerton Pty Ltd and J and J Elsol.
- URS (2007) *Goonyella Riverside Mine Expansion EIS - Terrestrial Flora Report*; Unpublished Draft.
- URS (2009a) *Goonyella Riverside Mine Expansion EIS – Chapter 8 Terrestrial Ecology*, Unpublished draft.

Results from previous ecological surveys have been incorporated into a complete fauna species list for the area (refer to **Appendix K2**).

9.2.2 Flora Field Survey Methodology

The flora survey assessed floral taxa and vegetation communities in keeping with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.* 2005). Preliminary identification of the vegetation communities and target field sites was conducted prior to the commencement of fieldwork. Preliminary identification included vegetation community definition from stereoscopic imagery at scales of 1:33,000, 1:35,000 and 1:36,000 colour aerial photography (AAM Hatch 2003, 2005 and 2008) and interpretation of 1:100,000 RE coverage Version 6.0b for the region (DERM 2010).

Field surveys involved a botanical assessment at a number of representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches outlined in **Section 9.2.1.1**. The surveys employed a number of standard methods including: secondary survey sites, tertiary survey sites, quaternary survey sites and random meander search areas. The methods used for each of these are described in more detail below.

A number of vehicle traverses of the survey area were included during the survey periods to identify changes in landform and identify community boundaries. Community structural formation classes were assessed according to Neldner *et al.* (2005). RE classification of communities was determined as per Sattler and Williams (1999), and in accordance with the Regional Ecosystems Description Database (REDD) (Queensland Herbarium 2011). The survey was conducted under Queensland EHP Scientific Purposes Permit numbers WISP02056304 (2005 to 2006) and WISP06537209 (2009 and 2011). The flora surveys were conducted during the following months:

- 2005 (October);
- 2006 (January/February, May);
- 2009 (March, May); and
- 2011 (May).

Detailed weather conditions experienced during each survey is provided in **Appendix K1**.

9.2.2.1 Secondary Surveys

Field surveys employed 73 secondary survey sites within the survey area during the 2005 to 2006 survey period and 30 secondary survey sites during the 2009 survey. Tertiary level surveys were introduced in 2011 (**Figure 9-1**). Secondary survey sites were comprised of 10 by 50 metre (500 square metre (m^2)) transects. Fieldwork within secondary survey sites included detailed floristic and structural analysis.

Floristic analysis included plant identification and species diversity characterisation of all flora present. Relative abundance was assigned for all species recorded. Structural analysis included recording the height class and life form of the dominant species within each strata present. The height of each strata was recorded. The crown separation ratio (CSR) of the mid and upper strata was calculated along the transect; crown gaps (distance between crowns) were recorded and crown widths (spread) were recorded using ocular estimation. The foliage projection cover (FPC) of the ground layer was determined using ocular estimation of cover within five 1 m^2 subplots along the secondary transect. Foliage projection of the canopy and mid strata (where applicable) was calculated by converting CSR to FPC (Walker and Hopkins 1999).

Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity were compiled for each secondary survey site. Several time-encoded digital photographs were taken at each plot as a reference. Locations of data collection sites were recorded.

9.2.2.2 Tertiary Surveys

The 2011 field surveys utilised 16 tertiary transects (**Figure 9-1**). Tertiary transects were comprised of 10 by 50 metres (500 m^2) transects as per the Queensland Herbarium methodology (Neldner *et al.* 2005).

Descriptive site information recorded at Tertiary transects included location, aspect, slope, soil type, landform, disturbance, fire history, an assessment of bio-condition and general notes on ecological integrity.

Structural analysis included recording the height class and distribution of the dominant species within each strata present. The FPC of each strata was calculated along each transect, where foliage projection intersected a 50 metre centre tape. FPC of the ground layer was determined using visual estimation of cover within five 1 m^2 subplots spaced at 10 metre intervals along each transect.

Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity were compiled for each quaternary survey site. Several time-encoded digital photographs were taken at each plot as a reference. Locations of data collection sites were recorded.

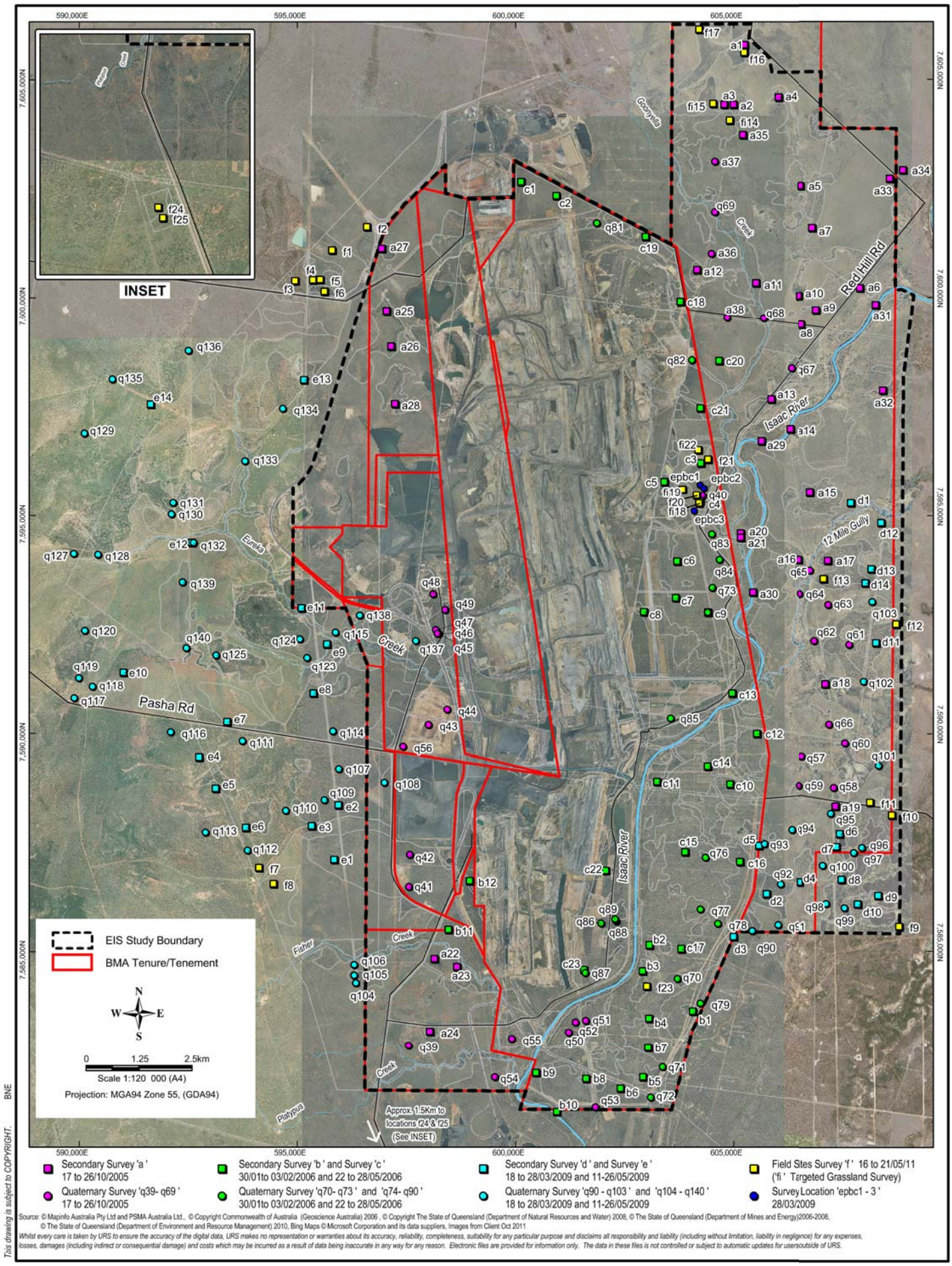
9.2.2.3 Quaternary Surveys

Quaternary surveys were undertaken at 51 sites in the 2005 to 2006 survey, 51 sites in the 2009 survey and nine sites in the 2011 survey. Quaternary-level sites were utilised to verify vegetation units and confirm dominant characteristic species (**Figure 9-1**). Structural analysis included recording the height class and life form of the dominant species within the mid and canopy strata as per Neldner *et al.* (2005). RE classification (Sattler and Williams 1999) was determined based on estimated structural and floristic analysis.

Evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity were compiled for each quaternary survey site. Several time encoded digital photographs were taken at each plot as a reference. Locations of data collection sites were recorded as meander searches.

Following the assessment at the secondary, tertiary and quaternary sites, an area of approximately one hectare surrounding each plot was searched for 20 minutes utilising the random meander technique (Cropper 1993). Care was taken to avoid sampling in different vegetation types to those of the plots. Meander searches were employed to:

- identify additional less abundant species not recorded within survey plots;
- identify any potential significant threatened or species not identified within the survey plot;
- confirm the representativeness of plot locations; and
- confirm boundaries and ecotone areas between vegetation communities.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

FLORA
SURVEY LOCATIONS

URS

TERRESTRIAL ECOLOGY

Figure: **9-1**

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9.2.2.4 Targeted Grassland Survey

Targeted grassland surveys for the remnant grassland RE 11.8.11 were undertaken in the north-east of the survey area (**Figure 9-1**) to determine whether the grasslands mapped at this location met the criteria for the endangered *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* threatened ecological community (TEC).

The survey methodology was based on the method set out in the EPBC listing advice for the *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (DEWHA 2008). It consisted of assessment of key diagnostic characteristics and condition thresholds. Refer to **Appendix K1** for further details of the methodology employed.

Key Diagnostic Characteristics

The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC may be recognised by the following diagnostic features:

- Distribution: Occurs within the Brigalow Belt north and south, which are largely within the Central Highlands and northern Fitzroy River Basin regions of Queensland.
- Tree canopy absent or sparse (less than 10 per cent projective crown cover). If it can be demonstrated, beyond reasonable doubt, that the grassland was derived from cleared woodland then it is not part of the national ecological community.
- The ground layer is typically dominated by perennial native grasses and contains at least three of the indicator native species listed below:
  - *Aristida latifolia* (feather-top wiregrass);
  - *Aristida leptopoda* (white speargrass);
  - *Astrebla elymoides* (hoop Mitchell grass);
  - *Astrebla lappacea* (curly Mitchell grass);
  - *Astrebla squarrosa* (bull Mitchell grass);
  - *Bothriochloa erianthoides* (satin-top grass);
  - *Dichanthium queenslandicum* (king bluegrass);
  - *Dichanthium sericeum* (Queensland bluegrass);
  - *Eriochloa crebra* (cup grass);
  - *Panicum decompositum* (native millet);
  - *Panicum queenslandicum* (yabila grass);
  - *Paspalidium globoideum* (shot grass); and
  - *Thellungia advena* (coolibah grass).

Note that in dry season or drought conditions, the only visible evidence of natural grassland may be scattered tussocks that are difficult to identify to species level. Therefore, condition of the ecological community must be assessed during a good season; two months after cessation of disturbance (fire/grazing/mowing/slashing) and within two months of effective rain. A survey which followed these conditions was undertaken and the results are presented in **Section 9.3.3.5.**

Condition Thresholds

The *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* TEC comprises those patches that meet the key diagnostic characteristics above, and the condition thresholds in **Table 9-1** below. Both the 'best quality' and 'good quality' patches are included in the listed ecological community.

Table 9-1 Condition Classes for the *Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin* TEC

	Best Quality	Good Quality
Patch size	At least 1 ha; and	At least 5 ha; and
Grasses	At least 4 native perennial grass species from the list of perennial native grass indicator species; and	At least 3 native perennial grass species from the list of perennial native grass indicator species; and
Tussock cover	At least 200 native grass tussocks; and	At least 200 native grass tussocks; and
Woody shrub[1] cover	Total projected canopy cover of shrubs is less than 30 per cent; and	Total projected canopy cover of shrubs is less than 50 per cent; and
Introduced species	Perennial non-woody introduced species are less than 5 per cent of the total projected perennial plant cover.	Perennial non-woody introduced species are less than 30 per cent of the total projected perennial plant cover.

Note 1: The shrub layer is typically absent. However, where shrubs are present, they are defined as woody plants more than 0.5 m tall that occupy the mid vegetation layer. The upper, or tree canopy layer, also is typically absent but may comprise scattered trees to less than 10 per cent projective crown cover.
Sampling should be based upon a quadrat size of 0.1 ha (e.g. 50 m x 20 m) selected in an area with the most apparent native perennial grass species. Unless exceptional circumstances apply, to maximise the assessment of condition, sites must be assessed during a good season, two months after cessation of disturbance (fire/grazing/mowing/slashing) and within two months of effective rain.

It should be noted that the Brigalow TEC is confirmed by standard flora survey techniques and the classification of REs as prescribed by Sattler and Williams (1999), and in accordance with the REDD (Queensland Herbarium 2011). Therefore, targeted surveys for this TEC are not required.

9.2.2.5 Specimen Identification

Where plant species could not be identified in the field, fruiting and/or flowering specimens were taken to assist with identification. For those species not field identified, samples were pressed and dried and positive identifications of plant specimens were subsequently made under laboratory conditions or submitted to the Queensland Herbarium for identification (herbarium references: LN:EJT:mh 676/09 and MBT/LN:548/09). A sample of conservation significant species recorded was also submitted to the herbarium for confirmation.

9.2.2.6 Nomenclature

Taxonomic nomenclature used for the description of floral species is according to Bostock and Holland (2010). Exotic flora species are signified in all text and tables by an asterix (*). Field references utilised for the identification and description of floral species include: Anderson (2003); Brooker and Kleinig (1994); Milson (2000); and Stanley and Ross (1989, 1995 and 2002).

9.2.2.7 Mapping Scale

Mapping for the survey area has been completed at a scale of 1:30,000 in order to accurately capture the extent of the vegetation communities present and provide information at an appropriate scale to adequately inform biodiversity management of the site.

9.2.2.8 Survey Limitations

Data acquisition during flora surveys generally has inherent limitations associated with variability of vegetation communities across a site, and changes to the detectability and presence of species with time. A high level of confidence in comprehensiveness is implicit in this study as survey sites were strategically located to capture representative samples of all communities. Further, the seasonal conditions during which this survey was undertaken were conducive to a relatively high degree of detectable floral diversity (**Appendix K1**). However, given the above it is recognised that field studies with a temporal limitation cannot always account for 100 per cent of potential floral diversity present within a site.

9.2.3 Fauna Field Survey Methodology

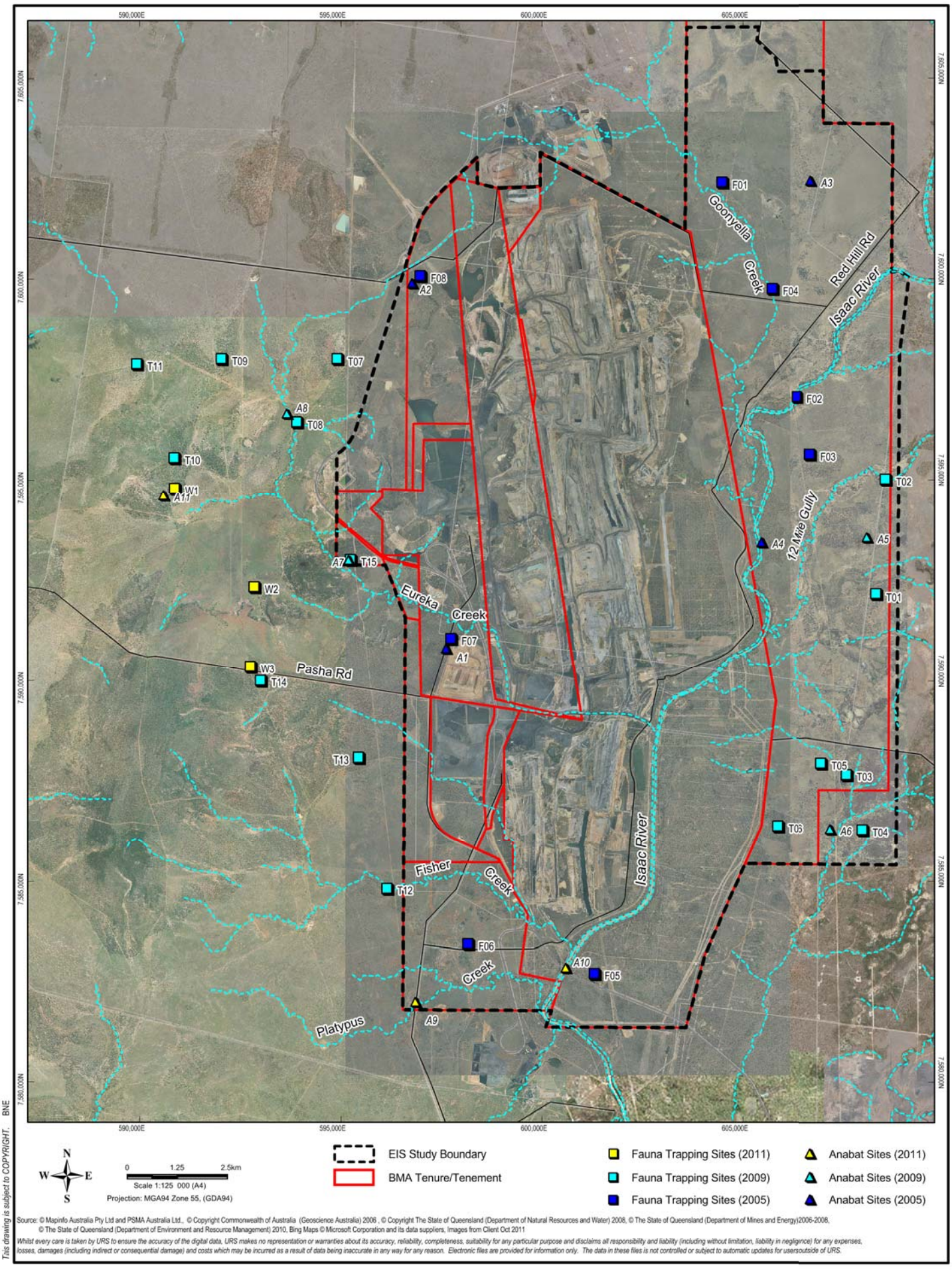
Fauna surveys were conducted by URS in 2005, 2009 and 2011. Prior to each survey event, potential fauna survey transect sites were identified during desktop studies and aerial photograph analysis, with the objective to target and characterise the key habitats across the site. Each survey period featured systematic fauna surveys, which were undertaken using standard methodologies for the systematic survey of terrestrial fauna in eastern Australia (Eyre *et al.* 1997; EPA 1999) as well as a number of observational methods. Methods employed during each survey period included live capture and release trapping, bird census, spotlighting, active searches, call playback, and microchiropteran bat call detection. Incidental observations were made during surveys and away from the main sampling sites. The survey methodology and seasonal timing was designed to build on previous fauna surveys in the local environs (WBM 1998, 2000 and 2002; Ecoserve and LAMR 2005; Ecoserve 2006c).

The fauna surveys utilised a range of standard fauna survey methods. These are described in more detail below. Trapping effort for live capture/release and pitfall trapping is detailed in the fauna technical report (**Appendix K2**). Survey locations are presented on **Figure 9-2**.

9.2.3.1 Live Capture/Release Trapping

Small mammals and reptiles were surveyed using live trapping methods including aluminium type A and B Elliott box traps, cage traps and pitfall traps with drift fences. Elliott traps were placed at 10 metre intervals along one transect (two transects in the 2005 survey) at each survey site. Traps were baited with a mixture of rolled oats, peanut butter, honey and vanilla essence and were individually placed to sample microhabitats such as dense grass, rocky cover and fallen timber.

Pitfall trap systems incorporated PVC buckets approximately 40 centimetres deep (18 litre) with a plastic drift fence typically five metres long by 0.4 metres high. Pitfall traps were checked for and cleared of captures in the mornings and late afternoons. Leaf litter and shallow dishes holding water were placed in each bucket to shelter and reduce the opportunity for dehydration of trapped fauna.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

FAUNA SURVEY LOCATIONS

URS | **TERRESTRIAL ECOLOGY** | Figure: **9-2**

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9.2.3.3 Daytime Bird Census

Diurnal birds were sampled using an area census method supplemented by broad observational surveys. Birds were systematically sampled at each of 27 main sample sites. Surveys were carried out in the early morning (in the first three to four hours after sunrise) due to variation in avian activity during the day. Birds were counted on one hectare plots at each site, over a period of 20 minutes per sample. Three or four such surveys were undertaken at each of the sample sites, while additional surveys were undertaken at a range of other sites. Incidental observations were noted throughout the survey area.

9.2.3.4 Spotlight Survey

In order to locate nocturnal birds, reptiles, amphibians and mammals, spotlighting was undertaken on foot using hand-held spotlights. This was done at all primary sample sites and in other areas of representative habitat. Spotlighting from a slow moving vehicle was undertaken along the main tracks of the survey area. This method was used to locate larger ground and arboreal mammals and nocturnal birds.

9.2.3.5 Owl Call Playback

Call playback of various owl species' calls was undertaken during the nocturnal surveys. Calls were played for several minutes, followed by a period of listening for responses.

9.2.3.6 Microchiropteran Bat Call Detection

Microchiropteran bat echolocation calls were recorded using an ultrasonic bat call detector (Anabat SD2; Titley Electronics). Anabat detection was conducted across the site in representative communities between dusk and dawn.

9.2.3.7 Active Searches

Active diurnal searching for reptiles, amphibians and small mammals included scanning of trees and ground, searching beneath microhabitat such as rocks, fallen timber and peeling bark and digging through leaf litter and soil at tree bases. Searches also focussed on locating and identifying tracks and traces such as nests, scats and scratches on trees.

9.2.3.8 Incidental Observations

All fauna observed incidentally throughout the site were recorded. Large mammals were recorded when encountered during trapping, bird surveys, spotlight surveys, and along roads and tracks throughout the survey area. Observations of wildlife recorded outside the main sampling sites were noted according to the habitat in which they were observed.

9.2.3.9 Nomenclature

Taxonomic nomenclature used for describing fauna species follows Stanger *et al.* (1998), with the exception of recently published taxonomic revisions. Exotic species are denoted by an asterix (*). Field references used for the identification and description of fauna species include Churchill (1998), Cogger (2000), Menkhorst and Knight (2001), Morecombe (2004), Pizzey and Knight (2007), Robinson (1998), Simpson and Day (2004), Strahan (2008), Triggs (2004) and Wilson (2005).

9.3 Terrestrial Flora Results

9.3.1 Literature Review Results

A literature review of current legislation, regional information, RE and regrowth mapping pertaining to the EIS study area is summarised below. It includes information on the region's vegetation communities, remnant and regrowth REs and essential habitat mapped in the EIS study area, and MNES flora data for the area.

9.3.1.1 Regional Ecosystems

Current State Government RE mapping shows 19 REs are mapped within the EIS study area, including seven listed as endangered, four as of concern and eight as least concern (under the VM Act).

Of the REs mapped, 1,402 hectares are mapped as dominant endangered vegetation communities, 2,419 hectares are mapped as of concern communities and 3,550 hectares are mapped as least concern REs.

EPBC Threatened Ecological Communities

Two endangered EPBC TECs were identified from desktop sources as potentially occurring in the EIS study area;

- *Brigalow (Acacia harpophylla dominant and co-dominant)*; and
- *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin*.

9.3.1.2 Conservation Significant Species

A review of the existing databases and literature on terrestrial flora for the region identified a total of seven conservation significant flora species as being potentially present within the EIS study area. Of the species identified, six are listed as near threatened and one is listed as vulnerable under the NC Act. Two of these species are listed as vulnerable and one is listed as endangered under the EPBC Act. A summary of the literature review results is provided in **Table 9-2**.

Species of cultural significance that might potentially be present within the broader region include species traditionally utilised for food or medicinal purposes, tree species utilised for their bark for painting, and wildflower species traditionally collected for decoration or adornment. No cultural values have previously been identified for any species as described in previous flora surveys or studies undertaken for the survey area (WBM 2002; Ecoserve 2005a; URS 2007).

Table 9-2 Conservation Significant Flora Determined as Potentially Present within the EIS Study Area from Database Searches

Scientific Name (common name)	NC Act Status[1]	EPBC Act Status[2]	Distribution/Habitat[3]	Likelihood of presence	Data source[4/5]
Bertya sharpeana	NT	Not listed	Rare, hairy shrub to 2 m on steep cliffs of Mt. Coolum, SE Queensland. Also known from central coastal Qld north of Mackay.	Unlikely	(A)
Melaleuca pearsonii formerly *Callistemon pearsonii*	NT	Not listed	Blackdown Tablelands, central Queensland.	Unlikely	(A)
Desmodium macrocarpum	NT	Not listed	Known from the Great Dividing Range in northern Queensland between Blackall and Pentland.	Unlikely	(A)
Dichanthium setosum	Not listed	V	An upright bluegrass less than 1 m tall. Associated with heavy basaltic black soils and found in moderately disturbed areas. In Queensland its distribution includes the Leichhardt, Moreton, North Kennedy and Port Curtis regions.	Presence confirmed on site.	(A); (B); EHP (i); EHP (ii), DSEWPaC
Dichanthium queenslandicum (king blue-grass)	V	E	Endemic to Queensland where it occurs mostly on black clay soils around Emerald and more rarely on the Darling Downs.	Likely	(A); (B); EHP (i) DSEWPaC
Digitaria porrecta (finger panic grass)	NT	E	Occurs in four disjunct areas: in Queensland this includes the Nebo District, south-west of Mackay; the Central Highlands between Springsure and Rolleston; and from Jandowae south to Warwick. Found in grasslands on extensive basaltic plains and undulating woodlands / open forests with basaltic geology.	Likely	(A); (B); DSEWPaC
Paspalidium scabrifolium	NT	Not listed	Occurs along coastal and sub-coastal Qld from Tin Can Bay to Cape Melville.	Unlikely	(A); (B)

*Conservation significant flora species as being potentially present within the EIS study area
Note 1: NC Act Status codes; Extinct in the wild (PE); endangered (E); vulnerable (V); near threatened (NT); least concern (C).
Note 2: EPBC Act codes: vulnerable (V); conservation dependent (CD); critically endangered (CE); endangered (E); extinct (EX)
Note 3: Information based on a number of sources including: Anderson (2003); Milson (2000); and PlantNET (2009).
Note 4: Queensland Herbarium records retrieved 1/2/11; Queensland EHP Wildlife Online database records retrieved 21.1.11. DSEWPaC: Commonwealth EPBC online MNES search generated 4.7.12 and 12.6.13.
Note 5: Indicates previous flora studies identified potentially significant species occurring in the region. (A): WBM 2002; (B): Ecoserve 2005a and 2005b.

9.3.1.3 Essential Habitat Mapping

Essential habitat for *Dichanthium setosum* has been mapped in the central-eastern side of the EIS study area in RE 11.8.11 (EHP 2012d). This is depicted on **Figure 9-3**. This species has recently been delisted from the NC Act and therefore it is expected that subsequent updates to the EHP essential habitat map will not include this species.

9.3.1.4 Significant Biodiversity Values

An analysis of the biodiversity planning assessment (BPA) for the Brigalow Belt shows that approximately 3,929 hectares of state significant habitat, 2,069 hectares of regionally significant habitat and 1,612 hectares of locally significant habitat is present within the EIS study area (EHP 2012a). Regional connectivity and biodiversity corridors identified from the BPA are displayed in **Figure 9-4**.

Both the Brigalow Belt BPA and the Fitzroy Basin Association bioregional corridor mapping (Cook *et al.* 2006) indicate that the Isaac River and its associated riparian vegetation contribute to habitat connectivity from north to south on both a regional and state level. Regionally significant habitat exists within the far north-east and the south-west of the EIS study area where it connects to a larger tract of regional and locally significant habitat.

9.3.2 Field Survey Results

This section documents the results of detailed field surveys of the flora and vegetation communities of the survey and includes a summary of species diversity, remnant and regrowth REs, conservation significant flora, condition of grasslands, regional connectivity and weeds of concern. Detailed community descriptions and quantitative data including detail of the floristics and structure for each survey site are provided in the **Appendix K1**.

Flora field surveys were undertaken over six periods during 2005, 2006, 2009 and 2011. The seasonal weather conditions for each survey period are described in the **Appendix K1**.

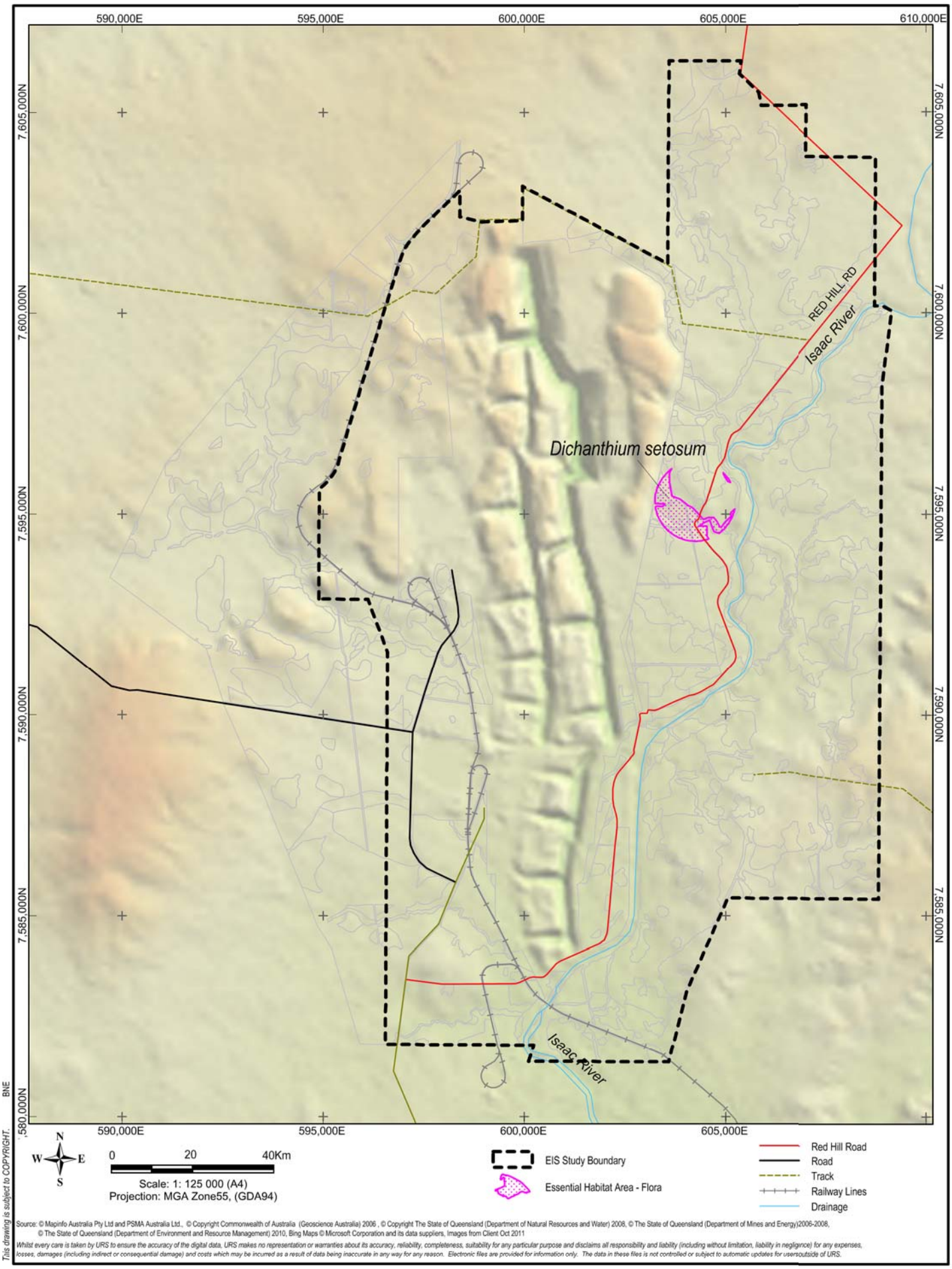
9.3.2.1 Regional Connectivity

Continued grazing practices and historical tree clearing throughout the region have greatly altered vegetation patterns from large extents of woodlands to open modified grasslands and discrete patches of disturbed *Eucalyptus populnea* (poplar box), *Eucalyptus cambageana* (Dawson gum), *Acacia harpophylla* (brigalow) and *Acacia shirleyi* (lancewood) woodlands. Grazing impacts have left the majority of woodland habitat in the region with a highly modified and mostly absent mid-strata. Only the remnant woodland vegetation in the south-east corner of the survey area and riparian woodlands along the Isaac River and 12 Mile Gully represents significant habitat connectivity at a state scale (**Figure 9-4**).

Contiguous tracts of vegetation within the survey area representing local connectivity of habitat are primarily provided by riparian corridors associated with the local creek and river systems. These connect areas of remnant vegetation across the survey area.

North-south connectivity in the EIS study area is primarily provided by the Isaac River riparian corridor. The Isaac River corridor joins a large tract of vegetation at the Burton Range approximately 10 kilometres to the north-west of the project. Vegetation in the Burton Range has been protected from clearing by the hilly topography in this area and represents a contiguous extent of woodland approximately 18 kilometres long varying in width from one to five kilometres.

Connectivity of habitat at the local scale is relatively limited in an east-west pattern across the survey area. This is a result of grazing and land use impacts, including the current GRB mine complex. Vegetation clearing and grazing disturbance have impeded local connectivity to the east and north of the survey area. The Isaac River affords connectivity of habitat to the north and south on the local scale (**Figure 9-4**).



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

ESSENTIAL HABITAT WITHIN THE EIS STUDY AREA

URS

TERRESTRIAL ECOLOGY

Figure: **9-3**

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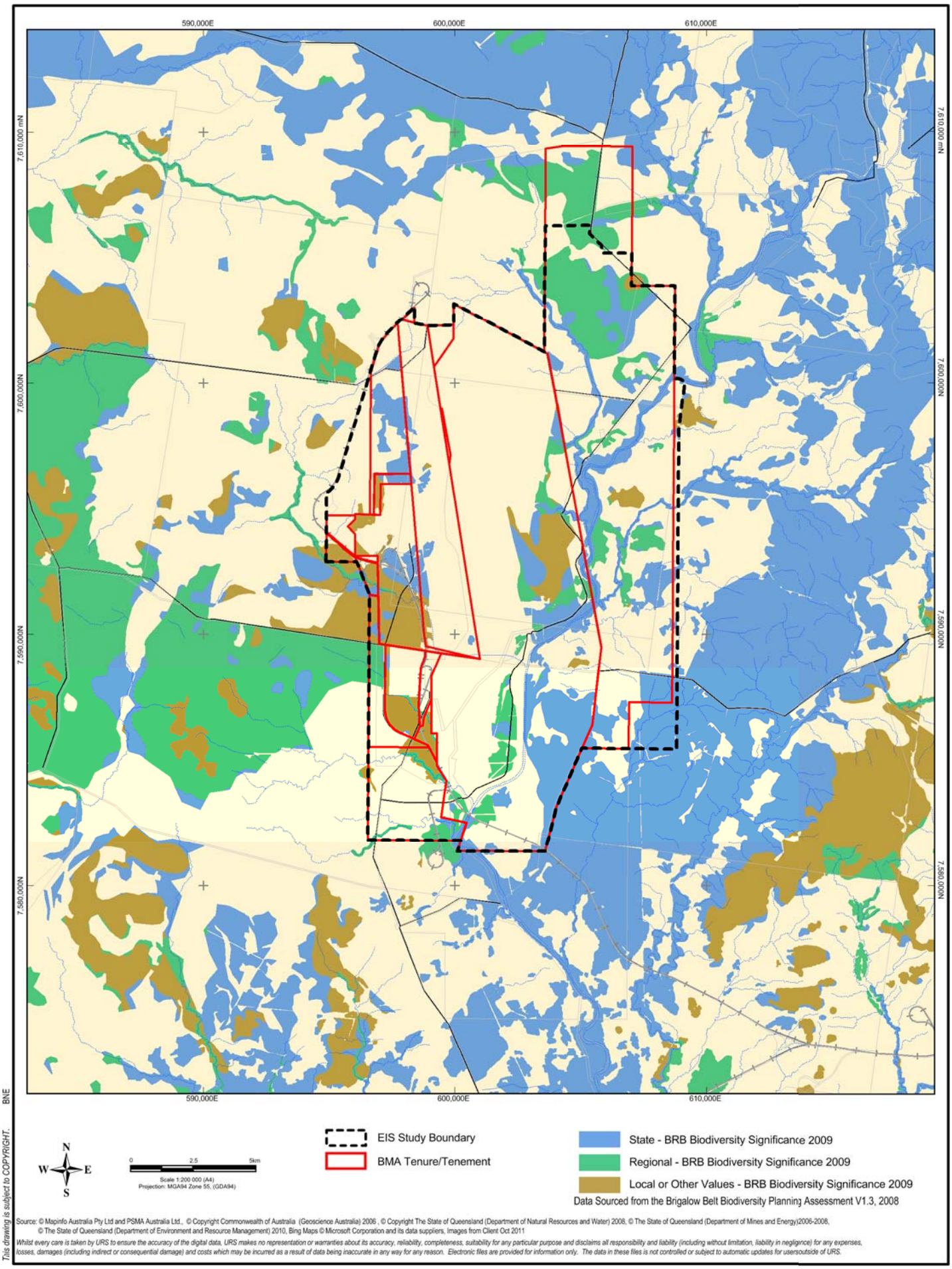

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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

BIODIVERSITY PLANNING ASSESSMENT FOR THE EIS STUDY AREA

URS

TERRESTRIAL ECOLOGY

Figure: **9-4**

File No: **42627136-g-1054.wor** Drawn: **VH** Approved: **CT** Date: **11-06-2013** Rev.**A** A4

9.3.3.1 Species Diversity

The field surveys of the survey area identified the presence of 368 plant taxa representing 67 families and 202 genera. Families represented by three or more genera included Amaranthaceae (7 genera), Apocynaceae (4), Asteraceae (13), Caesalpiniaceae (6), Chenopodiaceae (7), Euphorbiaceae (8), Fabaceae (14), Malvaceae (7), Mimosaceae (3), Myrtaceae (3), Poaceae (42), Rubiaceae (7) and Rutaceae (3).

Genera represented by three or more species included *Acacia* (13 species), *Alectryon* (3), *Amyema* (4), *Aristida* (13), *Atriplex* (3), *Bothriochloa* (5), *Brachychiton* (3), *Chamaesyce* (3), *Chloris* (4), *Corymbia* (6), *Cyperus* (7), *Dichanthium* (4), *Digitaria* (4), *Enneapogon* (6), *Enteropogon* (3), *Eragrostis* (9), *Eremophila* (3), *Eucalyptus* (12), *Hibiscus* (4), *Indigofera* (4), *Jasminum* (4), *Leptochloa* (4), *Lysiphyllum* (3), *Melaleuca* (6), *Paspalidium* (5), *Phyllanthus* (3), *Sclerolaena* (4), *Sida* (9) and *Sporobolus* (7).

The surveys identified 46 exotic taxa representing 18 families. Families with three or more exotic weed taxa include Asteraceae (3), Cactaceae (3), Malvaceae (5) and Poaceae (15). Weed species present are discussed further below in **Section 9.3.3.7**.

A full flora species list including exotic species identified from each survey period is provided in the **Appendix K1**.

9.3.3.2 Regional Ecosystems

Under the VM Act, REs are assigned a conservation status (vegetation management status (VM status)) based on an assessment of the pre-clearing and remnant extent of a RE. A second status rating (biodiversity status) is defined by EHP and is based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of a RE.

Nineteen REs were described and mapped in the EIS study area on the basis of stereo pair aerial photo analysis and field survey results (**Figure 9-5**, **Figure 9-6** and **Figure 9-7**). These REs include six REs listed as endangered, six as of concern and seven as least concern under the VM Act. This broadly corresponds with the current State Government RE mapping, which also shows 19 REs mapped within the EIS study area. However, the current State Government RE mapping shows seven REs listed as endangered, four as of concern and eight as least concern (under the VM Act).

Table 9-3 provides a summary of the classification of vegetation communities and REs identified during the flora survey. Vegetation communities in the EIS study area have been delineated on the basis of REs. The area of each RE within the EIS study area varies considerably; some REs are represented only marginally. The areas shown are calculated for the EIS study area. Vegetation community descriptions collected during the field survey include RE description, general structural and floristic character, evidence of previous disturbance, fire history, incidence of exotic species and general disturbance notes. Descriptions are provided for each secondary and tertiary survey site in **Appendix K1**.

The majority of the vegetation associations surveyed have been disturbed or modified by grazing practices to some degree. Grassland communities were common across the survey area and have been modified with heavy grazing and the introduction of exotic grass species. Ground cover was dominated in most communities by the exotic grass species *Pennisetum ciliare** (buffel grass), introduced for cattle grazing. Although grazing impacts are evident in both the ground layer and much

of the mid strata for woodland communities of the survey area, pastures do not appear to have been overstocked and excessive trampling of groundcover was not evident at the time of survey. Existing land management has minimised grazing impacts and incidences of problematic declared weed species such as *Parthenium hysterophorus** (parthenium) were found to be relatively low.

The west of the survey area is dominated by non-remnant grasslands and large stands of *Eucalyptus populnea* (poplar box) woodland (RE 11.5.3). Isolated pockets of *Acacia harpophylla* (brigalow) woodland (RE 11.4.9) and *Acacia shirleyi* (lancewood) forest (RE 11.7.2) are scattered in relatively small remnants across the landscape (**Figure 9-5**). Significant stands of *A. shirleyi* woodland are situated upon the elevated lateritic duricrust landform and appear to be the most integral communities present, with less disturbance evident in the understorey and ground layers. Several *Acacia harpophylla* (brigalow) associations that were present in the west of the site have been thinned to allow for improved grazing and are now only present as regrowth communities.

In the east of the survey area, large stands of *Eucalyptus crebra* (narrow-leaved ironbark) woodland on sand plains (RE 11.5.9) share dominance with *Eucalyptus populnea* (poplar box) woodland (RE 11.5.3) (**Figure 9-6**). Several pockets of lateritic duricrust are evident within these areas and support densely vegetated *Acacia shirleyi* (lancewood) dominated communities (RE 11.7.2). Non-remnant grassland dominates the north-east of the survey area, with large stands of *Eucalyptus populnea* (poplar box) woodland on clay plains (RE 11.4.2) and some *Acacia harpophylla* (brigalow) regrowth present (high vegetation regrowth (HVR) 11.4.8).

9.3.3.3 Conservation Significant Vegetation Communities

Endangered and Of Concern Regional Ecosystems

As shown in **Table 9-3**, 14 REs identified within the EIS study area are considered conservation significant under the VM Act; listed as either endangered or of concern. These include:

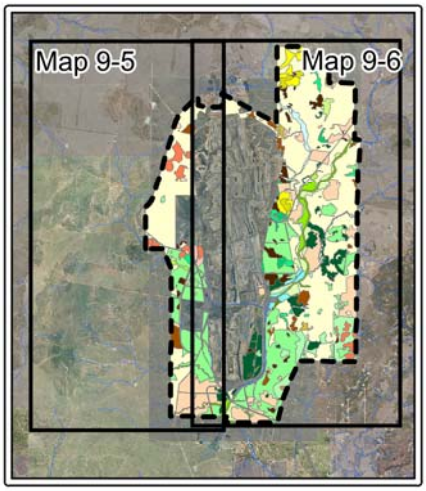
- endangered REs11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16, 11.9.1; and
- of concern REs 11.3.2, 11.3.3, 11.3.4, 11.3.4a, 11.3.36, 11.4.2, 11.8.11 and 11.8.11/non-remnant.

As shown in **Figure 9-6** these communities largely occur around the Isaac River and other waterways. The total area of these communities is 1,097 hectares of endangered REs and 1,816 hectares of concern REs. All RE codes and status are presented in **Table 9-3**.

EPBC Threatened Ecological Communities

The literature review identified two EPBC TECs potentially present in the EIS study area. The ground verified TECs and areas and the REs analogous to each are listed below and shown in **Figure 9-8**.

- 235.8 hectares of the endangered EPBC threatened community *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (of concern RE 11.8.11); and
- 1,097 hectares of the endangered EPBC threatened community *Brigalow (Acacia harpophylla dominant and co-dominant)* (endangered REs 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16 and 11.9.1).



592,000 E
596,000 E
7,604,000 N
7,600,000 N
7,596,000 N
7,592,000 N
7,588,000 N
7,584,000 N

Clear
Eureka Creek
Pasha Rd
Fisher Creek
Playgus Creek

NOTE:
Description of Vegetation Community Code presented in Figure 9-7.

EIS Study Boundary
ML & MLA Boundary
7a Vegetation Community Code

N
W E
S

0 1.25 2.5km
Scale 1:95 000 (A4)
Projection: GDA94, MGA Zone 55

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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

VEGETATION COMMUNITIES WITHIN THE EIS STUDY AREA (WEST)

URS | TERRESTRIAL ECOLOGY | Figure: 9-5

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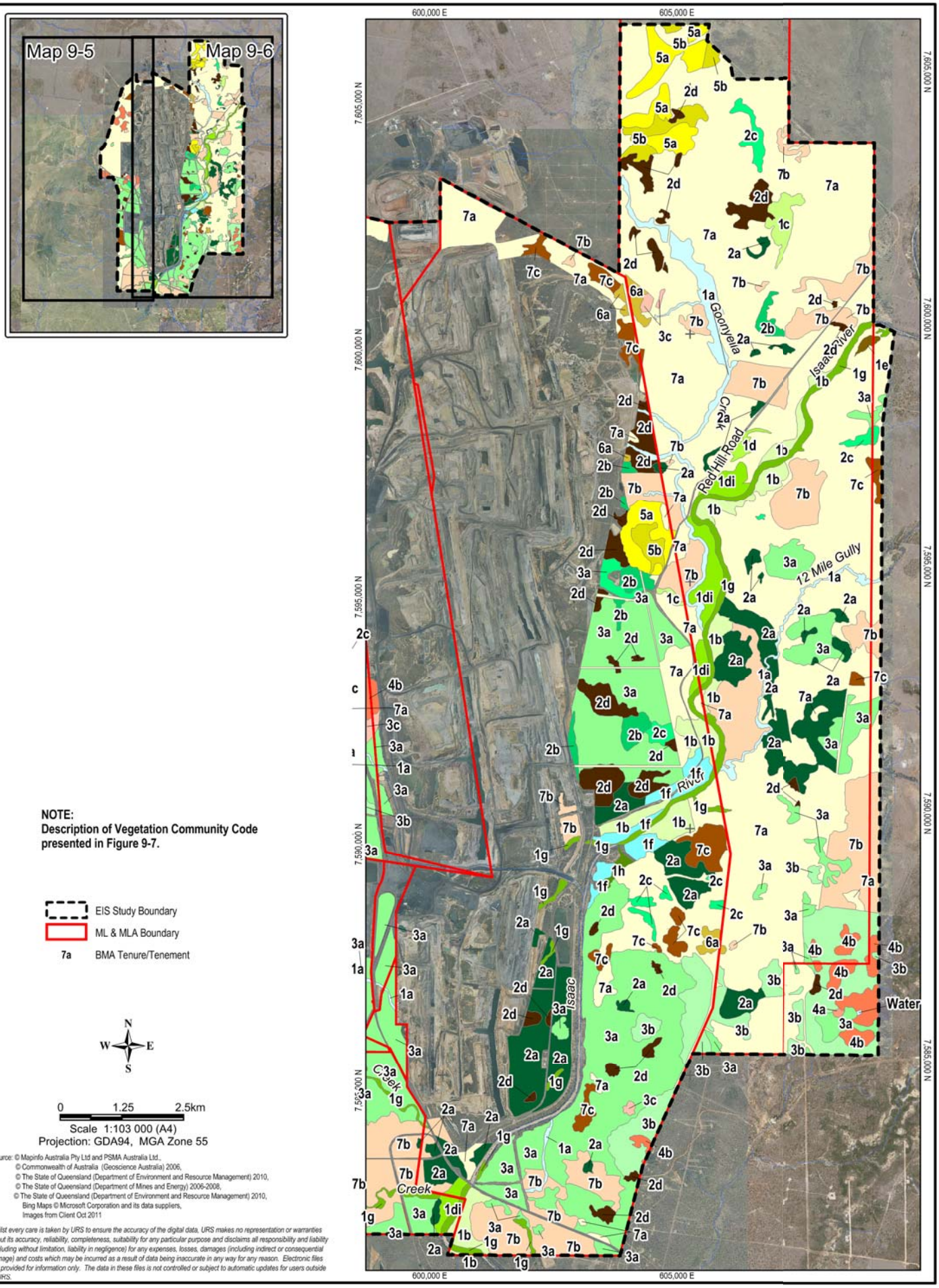

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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

VEGETATION COMMUNITIES WITHIN THE EIS STUDY AREA (EAST)

URS | TERRESTRIAL ECOLOGY | Figure: 9-6

File No: 42627136-g-1059.wor | Drawn: VH | Approved: CT | Date: 11-06-2013 | Rev.A | A4

Vegetation Community Code	Community Description	Regional Ecosystem	VMA Status	EPBC Status
1a	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	RE 11.3.1	Endangered	Endangered
1b	*Eucalyptus populnea* woodland on alluvial plains.	RE 11.3.2	Of Concern	Not Listed
1c	*Eucalyptus coolabah* woodland on alluvial plains.	RE 11.3.3	Of Concern	Not Listed
1d	*Eucalyptus tereticornis* and/or Eucalyptus spp. woodland on alluvial plains.	RE 11.3.4	Of Concern	Not Listed
1di	*Corymbia tessellaris* woodland on alluvial sand ridges to elevated levees and level terraces.	RE 11.3.4a	Of Concern	Not Listed
1e	*Acacia cambagei* woodland on alluvial plains.	RE 11.3.5	Least Concern	Not Listed
1f	*Corymbia* spp. woodland on alluvial plains. Sandy soils	RE 11.3.7	Least Concern	Not Listed
1g	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	RE 11.3.25e	Least Concern	Not Listed
1h	*Eucalyptus crebra* and/or *E. populnea* and/or *E.melanophloia* on alluvial plains, higher terraces.	RE 11.3.36	Of Concern	Not Listed
2a	*Eucalyptus populnea/brownii* woodland on Cainozoic clay plains.	RE 11.4.2	Of Concern	Not Listed
2b	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* Open forest to woodland on Cainozoic clay plains.	RE 11.4.7	Endangered	Endangered
2c	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	RE 11.4.8	Endangered	Endangered
2d	*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains.	RE 11.4.9	Endangered	Endangered
3a	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.	RE 11.5.3	Least Concern	Not Listed
3b	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests.	RE 11.5.9	Least Concern	Not Listed
3c	*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces.	RE 11.5.16	Endangered	Endangered
4a	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. macrocarpa* woodland on lower scarp slopes on Caino zoic lateritic duricrusts.	RE 11.7.1	Least Concern	Not Listed
4b	*Acacia* spp. woodland on lateritic duricrust. Scarp retreat zone.	RE 11.7.2	Least Concern	Not Listed
5a	*Dichanthium sericeum grassland on Cainozoic igneous rocks.*	RE 11.8.11	Of Concern	Endangered
5b	*Dichanthium sericeum grassland on Cainozoic igneous rocks/ non remnant modified grassland (50%/50%).*	RE11.8.11/ n/a	Of Concern/ Not Listed	Not Listed
6a	*Eucalyptus thozetiana with Acacia harpophylla open woodland.*	RE 11.9.1	Endangered	Endangered
7a	Non remnant modified open grassland.	n/a	Not Listed	Not Listed
7b	Non remnant mixed shrubby regrowth.	n/a	Not Listed	Not Listed
7c	Non remnant *Acacia harpophylla* regrowth.	n/a	Not Listed	Not Listed

NOTE: This Figure 9-7 must be viewed in conjunction with Figures 9-5 and 9-6.

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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

VEGETATION COMMUNITIES WITHIN THE EIS STUDY AREA (LEGEND)

URS | TERRESTRIAL ECOLOGY | Figure: 9-7

File No: 42627136-g-1059.wor | Drawn: VH | Approved: CT | Date: 11-06-2013 | Rev.A | A4

Table 9-3 Vegetation Communities Mapped by URS within the Survey Area

Unit	Land zone	Community Description	Regional Ecosystem	Status			EIS Study Area Areas (ha)	Survey Sites [1]
				EPBC	Biodiv	VMA		
1a	Quaternary alluvial soils (Landzone 3)	*Acacia harpophylla* open woodland on alluvial plains	RE 11.3.1	E	E	E	248	a11, a13, a22, q65, q68, q69, d12, e12, q133
1b		*Eucalyptus populnea* woodland on alluvial plains	RE 11.3.2	NL	OC	OC	307	a16, b9
1c		*Eucalyptus coolabah* woodland on alluvial plains	RE 11.3.3	NL	OC	OC	60	a8, a21
1d		*Eucalyptus tereticornis* and/or *Eucalyptus* spp. woodland on alluvial plains	RE 11.3.4	NL	OC	OC	44	a13, a15, e9
1di		*Corymbia tessellaris* woodland on alluvial sand ridges to elevated levees and level terraces	RE 11.3.4a	NL	OC	OC	158	a29
1e		*Acacia cambageana* woodland on alluvial plains	RE 11.3.5	NL	OC	LC	8	q64
1f		*Corymbia* spp. woodland on alluvial plains. Sandy soils	RE 11.3.7	NL	OC	LC	116	a30, a31, c16
1g		*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	RE 11.3.25e	NL	OC	LC	293	a14, a30, a31, b10, c15, q106
1h		*Eucalyptus crebra* and/or *E. populnea* and/or E. *melanophloia* on alluvial plains	RE 11.3.36	NL	OC	OC	13	c15
2a	Flat to gently undulating Cainozoic clay	*Eucalyptus spp*. and/or *Corymbia spp*. grassy or shrubby woodland on Cainozoic clay plains	RE 11.4.2	NL	OC	OC	864	f25, a9, a15, a16, a17, c19, d2, a18, q92, q61, q62, q89, q102, d11, d14

Unit	Land zone	Community Description	Regional Ecosystem	Status			EIS Study Area Areas (ha)	Survey Sites [1]
				EPBC	Biodiv	VMA		
2b	plains (Landzone 4)	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* Open forest to woodland on Cainozoic clay plains	RE 11.4.7	E	E	E	111	a10, a32, b7
2c		*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	RE 11.4.8	E	E	E	170	f23, c5, e13, e14, q104, q121, q126, q128, q131, q137
2d		*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains	RE 11.4.9	E	E	E	439	f24, a5, a7, c8, c18, d8, e3, e6, q108, q132
3a	Plains and plateaux on Tertiary land surfaces, with medium to coarse textured soils (Landzone 5)	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces	RE 11.5.3	NL	NCP	LC	3,008	f5, f7, f12, f13, c10, c12 c14, c26, c35 q59, q60, q61, q67, d4, q90, q95, q99, q100, e2, e4, q105, q107, q109, q110, q111, q112, q113, q114, q116, q117, q120, q122, q123, q127, q130, q134, q135, q139
3b		*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces, plateaus and broad crests	RE 11.5.9	NL	NCP	LC	580	f9, c20, q81, d3, q91, d6, q97, q98

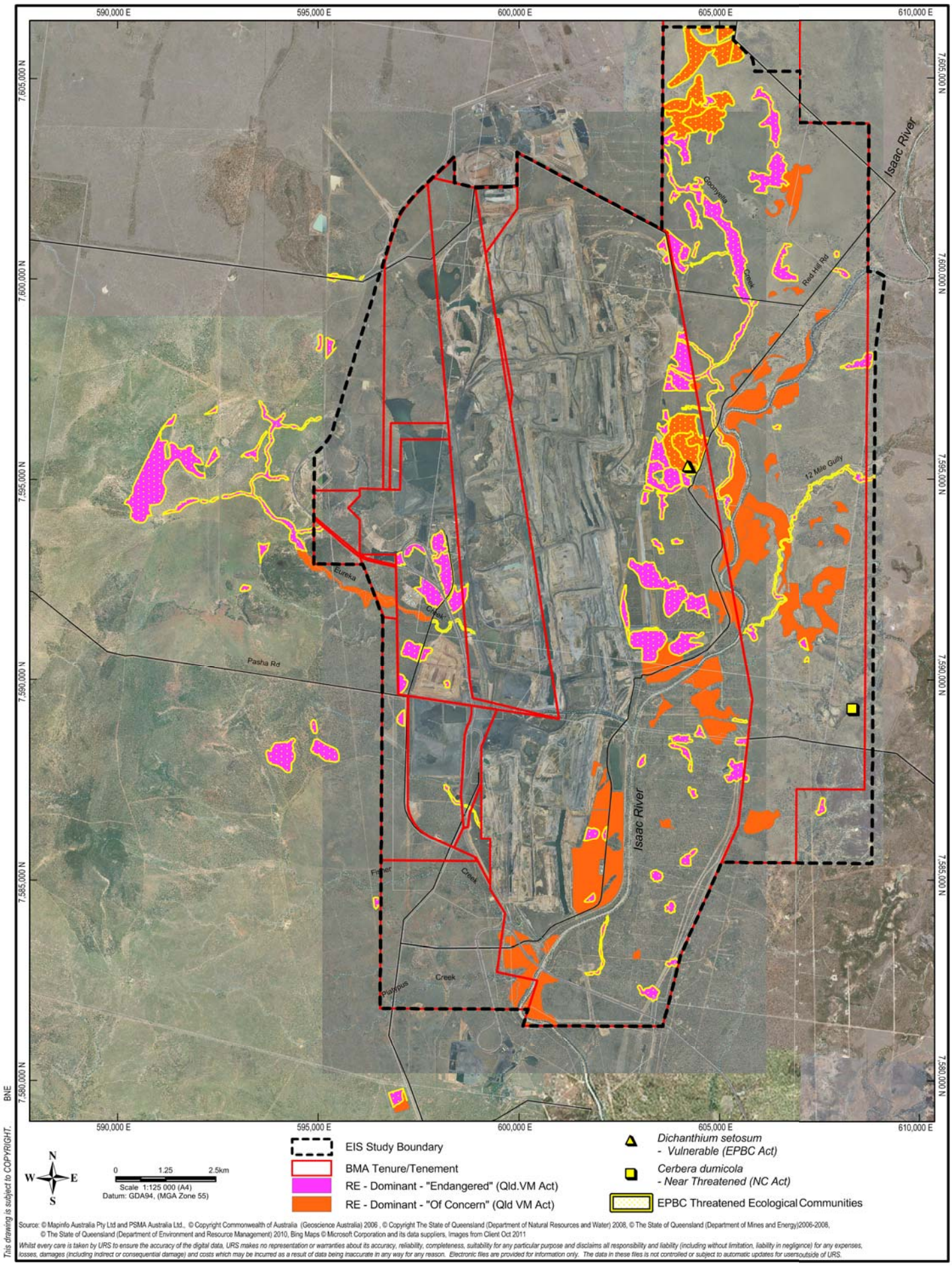
Unit	Land zone	Community Description	Regional Ecosystem	Status			EIS Study Area Areas (ha)	Survey Sites [1]
				EPBC	Biodiv	VMA		
3c		*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces	RE 11.5.16	E	E	E	74	q48
4a	Exposed or shallowly covered duricrusts (Landzone 7)	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. macrocarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrusts	RE 11.7.1	NL	OC	LC	3	d10
4b		*Acacia* spp. woodland on lateritic duricrust; Scarp retreat zone	RE 11.7.2	NL	NCP	LC	406	f20, f21, a26, a27, q50, d7, q97, d9, e5, e8, e10, e11, q119, q124, q125
5a	Basalt associated with undulating to gently undulating rises (Landzone 8)	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	RE 11.8.11	E	OC	OC	235	f14, f15, f16, f17, f18, f19, f22, c4
5b		*Dichanthium sericeum* grassland on Cainozoic igneous rocks	RE 11.8.11/ non remnant grassland	NL	OC	OC	113	c3, q40, epbc1, epbc 2
6a	Fine grained sediments with little or no deformation (Landzone 9)	*Eucalyptus thozetiana* with Acacia harpophylla open woodland	RE 11.9.1	E	E	E	52	a14, d5

Unit	Land zone	Community Description	Regional Ecosystem	Status			EIS Study Area Areas (ha)	Survey Sites [1]
				EPBC	Biodiv	VMA		
7a	Various Landzones 3, 4, 5 7, 8 and 9	Non remnant modified open grassland	n/a	NL	NL	NL	7,706	a1, a4, c17, a36, a38, q40, q58, d1, q94, q103, q115, q129, q140
7b		Non remnant mixed shrubby regrowth	n/a	NL	NL	NL	1,831	a2, a 28, a39, q87, q94, q101, e7, q118
7c		Non remnant *Acacia harpophylla* regrowth	Analogous to HVR11.4.8/9	E	NL	NL	338	c9 c26, q85, d13, e1, q136, q138

Note 1: Survey sites coding- a= Secondary sites surveyed 17-26/10/05; b= Secondary sites surveyed 30/01-03/02/06; c= Secondary sites surveyed 22-28/05/06; d= Secondary sites surveyed 18-28/03/09; e= Secondary sites surveyed 11-26/05/09; q39- q69: = Quaternary sites surveyed 17-26/10/05; q70- q73 =: Quaternary sites surveyed 30/01-03/02/06; q74- q90= Quaternary sites surveyed 22-28/05/06; q90- q103= Quaternary sites surveyed 18-28/03/09; q104 – q140= Quaternary sites surveyed 11-26/05/09; epbc1 and epbc 2= Surveyed 28/03/09; f= Sites surveyed 16-21/05/11

* These REs are present in the wider survey area, but are not present within the EIS study area. They are detailed here for information purposes only.

E=Endangered; OC=Of Concern; LC= Least Concern; NCP=No Concern at Present; NL=Not Listed



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

FLORA OF CONSERVATION SIGNIFICANCE WITHIN THE SURVEY AREA

URS

TERRESTRIAL ECOLOGY

Figure: **9-8**

File No: **42627136-g-1058.wor** Drawn: **VH** Approved: **CT** Date: **17-06-2013** Rev.**A** A4

9.3.3.4 Conservation Significant Flora Species

The literature review identified seven flora species of conservation significance as potentially occurring in the survey area. Of the seven species, field surveys confirmed the presence of two:

- *Dichanthium setosum* (bluegrass), listed as vulnerable under the EPBC Act, and
- *Cerbera dumicola*, which is listed as near threatened under the NC Act.

An additional two species *Dichanthium queenslandicum* (king bluegrass) and *Digitaria porrecta* (finger panic grass) were identified as being potentially present given the types of habitat available. However, neither species was identified during any of the field surveys.

Dichanthium setosum (bluegrass) was recorded in the east of the EIS study area (**Figure 9-8**) where it was observed within RE 11.8.11. This RE forms part of the *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* EPBC TEC. Only one specimen of *Dichanthium setosum* was observed during the 2009 field survey. However, the area was heavily grazed at the time of survey and it is anticipated that additional specimens would be recorded with decreased grazing pressure and improved growing conditions. Suitable habitat for the species was observed to extend approximately one kilometre to the north of its recorded location.

Cerbera dumicola was recorded at a single location in the east of the EIS study area (**Figure 9-8**) where it was identified within non-remnant modified open grassland. The grassland was dominated by a dense layer of *Pennisetum ciliare** (buffel grass), with *Cerbera dumicola* observed as shrub species growing one to three metres in height.

9.3.3.5 Targeted Grassland Survey

A detailed ground truthing survey in 2011 of areas delineated by EHP RE mapping as RE 11.8.11 (refer to **Section 9.2.2.4** for methodology) confirmed that some areas were comprised of 100 per cent RE 11.8.11. However, other areas were identified as being RE 11.8.11/non-remnant modified open grassland (50 per cent / 50 per cent, respectively).

The areas mapped during the survey as 100 per cent RE 11.8.11 fit the criteria for the EPBC TEC *Natural grassland of the Queensland Central Highlands and the Northern Fitzroy Basin*, listed as endangered under the EPBC Act (**Figure 9-6**). The 0.1 hectare plots surveyed under the methodology outlined by DSEWPaC for determining this community met the condition threshold of 'good quality' for the EPBC listed community.

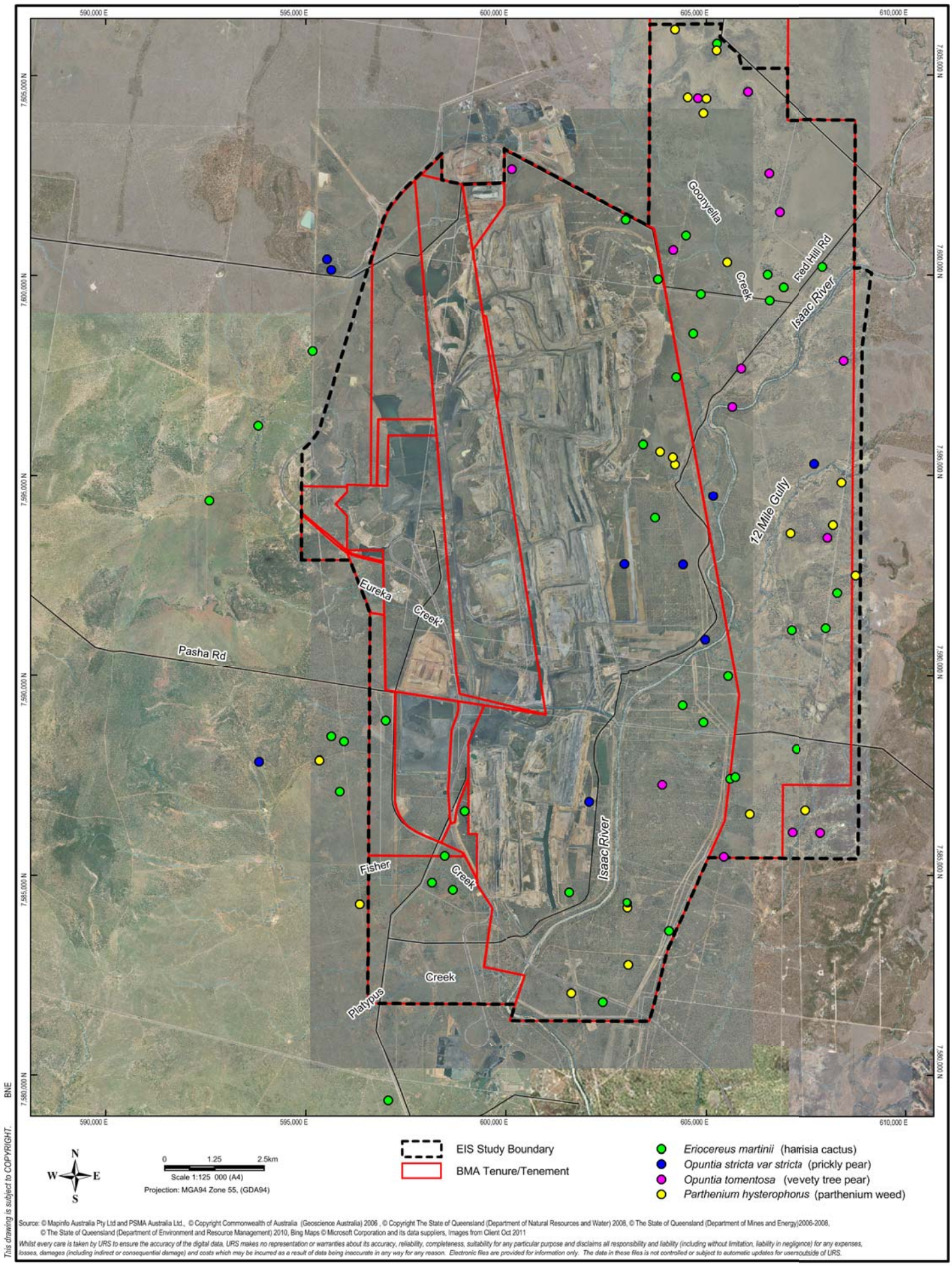
The areas surveyed and mapped as mixed RE 11.8.11/non-remnant grassland (**Figure 9-6**) do not currently meet the criteria of good quality for the EPBC listed community. However, under suitable conditions, including absence of grazing, management of weeds and optimal seasonal weather conditions, it is likely that the entire area mapped as mixed RE 11.8.11/non-remnant modified open grassland would qualify for the EPBC listed community. For this reason the entire area has been mapped as an EPBC TEC (refer to **Figure 9-8**).

9.3.3.6 Riparian Communities

In general, the riparian communities of the survey area are confined to the upper banks of the smaller creeks and the upper and lower banks of the Isaac River, with the majority of these areas showing evidence of cattle disturbance. The west of Eureka Creek is dominated by *Acacia harpophylla* (brigalow) and *Casuarina cristata* (belah) open forest (RE 11.3.1), changing to a *Eucalyptus tereticornis* (forest red gum) dominated community (RE 11.3.4) on alluvial plains directly to the south of the GRB mine complex, before reverting to RE 11.3.1. In the south-west of the EIS study area, Fisher Creek and Platypus Creek are predominantly *Eucalyptus tereticornis* (forest red gum) dominated communities fringing drainage lines (RE 11.3.25). To the east of the GRB mine complex, the Isaac River is dominated by tall *Eucalyptus tereticornis* (forest red gum) and *Casuarina cunninghamiana* (river oak) (RE 11.3.25e) fringing the river. Extensive alluvial areas adjacent to Isaac River on the north-east of the EIS study area support exclusive stands of *Corymbia tessellaris* (Moreton Bay ash) (RE11.3.25e).

9.3.3.7 Weeds of Concern

Of the 46 exotic species described in this survey, five species were identified as being of management concern. These include *Eriocereus martinii** (harrisia cactus), *Parthenium hysterophorus** (parthenium), *Opuntia stricta* var. *stricta** (prickly pear) and *Opuntia tomentosa** (velvety tree pear). These are species currently declared as Class 2 pest species under the LP Act. **Figure 9-9** shows survey point locations where weeds were found. A full list of all exotic species is included in **Appendix K1**.



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DECLARED WEED SPECIES

URS

TERRESTRIAL ECOLOGY

Figure: **9-9**

File No: **42627136-g-1060.wor** Drawn: **VH** Approved: **CT** Date: **11-06-2013** Rev.**A** A4

9.4 Terrestrial Fauna Results

9.4.1 Literature Review

A desktop review of ecological data and literature was undertaken to characterise the ecological values and identify the potential presence of conservation significant fauna species. **Appendix K2** details the results of the review and presents the likelihood of presence for each fauna species of conservation significance identified from database searches.

Conservation significant fauna species listed under both state and Commonwealth legislation were identified from the database searches and subsequently targeted during the field surveys. The fauna species identified from the literature review as being potentially present or known to occur within the survey area are detailed below in **Table 9-4** and the status and source for each are provided. Conservation significant fauna species identified include any critically endangered, endangered, vulnerable, or near threatened taxa listed as per:

- the Nature Conservation (Wildlife) Regulation 2006 under the provisions of the NC Act; and
- the EPBC Act.

Target species also include migratory bird species listed under:

- the Convention of Migratory Species of Wild Fauna (Bonn Convention); and
- bilateral agreements between Australia and Japan (Japan-Australia Migratory Bird Agreement (JAMBA)), Australia and China (China-Australia Migratory Bird Agreement (CAMBA)) and Australia and Republic of Korea (Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA)).

Table 9-4 Conservation Significant Fauna Identified from the Literature Review

Scientific Name/Common name	NC Act Status[1]	EPBC Act Status[1]	Source[2, 3]
Birds			
Erythrotriorchis radiatus red goshawk	E	V	DSEWPaC
Geophaps scripta scripta squatter pigeon, (southern subspecies)	V	V	DSEWPaC, BA, ER1, ER3
Neochmia ruficauda ruficauda star finch (eastern and southern)	-	E	DSEWPaC
Haliaeetus leucogaster white-bellied sea-eagle	-	Mi, M	DSEWPaC, ER5
Merops ornatus rainbow bee-eater	-	Mi, M	DSEWPaC, BA, ER5
Monarcha melanopsis black-faced monarch	-	Mi	DSEWPaC
Ardea ibis cattle egret	-	Mi, M	DSEWPaC, BA
Apus pacificus fork-tailed swift	-	Mi, M	DSEWPaC, BA, ER3
Ardea alba great egret, white egret, eastern great egret	-	Mi, M	DSEWPaC

Scientific Name/Common name	NC Act Status[1]	EPBC Act Status[1]	Source[2, 3]
Gallinago hardwickii Latham's snipe, Japanese snipe	-	Mi, M	DSEWPaC, ER1
Nettapus coromandelianus cotton pygmy-goose	NT	Mi, M	ER1
Ephippiorhynchus asiaticus black-necked stork	NT	-	BA
Rostratula australis Australian painted snipe	-	E, Mi, M	DSEWPaC
Rhipidura rufifrons rufous fantail	-	Mi, M	ER5
Cuculus saturatus oriental cuckoo	-	Mi, M	ER3
Mammals			
Nyctophilus corbeni eastern long-eared bat (south-eastern form)	-	V	DSEWPaC
Dasyurus hallucatus northern quoll	-	E	DSEWPaC
Chalinolobus picatus little pied bat	NT	-	ER1, ER3, ER5
Tachyglossus aculeatus short-beaked echidna	SLC	-	ER3, ER5
Phascolarctos cinereus koala	SLC	V	ER5, DSEWPaC
Reptiles			
Rheodytes leukops Fitzroy River turtle	-	V	DSEWPaC
Denisonia maculata ornamental snake	V	V	EHP, EH, QM, ER5, DSEWPaC
Egernia rugosa yakka skink	V	V	DSEWPaC
Paradelma orientalis brigalow scaly-foot		V	EHP, WBM 2000; DSEWPaC
Lerista allanae Allan's lerista	E	E	DSEWPaC
Furina dunmalli Dunmall's snake	V	V	DSEWPaC

Note 1: E – endangered V – vulnerable NT – near threatened SLC – special least concern Mi – migratory M – marine
Note 2: DSEWPaC – EPBC Protected Matters Search; EHP – Wildlife Online Search; EH – Essential Habitat; QM – Queensland Museum; BA – Birds Australia
Note 3: ER1: WBM (1998 2000); ER3: WBM (2002) ER5: Ecoserve (2006c)

9.4.2 Field Survey Results

It should be noted that the field survey area encompassed a larger area than the EIS study area. However, it is expected that the fauna identified in the survey area may utilise habitat found within the EIS study area, therefore is included for information and to guide management. Fauna field surveys were undertaken by URS over four events during April 2005, March 2009, June 2009, and May 2011. The seasonal weather conditions for each survey period are described in **Appendix K2**.

9.4.2.1 Fauna Diversity

A total of 210 native and nine introduced terrestrial vertebrate species were recorded during all URS field surveys within the survey area. Native species included 133 bird, 32 mammal, 10 amphibian and 35 reptile species. One additional microbat species was provisionally identified on site but positive identification to species level could not be confirmed due to an overlap of ultrasonic call patterns between species.

A species list for all fauna identified within the survey area during the URS studies in 2005, 2009 and 2011 has been compiled in the **Appendix K2** and also includes all fauna species recorded by WBM (1998, 2000 and 2002) and Ecoserve (2006c). This list details a cumulative total (including exotic fauna) of 168 bird, 49 mammal, 17 amphibian and 54 reptile species recorded for the site over all survey periods.

Amphibians

The lack of rain prior to both the 2005 and 2009 URS survey periods was not conducive to amphibian activity. There was, however, a single storm event on 26 June 2009 which elicited a number of frog captures in pitfall traps at various trapping sites, resulting in the recognition of representative amphibian diversity. During the months prior to the 2011 survey, the area received high levels of rain, and in some areas inundation from flood water occurred. As a result, 10 species (including the exotic cane toad (*Rhinella marina**) were identified during the surveys. Given that 17 species of amphibians were identified from surveys undertaken over a 13 year survey period, this is believed to be reasonably indicative of the current amphibian diversity throughout the survey area.

Native frog species from the genera *Cyclorana*, *Litoria, Limnodynastes* and *Opisthodon* were recorded during all URS surveys, along with the exotic cane toad (*Rhinella marina**). The survey results show that despite significant historical habitat alteration, amphibians are resilient within this landscape. No amphibian species of conservation significance were identified.

Reptiles

During the URS surveys, 35 reptile species were encountered within the survey area, featuring representatives of eight families. These included six gecko (Gekkonidae), one legless lizard (Pygopodidae), four dragon (Agamidae), one goanna (Varanidae), 16 skink (Scincidae), two python (Pythonidae), two elapid snake (Elapidae) and three colubrid snake (Colubridae) species. The ornamental snake (*Denisonia maculata*) was recorded during the 2011 survey in constructed dam dredge spoil in the east of the EIS study area. It was the only reptile species of conservation significance recorded during URS surveys. This species is listed as vulnerable under both the EPBC Act and the NC Act.

Birds

In the course of the URS survey periods, 133 bird species were recorded during targeted searches and as incidental observations. Species from all habitat and feeding groups were observed with woodland generalists, raptors and waterbirds being particularly prominent. The highest avian diversities were encountered within the riparian and alluvial woodlands where flowering *Eucalyptus tereticornis* (forest red gum) and *E. crebra* (narrow-leaved ironbark) attracted honeyeaters, canopy gleaners and insectivores. Seven bird species of conservation significance were identified from URS surveys. These include the squatter pigeon (*Geophaps scripta scripta*) (vulnerable under the EPBC Act and NC Act), black-necked stork (*Ephippiorhynchus asiaticus*) (vulnerable under the NC Act) and cotton pygmy-goose (*Nettapus coromandelianus*) (near threatened under the NC Act and listed as Marine under the EPBC Act) plus four bird species listed as migratory or marine under the EPBC Act. Previous surveys of the survey area have recorded an additional 35 bird species in the area (**Appendix K2**).

Mammals

Thirty-two native and eight introduced mammal species were identified during the URS surveys. Results from the small mammal live trapping program were poor, with only eight specimens from four species (*Rattus fuscipes, Mus musculus*, Pseudomys gracilicaudatus* and *Pseudomys delicatulus*) captured, following an overall effort of 2,179 Elliot trap and 245 pitfall trap nights. This low result reflects that of the WBM (2002) survey, which recorded no small mammals. However, previous studies within the survey area in 1998 and 2000 recorded seven rodent and three dasyurid species (**Appendix K2**). These results may reflect a combination of poor rainfall years in recent times, along with the continuing disturbance of ground habitats from cattle grazing and other activities.

Medium-sized arboreal mammals were represented by four species in the survey area: common brushtail possum (*Trichosurus vulpecula*), koala (*Phascolarctos cinereus*), sugar glider (*Petaurus breviceps*) and greater glider (*Petauroides volans*). Throughout the majority of the survey area medium-sized arboreal mammals occur in low densities, despite high numbers of habitat hollows present. The fringing riparian woodland along the Isaac River was the only habitat within the survey area in which arboreal mammals were observed in high densities. The Isaac River was also identified to support high numbers of microchiropteran bats. Nineteen species of bat were identified as occurring within the survey area.

Conservation significant mammal species recorded within the survey area include the koala (*Phascolarctos cinereus*) (special least concern under the NC Act; vulnerable under the EPBC Act), short-beaked echidna (*Tachyglossus aculeatus*) (special least concern under the NC Act), and the little pied bat (*Chalinolobus picatus*) (near threatened under the NC Act). Previous surveys of the existing GRB mine complex lease have recorded an additional nine mammal species, most of which are small ground dwelling rodents or dasyurids.

9.4.2.2 Conservation Significant Fauna Species

The majority of the species recorded within the survey area are widespread in northern or eastern Australia, while a small number of species are restricted to the region.

Fauna species are assigned threatened status according to Commonwealth or Queensland or legislation as described in:

- the EPBC Act; and
- the NC Act and the subordinate Nature Conservation (Wildlife) Regulation 2006.

Under these listings, threatened species may be classified as critically endangered, endangered, vulnerable or near-threatened. A lesser classification of special least concern applies to iconic marsupials such as the echidna (*Tachyglossus aculeatus*) under the NC Act.

In addition to the threatened species, the EPBC Act includes a list of migratory species. These species are those listed under the following international agreements, to which Australia is a signatory nation:

- JAMBA;
- CAMBA;
- ROKAMBA; and
- Convention on the Conservation of Migratory Species of Wild Fauna - (Bonn Convention).

Under the EPBC Act, Australia has an international obligation to protect significant populations and significant sites for these species.

Conservation significant fauna species recorded within the survey area are detailed in **Table 9-5** below. The location where conservation significant species were recorded (only URS surveys) is depicted in **Figure 9-10**. No endangered or critically endangered species are known or expected to occur in the area. Species descriptions of all identified and potentially occurring significant fauna species are provided in **Appendix K2**.

Table 9-5 Status of Conservation Significant Fauna Species Recorded within the Survey Area

Common Name	Scientific Name	EPBC Act	Qld NC Act
squatter pigeon	*Geophaps scripta scripta*	V	V
cotton pygmy-goose	*Nettapus coromandelianus*	M	NT
rainbow bee-eater	*Merops ornatus*	M, Mi	-
great egret	*Ardea alba*	M, Mi	-
white-bellied sea-eagle	*Haliaeetus leucogaster*	M, Mi	-
black-necked stork	*Ephippiorhynchus asiaticus*	-	NT
Latham's snipe[1]	*Gallinago hardwickii*	M, Mi	-
white-throated needletail[1]	*Hirundapus caudacutus*	M, Mi	-
fork-tailed swift[1]	*Apus pacificus*	M, Mi	-
rufous fantail[1]	*Rhipidura rufifrons*	M, Mi	
marsh sand-piper[1]	*Tringa stagnatilis*	M, Mi	-

Common Name	Scientific Name	EPBC Act	Qld NC Act
oriental cuckoo [1]	*Cuculus saturatus*	M, Mi	-
brigalow scaly-foot [1]	*Paradelma orientalis*	-	V
ornamental snake	*Denisonia maculata*	V	V
little pied bat	*Chalinolobus picatus*	-	NT
koala	*Phascolarctos cinereus*	V	SLC
short-beaked echidna	*Tachyglossus aculeatus*	-	SLC

V - vulnerable; NT - near threatened; SLC - species of special least concern; Mi - migratory; M - marine;
Note 1: not recorded during URS surveys.

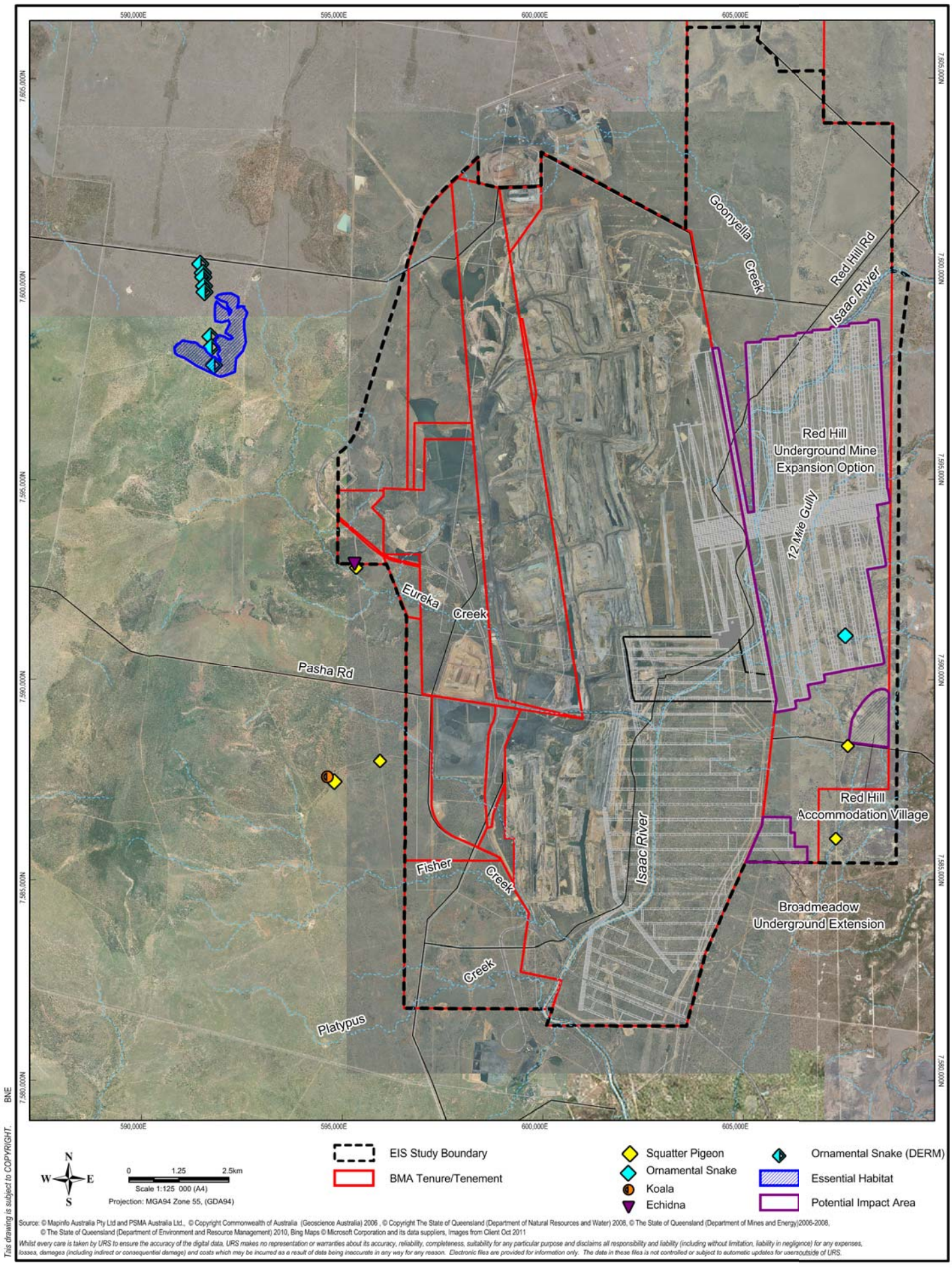
9.4.2.3 Introduced Species

Nine introduced vertebrate fauna species were recorded within the survey area; eight mammals and one amphibian. The survey area is used for grazing domesticated horses (*Equus caballus**) and cattle (*Bos indicus**). All other introduced species noted are present as true feral fauna. Rabbits (*Oryctolagus cuniculus**) are abundant throughout the site, as are cane toads (*Rhinella marina**). Feral cats (*Felis catus**) were observed, while wild dogs (*Canis lupus dingo/familiaris**) were occasionally seen in the east of the site. Signs of feral pigs (*Sus scrofa**) were common in the western portions, especially as wallows in creek beds and dam verges, while one sighting was recorded near a dam in the east during the May 2011 survey. House mice (*Mus musculus**) were trapped in grassland in the north-west of the survey area and are likely to be widespread over the survey area. Foxes (*Vulpes vulpes**) were observed during nocturnal surveys. Introduced species detected during URS surveys are supported by the results of the WBM (1998; 2000; 2002) and Ecoserve (2006c) surveys with no additional exotic species detected within the survey area.

9.4.2.4 Habitat Values

The majority of the land within the EIS study area is considered to be generally of low conservation value for fauna. As the majority of the surveyed area is an operational cattle property, most habitats have been highly modified. This has occurred through tree clearing, cattle grazing, cattle trampling of ground cover, disturbance to and pollution of water bodies, proliferation of feral fauna, and the widespread occurrence of introduced plants, especially pastoral grasses such as *Pennisetum ciliare** (buffel grass).

These modifications have affected the majority of habitats and fauna assemblages to some degree, but appear to have particularly impacted on small ground dwelling mammal populations, based on the lack of these fauna observed. Despite this, some sites or habitats in the EIS study area possess conservation values and require special management, as detailed below. Corresponding REs for each habitat type (where applicable) are provided.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

CONSERVATION SIGNIFICANT FAUNA SPECIES

URS

TERRESTRIAL ECOLOGY

Figure: **9-10**

File No: **42627136-g1076.wor** Drawn: **VH** Approved: **CT** Date: **17-06-2013** Rev.**A** A4

Brigalow

Brigalow communities (endangered REs 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16 and 11.9.1 and least concern RE 11.7.1) in the survey area were generally small, fragmented and heavily degraded by cattle grazing. They were also found to be generally low in fauna diversity. However, these areas traditionally offer refuge for a number of species that are typically associated with this community, including specialists such as the gecko *Gehyra catenata*. Although not observed in surveys to date, brigalow communities may also provide habitat for conservation significant species including the brigalow scaly-foot (*Paradelma orientalis*), ornamental snake (*Denisonia maculata*), and an un-named skink (*Anomolopus brevicollis*).

Riparian and Alluvial Woodlands

The riparian and adjacent alluvial woodlands (endangered RE 11.3.1, of concern REs 11.3.2, 11.3.3, 11.3.4, 11.3.36 and least concern REs 11.3.5, 11.3.7 and 11.3.25) along the Isaac River and other waterways provide important local habitat for a number of species, especially arboreal mammals such as possums and gliders. Large, mature forest *Eucalyptus tereticornis* (forest red gums) present in riparian habitats frequently contain hollow limbs which provide den sites for arboreal mammals and microbats and nesting sites for many bird species such as parrots, owls and dollarbirds (*Eurystomus orientalis*). These trees also act as a food source for insectivorous and nectivorous birds and mammals. Where this habitat forms a continuous corridor, it constitutes a route for migratory and dispersing fauna of all types.

Seasonal inundation and flow along the Isaac River also provides habitat and breeding sites for aquatic or semi-aquatic species such as frogs and their predators such as snakes.

The three small waterways to the west of the survey area (Eureka, Fisher and Platypus creeks) and two in the east (12 Mile Gully and Goonyella Creek) are ephemeral streams. Of these, Eureka Creek is the most significant in terms of fauna habitat, as it contains a narrow but well developed riverine forest dominated by *Eucalyptus* and *Acacia* species, a dense grassy understorey, and a deep shaded stream channel with small, ephemeral refuge pools.

In the south of the survey area, the Isaac River channel was diverted in 1983 for approximately eight kilometres (replacing approximately 11 kilometres of pre-existing river) to accommodate the existing GRB mine complex operations. This river diversion is markedly different to the natural river habitat in this area in the following ways:

- The diverted river bed is much wider than the natural river, and banks are deeper and more eroded.
- There is a lack of alluvial plain development due to insufficient time for it to develop, different substrate type, and because the channel is now contained and no longer overtops resulting in alluvium deposits.
- There is a lack of mature trees with nesting/denning hollows.
- There is an absence of the central sand/habitat accretions.

The regenerating communities along the diversion therefore do not provide the same habitat opportunities as riparian woodlands upstream and downstream of the diversion.

Poplar Box Woodlands

Poplar box (*E. populnea*) woodland (endangered RE 11.4.7, and of concern REs 11.3.2 and 11.4.2 and least concern RE 11.5.3) has been largely cleared throughout the survey area. However, significant tracts are still present within the region, especially in the west of the survey area. Poplar box readily forms hollows and as a result many trees within these communities possessed one or more such habitat features. Despite this, arboreal mammal diversity was found to be relatively low in poplar box woodland.

Laterite Ridges

The laterite ridge country in the west and north-west of the survey area (least concern RE 11.7.2) provides rocky habitats not present elsewhere on the site. Due to the vegetation density and ruggedness, these habitats are less disturbed by cattle than the adjacent woodland plains. They also provide habitat for bird species not found elsewhere in the survey area due to the less disturbed shrub layer. These habitats tend to be populated by species that were found to be primarily restricted to these areas (e.g. common wallaroo (*Macropus robustus*)), but were also the favoured habitat of some widespread species, such as echidna (*Tachyglossus aculeatus*). Occasionally the laterite is heavily weathered and less rocky, yet still influences the vegetation present. In all cases, lancewood (*Acacia shirleyi*) was found to be dominant on these substrates.

Dawson Gum Woodland

Dawson gum (*Eucalyptus cambageana*) woodlands (endangered RE 11.4.8) are located primarily to the west of the survey area, with small occurrences in the east including within the proposed RHM footprint and the north-east of EIS study area. These communities typically feature a mid-dense shrub layer that is attractive to woodland bird species. Arboreal hollows and ground timber also act as valuable habitat resources. Like the majority of habitat found within the survey area, these communities are heavily impacted by cattle. The presence of cattle and buffel grass may deter some ground fauna from utilising these areas.

Modified Grassland

The grasslands found in the EIS study area mostly exist as a relic from clearing practices, and form the largest type of community (approximately 58 per cent of the EIS study area). The introduced pasture species *Pennisetum ciliare** (buffel grass) dominates much of this community, although patches of native grasses still exist in places. Buffel grass does not provide preferred habitat for native ground fauna. However, the modified grasslands support a range of larger mammal species such as the grey kangaroo (*Macropus giganteus*) and specialist grassland bird species such as the nankeen kestrel (*Falco cenchroides*), tawny grassbird (*Megalurus timoriensis*) and the Australasian pipit (*Anthus novaeseelandiae*). The presence of native grasses found in isolated patches in the northern area of the EIS study area would typically offer better habitat values for native ground mammals, reptiles and amphibians.

Water Bodies

Water bodies in the area, both natural and artificial, are attractive as watering points for woodland bird species and provide habitat for a number of waterbird and frog species. They are also important in promoting the survival and proliferation of feral fauna such as pigs and cane toads. All water courses (including the Isaac River) are ephemeral and natural waterholes are uncommon and short-lived.

Therefore, farm dams (and mine dams) act as reliable water sources and refugia for fauna throughout the year.

9.4.2.5 Habitat Connectivity

The functional habitat connectivity in an east to west direction across the entire survey area is interrupted by the GRB mine complex in the centre of the EIS study area. However, to the east and west of the GRB mine complex, there are opportunities for fauna movement despite the historical clearing of woodland for grazing. While large swathes of woodland have been historically cleared, connectivity exists in bands of remnant woodland or along the ephemeral creeks in the area. In addition, the Isaac River, including the sections diverted for mine operations, acts as a functioning north-south fauna corridor linking Burton Gorge dam to the north with habitat to the south. The Isaac River is mapped as being of state significance on BPA mapping. Therefore, while terrestrial and arboreal fauna movement is generally limited and compromised across the EIS study area, there remain opportunities for fauna movement within the eastern and western sectors, in a north to south direction and to areas beyond the EIS study area.

9.4.2.6 Summary of Significant Values

As highlighted above, the habitat found within the survey area is highly impacted by grazing practices and is, for the majority, of low conservation value. However, the riparian forest and alluvial woodland adjacent to the Isaac River is primary habitat for arboreal mammals and other native wildlife. Arboreal mammals were observed in low densities across the site and recorded at a relatively high density during surveys along the Isaac River. The Isaac River also provides the only north-south corridor for wildlife dispersing through the survey area.

As detailed in **Section 9.4.2.2**, eight conservation significant species (not including migratory species) are known to occur within or in close proximity to the survey area, including:

- squatter pigeon (*Geophaps scripta scripta*);
- cotton pygmy-goose (*Nettapus coromandelianus*);
- black-necked stork (*Ephippiorhynchus asiaticus*);
- koala (*Phascolarctos cinereus*);
- short-beaked echidna (*Tachyglossus aculeatus*);
- little pied bat (*Chalinolobus picatus*);
- ornamental snake (*Denisonia maculata*); and
- brigalow scaly-foot (*Paradelma orientalis*).

Nine EPBC listed migratory species are also known to occur within the survey area (**Section 9.4.2.2**). Habitat on the site is unlikely to act as significant habitat for core populations of the above species but acts as part of a matrix of habitat across the landscape.

9.5 Environmentally Sensitive Areas

9.5.1 Introduction

This section of the EIS describes the ESAs present within the EIS study area and surrounding region. ESAs include national parks, state forests, world heritage areas, Ramsar wetlands, and nationally important wetlands. In addition, they feature areas of elevated natural and cultural value such as habitat for conservation significant flora and fauna and places of Aboriginal and European cultural heritage.

9.5.2 Approach

The utilisation of accessible, current and reliable data sources was undertaken in the preparation of this section. Datasets provided by EHP were obtained to determine the location of ESAs in relation to the EIS study area. Additionally, an EPBC protected matters search was undertaken to identify all MNES potentially present. A 100 kilometre search radius from the EIS study area was used to identify any ESAs in the surrounding region. As impacts on REs outside the study area are unlikely and state RE mapping can be relatively coarse, REs were excluded from searches outside the EIS study area. ESAs within the search area were identified and the potential impacts that the project may have on those ESAs were determined. It is considered that any ESAs outside the 100 kilometre radius are unlikely to be impacted by the project. However, due to the dynamic nature of waterways and aquatic habitats, the potential for impact on ESAs such as wetlands and fish habitats lying downstream of the proposed mine development beyond the 100 km radius was determined. The level of protection applied to each ESA as declared under current legislation is discussed in **Section 9.5.3.1**.

9.5.3 Description of Environmentally Sensitive Areas

9.5.3.1 Classification of Environmentally Sensitive Areas

The Queensland *Environmental Protection Act 1994* (EP Act) and its subordinate legislation Environmental Protection Regulation 2008 (EP Regulation) place ESAs into two categories; Category A and Category B. Category A and B ESAs are enshrined in Queensland legislation and are easily determined as they are typically based on land tenure. Category C ESAs are defined in EHP's (2012b) *Code of Environmental Compliance for Mining Lease Projects.* The ESAs which make up each category are described in the following sections.

9.5.3.2 Category A ESAs

Category A ESAs, as defined by the EP Regulation, are displayed in **Table 9–6**. The occurrence of these areas in relation to the EIS study area is described below. In Queensland, mining activities may not be undertaken in land comprising Category A ESAs.

Table 9-6 Category A ESAs and Administering Legislation

Category A Protected Areas	Administering Legislation
National Park; National Park (Scientific); National Park (Cape York Peninsula Aboriginal Land); and National Park (Recovery).	NC Act
Conservation Park	NC Act
Wet Tropics World Heritage Area	*Wet Tropics World Heritage Protection and Management Act 1993*
Great Barrier Reef Marine Park Area	*Great Barrier Reef Marine Park Act 1975* (Commonwealth)
Marine Parks (other than general use zones)	*Marine Parks Act 2004*
Forest Reserve	NC Act

Geographic information system (GIS) interpretation was undertaken to determine if Category A ESAs exist within or in close proximity to the EIS study area. The results of this interpretation are discussed below. There are no Category A ESAs in the EIS study area.

National Parks

National Parks are declared under the NC Act and defined as Category A protected areas. They include national parks (scientific), national parks (Cape York Peninsula Aboriginal Land) and national parks (recovery).

There are five national parks that occur within a 100 kilometre radius of the proposed project (refer to **Figure 9-11**) (approximate distance in brackets):

- Homevale National Park (60 kilometres);
- Dipperu National Park (scientific) (65 kilometres);
- Mazeppa National Park (80 kilometres);
- Peak Range National Park (85 kilometres); and
- Eungella National Park (100 kilometres).

Forest Reserves and Conservation Parks

Conservation parks, as listed under the Nature Conservation (Protected Areas) Regulation 1994 and forest reserves are protected areas under the NC Act. The Homevale Conservation Park is situated approximately 60 kilometres east of the EIS study area (**Figure 9-11**).

There are no forest reserves within 100 kilometres of the EIS study area.

Wet Tropics World Heritage Area

The Wet Tropics World Heritage Area is declared under the *Wet Tropics World Heritage Protection and Management Act 1993* and is administered by the Wet Tropics Management Authority. The Wet Tropics World Heritage Area is located approximately 300 kilometres northeast of the EIS study area.

Great Barrier Reef Marine Park and other Marine Parks (other than general use zones)

The Great Barrier Reef Marine Park (GBRMP) is declared under the *Great Barrier Reef Marine Park Act 1975*. The project is situated approximately 145 kilometres directly west of the GBRMP. However, the project is situated within the Fitzroy Catchment which discharges into the GBRMP, approximately 690 kilometres downstream. The potential impacts on downstream ESAs are discussed below in **Section 9.7.2**.

The nearest marine park zone (that is not a general use zone) is approximately eight kilometres from the mouth of the Fitzroy River.

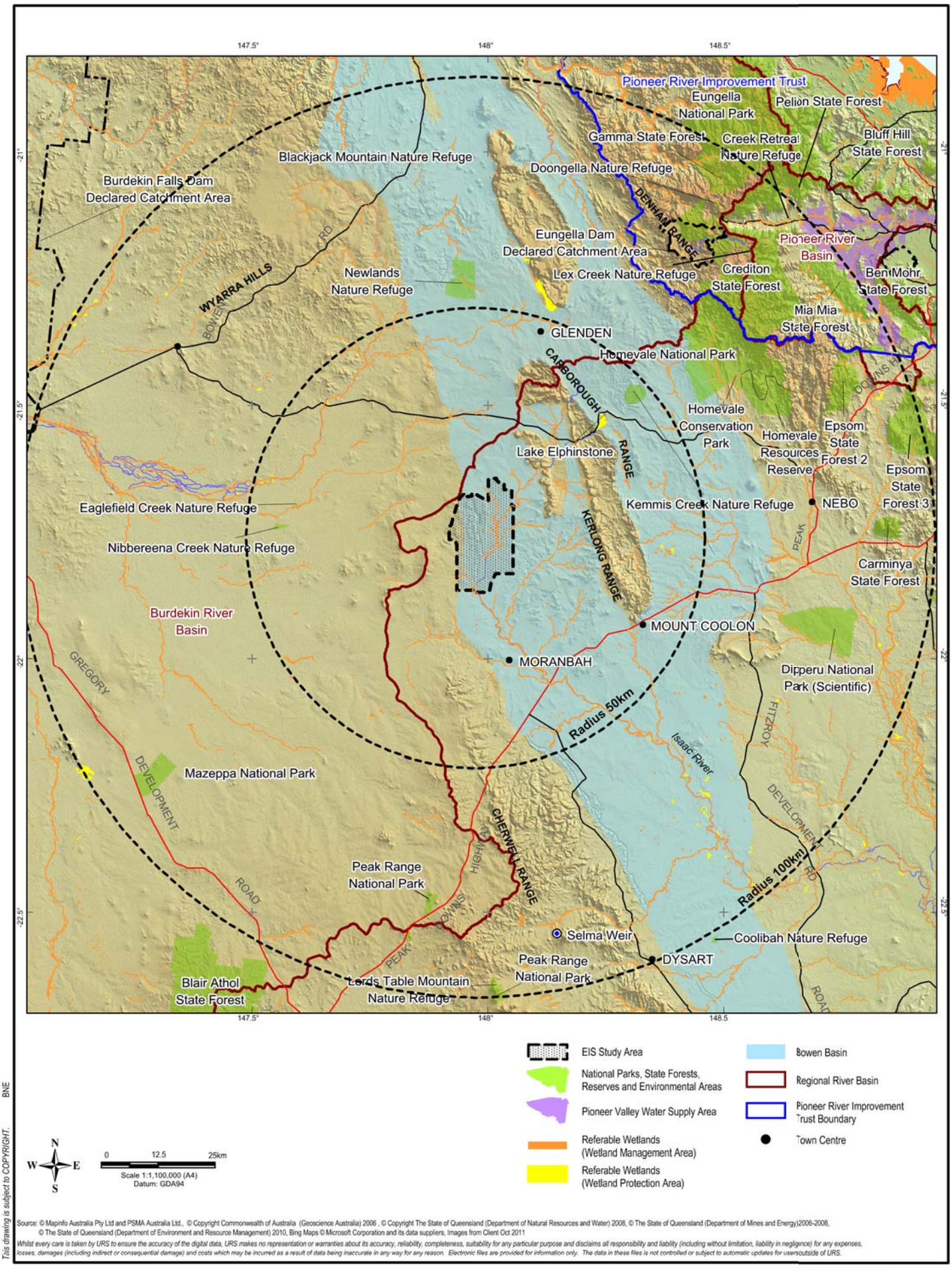
Category B ESAs

Category B ESAs are defined in the EP Regulation, and are presented in **Table 9-7**. The occurrence of these areas in relation to the EIS study area is described below.

Table 9-7 Category B ESAs and Administering Legislation

Category B Protected Areas	Administering Legislation
Endangered Regional Ecosystems (Biodiversity Status)	VM Act
Coordinated Conservation Areas	NC Act
Ramsar Wetlands	Ramsar Convention
World Heritage Areas	NC Act
International Agreement Areas	International Conventions
General Use Zones of Marine Parks	*Marine Parks Act 2004*
Queensland Heritage Registered Places	*Queensland Heritage Act 2004*
Aboriginal Cultural Heritage Areas Torres Strait Islander Cultural Heritage Areas	*Aboriginal Cultural Heritage Act 2003* *Torres Strait Islander Cultural Heritage Act 2003*
Designated Landscape Areas – other than Stanbroke	*Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987*
Special Forestry Areas	*Forestry Act 1959*
Fish Habitat Areas	*Fisheries Act 1994*
Marine Plants	*Fisheries Act 1994*
An Area to the Seaward Side of the Highest Astronomical Tide	Nil

GIS interpretation was undertaken to determine if the above ESAs are situated within or in close proximity to the EIS study area. The results of this interpretation are discussed below.



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

ESAs SITUATED WITHIN THE REGION SURROUNDING THE EIS STUDY AREA (EXCLUDING REGIONAL ECOSYSTEMS)

URS

TERRESTRIAL ECOLOGY

Figure: 9-11

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Endangered Regional Ecosystems

EHP use REs to describe the relationships between vegetation communities and the environment at the bioregional scale. REs are mostly derived by linking vegetation mapping units recognised at a scale of 1:100,000 to land zones that represent major environmental variables. These chiefly include geology, rainfall and landform.

REs listed as endangered (biodiversity status) are Category B protected ESAs. An RE is listed as having an endangered biodiversity status when:

- less than 10 per cent of the pre-clearing extent of remnant remains unaffected by severe degradation and/or biodiversity loss; or
- 10 to 30 per cent 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 (EHP 2012d).

Seven endangered REs (EREs) are mapped by EHP as occurring within the EIS study area (**Figure 9-12**). These are listed in **Table 9-8** below:

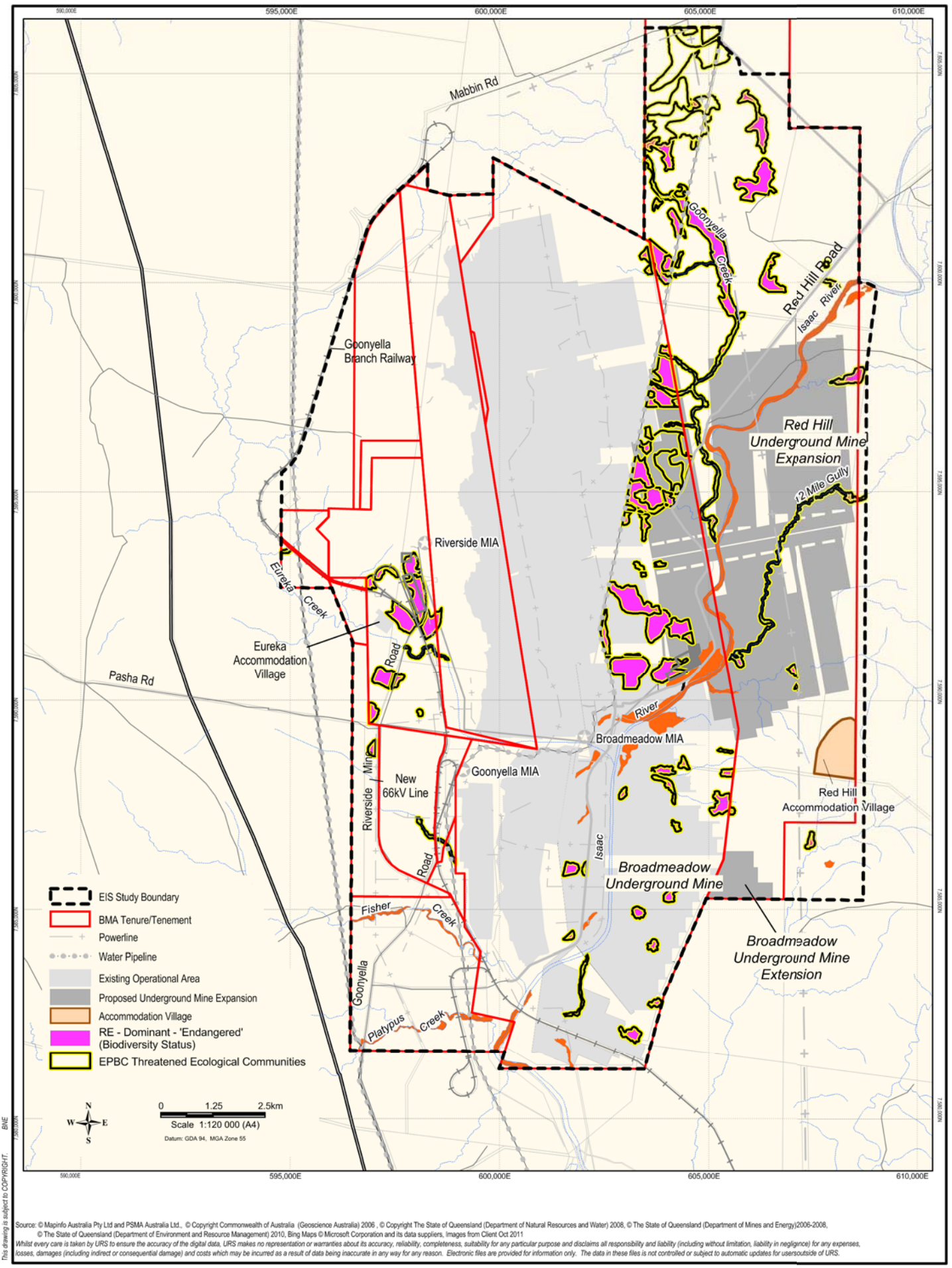
Table 9-8 Dominant Endangered Regional Ecosystems as Mapped by EHP

RE	Short Description
11.3.1	*Acacia harpophylla* open woodland on alluvial plains
11.3.21	*Dichanthium sericeum* and/or *Astrebla* spp. grassland on alluvial plains. Cracking clay soils
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
11.4.9	*Acacia harpophylla* shrubby open forest to woodland; *Terminalia oblongata* on Cainozoic clay plains
11.8.15	*Eucalyptus brownii* or *Eucalyptus populnea* woodland on Cainozoic igneous rocks. Lowlands
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rock
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks

Six EREs were identified during URS field surveys of the EIS study area (**Section 9.3.1.1**). These REs are listed in **Table 9-9** below and their locality depicted in **Figure 9-12**. It should be noted that the presence and extent of REs confirmed during URS surveys differ from those mapped by EHP. For example, only four EREs identified by EHP were mapped within the EIS study area and two additional EREs not mapped by EHP were identified.

Table 9-9 Endangered Regional Ecosystems as Mapped by URS

RE	Short Description
11.3.1	*Acacia harpophylla* open woodland on alluvial plains
11.4.7	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* open forest to woodland on Cainozoic clay plains
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains
11.4.9	*Acacia harpophylla* shrubby open forest to woodland; *Terminalia oblongata* on Cainozoic clay plains
11.5.16	*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces
11.9.1	*Acacia harpophylla-Eucalyptus cambageana* open forest to woodland on fine-grained sedimentary rock



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RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

ESAs
WITHIN THE EIS STUDY AREA

URS

TERRESTRIAL ECOLOGY

Figure: **9-12**

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Coordinated Conservation Areas and Wilderness Areas

Coordinated conservation areas and wilderness areas as declared under the NC Act are Category B protected areas. There are no coordinated conservation areas or wilderness areas within the EIS study area or the greater region.

Ramsar Wetlands

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (Ramsar 2011). Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity (DSEWPaC 2011a). There are no wetlands declared under the Ramsar Convention within the EIS study area. The nearest Ramsar wetland (Shoalwater and Corio bays) is approximately 250 kilometres south-east of the EIS study area. The Shoalwater and Corio bays occur within a separate catchment (Shoalwater and Waterpark Basin) to the project.

World Heritage and International Agreement Areas

'World heritage is the designation for places on earth that are of outstanding universal value to humanity and, as such, have been inscribed on the World Heritage List' (UNESCO 2011). International agreement areas include areas such as internationally significant sites for migratory shorebirds. As detailed above, the project occurs within the Fitzroy Basin which discharges into the Great Barrier Reef World Heritage Area (GBRWHA), approximately 690 kilometres adopted middle thread distance downstream of the EIS study area boundary.

General Use Zones of a Marine Park

General use zones of a marine park are declared under the *Marine Parks Act 2004*. As detailed above, the project occurs within the Fitzroy Basin which discharges into the GBRWHA. The GBRWHA borders a general use zone of the GBRMP.

Places of Cultural Heritage Significance and Areas Recorded in the Aboriginal and Torres Strait Islander Cultural Heritage Register

Places of cultural heritage significance are protected by the *Queensland Heritage Act 1992*, and listed on the heritage register. Aboriginal and Torres Strait Islander Cultural Heritage is protected under the *Aboriginal Cultural Heritage Act 2003* (ACH Act) and the *Torres Strait Islander Cultural Heritage Act 2003*. These areas are listed on the Aboriginal and Torres Strait Islander Cultural Heritage Register. There are no known areas of cultural heritage or Aboriginal and Torres Strait Islander Cultural Heritage significance within the EIS study area.

Designated Landscape Areas – Other than the Stanbroke Pastoral Development Holding

Under the provisions of the now repealed *Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987*, an area was declared a 'designated landscape area' if it was necessary or desirable for it to be preserved in order to prevent or regulate access. Designated landscape areas are recorded on the Cultural Heritage Register as required by the ACH Act. There are no designated landscape areas within the EIS study area or surrounding region.

Special Forestry Areas

Special forestry areas, including state plantation forests, state forests (scientific) and state parks, are declared under the *Forestry Act 1959*, and are administered by EHP. There are no special forestry areas within the EIS study area or the surrounding area.

Fish Habitat Area and Marine Plants

A declared fish habitat area (FHA) is 'an area protected against physical disturbance from coastal development' (DNPRSP 2012). No declared fish habitat areas are situated within 100 kilometres of the EIS study area. The Fitzroy River FHA extends along the Fitzroy River from the Fitzroy Barrage at Rockhampton to the coast, however this FHA is considered sufficiently far enough downstream to not be affected by the proposed project.

All marine plants are protected under Queensland law through provisions of the *Fisheries Act 1994* (DAFF 2010). There are no marine plants within a 100 kilometre radius of the EIS study area.

Critical Habitat

Critical habitat is 'habitat that is essential for the conservation of a viable population of protected wildlife or community of native wildlife, whether or not special management considerations and protection are required. A critical habitat may include an area of land that is considered essential for the conservation of protected wildlife, even though the area is not presently occupied by the wildlife' (NC Act). There are no declared critical habitats within or surrounding the EIS study area. However, URS surveys determined that the Isaac River was considered to be of high ecological value. BPA mapping supports this with the Isaac River mapped as State significant. The Isaac River and its habitat values are described further in **Section 9.5.3.4**.

An Area to the Seaward Side of the Highest Astronomical Tide

Areas that face the seaward side of the highest astronomical tide are a Category B protected areas. No areas within the EIS study area meet this criterion.

9.5.3.3 Category C ESAs

Category C ESAs are defined in EHP's *Code of Environmental Compliance for Mining Lease Projects* (**Table 9-10**). The occurrence of these areas in relation to the EIS study area is further described below. In Queensland, mining activities can be undertaken in Category C ESAs.

Table 9-10 Category C ESAs and Administering Legislation

Category C Protected Areas	Administering Legislation
Nature Refuges and Resource Reserves	NC Act
Declared Catchment Areas; Declared Irrigation Areas; and Drainage Areas	*Water Act 2000*
River Improvement Areas	*River Improvement Trust Act 1940*
Stanbroke Designated Landscape Area	ACH Act
State Forests or Timber Reserves	*Forestry Act 1959*
Koala Habitat Area	*Nature Conservation (Koala) Conservation Plan 2006*

Category C Protected Areas	Administering Legislation
Coastal Management Districts	*Coastal Protection and Management Act 1995*
Declared Areas Under the VM Act	VM Act
Referable Wetlands	EP Act
Reserves under the *Land Act 1994*	*Land Act 1994*
Dams and Weirs	Nil

GIS interpretation was undertaken to determine if the above ESAs are situated within or in close proximity to the EIS study area. The results of this interpretation are described below.

Nature Refuges and Resource Reserves

'A nature refuge is a voluntary agreement between a landholder and the Queensland Government that acknowledges a commitment to manage and preserve land with significant conservation values while allowing compatible and sustainable land uses to continue' (EHP 2013c).

There are no nature refuges or resource reserves within the EIS study area. Ten nature refuges and one resource reserve exist within 100 kilometres of the EIS study area (**Figure 9-11**). These, with distances from the EIS study area in brackets, are as follows:

- Eaglefield Creek Nature Refuge (30 kilometres);
- Nibbereena Creek Nature Refuge (30 kilometres);
- Kemmis Creek Nature Refuge (45 kilometres);
- Newlands Nature Refuge (55 kilometres);
- Blackjack Mountain Nature Refuge (70 kilometres);
- Lex Creek Nature Refuge (75 kilometres);
- Doongella Nature Refuge (75 kilometres);
- Creek Retreat Nature Refuge (85 kilometres);
- Lords Table Mountain Nature Refuge (85 kilometres); and
- Coolibah Nature Refuge (90 kilometres).

A resource reserve is an area of land dedicated under the NC Act, and is administered by EHP. The Homevale Resource Reserve is situated approximately 60 kilometres from the EIS study area.

None of these areas are downstream of the EIS study area.

State Forests

State forests are declared under the *Forestry Act 1959* and administered by EHP. Six state forests are situated within 100 kilometres of the EIS study area (**Figure 9-11**). These are (approximate distances in brackets):

- Crediton State Forest (80 kilometres);
- Carminya State Forest (85 kilometres);
- Epsom State Forest 2 (85 kilometres);

- Gamma Sate Forest (90 kilometres);
- Epsom State Forest 3 (95 kilometres); and
- Mia Mia State Forest (95 kilometres).

Declared Catchment and Irrigation Areas

Areas of land that immediately surround water storage areas are termed 'declared catchments'. Certain types of development proposed within declared catchment areas are referred to EHP during the integrated development assessment system (IDAS) process to ensure the quality of water entering the storage facility is not degraded by proposed development (NRM 2010).

Within Queensland there are 20 declared catchment areas administered by EHP, two of which are situated within 100 kilometres of the EIS study area. These are (approximate distances in brackets):

- Eungella Dam Catchment Area (65 kilometres); and
- Burdekin Falls Dam Catchment Area (98 kilometres).

These catchment areas have no functional connectivity with water systems within the Fitzroy Basin.

There are no declared irrigation areas within the EIS study area or downstream of the project. There are no declared drainage areas within the EIS study area. The Pioneer Valley water supply area is the closest drainage area; approximately 97 kilometres to the east of the EIS study area and in a different catchment.

River Improvement Areas

River improvement areas (RIA) are areas protected under the *River Improvement Trust Act 1940* (NRM 2013c). There are no RIAs within the EIS study area. The closest RIA is the Pioneer River Improvement Trust which is located approximately 70 kilometres to the east of the EIS study area (**Figure 9-11**).

Designated Landscape Area – Stanbroke Pastoral Holding

The Stanbroke Pastoral Holding designated landscape area does not occur within the EIS study area. It is located approximately 60 kilometres to the south of the township of Mt.Isa.

Timber Reserves

A timber reserve is land set apart and declared or deemed to be set apart and declared under the *Forestry Act 1959* as a timber reserve. There are no timber reserves in or within 100 kilometres of the EIS study area.

Koala Habitat Area

Koala habitat areas are declared under the *Nature Conservation (Koala) Conservation Plan 2006*. The plan provides for designation of koala districts and koala habitat areas, sets sequential clearing and koala spotting requirements, and defines wildlife permit restrictions. Koalas have been observed within the survey area (**Figure 9-12**). However, there are no declared koala habitat areas within 100 kilometres of the EIS study area.

Coastal Management Districts

Coastal management districts occur over all tidal waters and on most land adjacent to tidal waters in Queensland (EHP 2012c). Coastal management districts are declared under the *Coastal Protection and Management Act 1995*. There are no coastal management districts within 100 kilometres of the EIS study area.

Declared Areas under the Vegetation Management Act 1999

Areas declared under the VM Act may be declared as either of 'high conservation value' or 'vulnerable to land degradation' (VM Act). There are no such areas declared under the VM Act within the EIS study area or surrounding region.

Referable Wetlands

Referable wetlands are areas shown as wetlands on the 'map of referable wetlands'. Referable wetlands include two categories:

- wetland protection areas (WPAs); and
- wetland management areas (WMAs).

WPAs are wetlands of high ecological significance (HES) in the Great Barrier Reef (GBR) catchments. WMAs are wetlands of general ecological significance (GES) within the GBR catchments and wetlands of general or high ecological significance outside GBR catchments.

Within the EIS study area, there are wetland management areas declared along the Isaac River, 12 Mile Gully, and Goonyella Creek, as well as some small isolated wetlands and minor tributaries. No HES wetlands are mapped within the study area. A number of referable wetlands also occur downstream of the project (**Figure 9-11**).

Reserves under the Land Act 1994

A reserve is an area declared under the *Land Act 1994.* There are no reserves declared under the *Land Act 1994* within 100 kilometres of the EIS study area.

Dams and Weirs

Dams and weirs owned and controlled by the Queensland Government are considered Category C ESAs. There are no dams or weirs controlled by the Queensland Government within the EIS study area. The Selma Weir occurs approximately 80 kilometres downstream (south) of the EIS study area.

9.5.3.4 Other Environmentally Sensitive Features

A number of other environmental and cultural values not defined as Category A, B or C ESAs have been identified through the literature review and field studies. These are described below.

EPBC Matters of National Significance

The EPBC Act provides for the protection of the environment, especially MNES, and is administered by DSEWPaC. It is designed to provide for the conservation of biodiversity through the protection of threatened species and ecological communities, migratory, marine and other protected species listed under the EPBC Act.

Within the EIS study area, a number of endangered and of concern REs have been identified that are analogous to EPBC TECs. These TECs and relevant REs include:

- EPBC TEC *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (of concern RE 11.8.11); and
- EPBC TEC *Brigalow (Acacia harpophylla dominant and co-dominant)* (endangered REs 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16 and 11.9.1).

Figure 9-8 depicts the locality of these REs within the EIS study area. The potential impacts and mitigation strategies pertaining to these REs are discussed in **Section 9.6.5** and **Section 9.8.1** respectively.

URS field surveys also identified 12 EPBC-listed flora and fauna species within the EIS study area. These species include:

- *Dichanthium setosum* (bluegrass) (vulnerable);
- squatter pigeon (*Geophaps scripta scripta*) (vulnerable);
- ornamental snake (*Denisonia maculata*) (vulnerable); and
- nine fauna species listed as migratory.

Flora and Fauna Species Declared under the NC Act

The Queensland NC Act is administered by EHP and is the principal legislation for the conservation and management of the State's native flora and fauna. The primary objective of the NC Act is the conservation of nature, namely the preservation of endangered, vulnerable and near threatened species of flora and fauna as listed under the Nature Conservation (Wildlife) Regulation 2006. During field surveys, eight flora and fauna species declared under the NC Act were identified within the EIS study area. These include:

- *Cerbera dumicola* (no common name) (near threatened);
- squatter pigeon (*Geophaps scripta scripta*) (vulnerable);
- cotton pygmy-goose (*Nettapus coromandelianus*) (near threatened);
- black-necked stork (*Ephippiorhynchus asiaticus*) (near threatened);
- ornamental snake (*Denisonia maculata*) (vulnerable);
- little pied bat (*Chalinolobus picatus*) (near threatened); and
- short-beaked echidna (*Tachyglossus aculeatus*) (special least concern).

The potential impacts for these species are described in **Section 9.6.5** and mitigation strategies are described in **Section 9.8.1.4**.

Directory of Important Wetlands

The Directory of Important Wetlands describes wetlands that have been qualified as nationally important (Environment Australia 2001). A wetland may be considered nationally important if it meets at least one of the following criteria:

- it is a good example of a wetland type occurring within a bio-geographic region in Australia;

- it is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
- it is a wetland which 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;
- the wetland supports one per cent or more of the national populations of any native plant or animal taxa;
- the wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level; and
- the wetland is of outstanding historical or cultural significance.

Lake Elphinstone is listed in the directory. It is situated approximately 25 kilometres to the north east, and upstream of the EIS study area (**Figure 9-11**). A number of listed wetlands occur within the Fitzroy Basin. As the project is situated within the Fitzroy Basin the approximate distance from the mouth of the Fitzroy River is also given.

Table 9-11 Important Wetlands Located Downstream from the EIS Study Area

Important Wetland	Approximate Distance from Fitzroy River Mouth (km)	Basin(s) containing Wetlands
Fitzroy River Delta	0	Fitzroy, Waterpark
The Narrows	7	Fitzroy, Calliope Basin, Curtis Island
Fitzroy River Floodplain	33	Fitzroy
Hedlow Wetlands	46	Fitzroy

Wild River Preservation Areas

A wild river declaration is a statutory document under the *Wild Rivers Act 2005*, which aims to preserve a river that has all, or nearly all, of its natural values intact (EHP 2013a). The nearest wild river area is the Cooper Creek Basin Wild River Area which is situated approximately 185 kilometres to the west of the EIS study area. This area occurs within a separate catchment (Cooper Creek Basin) to the project. With the exception of Fraser Wild River Area, all other declared wild river areas occur in the far north or western Queensland.

Isaac River

Desktop analyses and field surveys carried out by URS determined that the riparian and alluvial woodlands fringing the Isaac River are of ecological importance, and thus considered an environmentally sensitive feature for the purposes of this report. This is largely due to the fact that the Isaac River provides the only functioning north-south corridor within the EIS study area for wildlife moving through the landscape. The results from the fauna surveys (**Section 9.4.2.4**) also identified that the Isaac River supports a high diversity of wildlife and a high density of arboreal mammals that was not evident elsewhere on the EIS study area.

9.6 Potential Impacts on Flora and Fauna

The EIS study area covers approximately 26,000 hectares, within which 3,821.3 hectares of remnant and non-remnant vegetation and grassland may be disturbed. Of this, 1,669 hectares is remnant vegetation (**Figure 9-13**).

The potential impacts on flora, fauna and ESAs are described below. Direct and indirect impacts are expected to occur as a result of construction and operation activities.

Table 9-12 presents the breakdown of the potential impacts to vegetation communities from all project components:

- development of the RHM, including clearing for incidental mine gas (IMG) infrastructure and subsidence;
- direct clearing for surface facilities (Red Hill mine industrial area (MIA), Red Hill accommodation village, conveyor, and Red Hill coal handling and preparation plant (CHPP)); and
- subsidence at the Broadmeadow extension.

The areas impacted by development of the RHM are considered as a maximum worst case. In reality only 50 per cent of these areas will be impacted as the IMG drainage area will likely only disturb a maximum of 50 per cent of the areas. A worst case 100 per cent has been shown in **Table 9-12**.

Disturbance to each community is indicated as a percentage of the community found within the Northern Bowen Basin sub-region.

More than half of the calculated disturbance area consists of non-remnant modified grassland and non-remnant regrowth (does not include HVR), with approximately 1,665.2 hectares and 461.9 hectares to be impacted respectively. An estimated 1,669 hectares of remnant vegetation will be impacted either by direct clearing or by subsidence.

The impacts on remnant vegetation communities, remnant and non-remnant habitat and the subsequent impact on fauna species specific to each project activity are discussed below.

Impacts on vegetation and habitat will occur throughout the life of the project. On commencement of construction, areas required for the accommodation village, Red Hill MIA, Red Hill CHPP, and conveyor will be cleared. As the footprints of these facilities will be fully developed, 100 per cent of vegetation will be cleared from these areas.

IMG drainage infrastructure will be installed as early as possible to allow adequate time to drain gas prior to mining. This is discussed further in **Section 3.8**. In terms of surface disturbance, installation of the IMG drainage infrastructure will result in a mosaic of clearing throughout the life of the project.

As mining progresses, the mined out panels will subside resulting a maximum change in topography of up to six metres across portions of the RHM footprint, as discussed in **Section 3.6.5**. While there is no direct removal of surface vegetation required over the subsided areas, changes in topography and surface drainage could alter conditions in many of the subsided areas.

Each of these impacts are discussed in **Sections 9.6.1, 9.6.2** and **9.6.3** respectively.

Sections 9.6.4.1 to **9.6.4.7** focus on particular categories of impacts, covering:

- loss of riparian habitat and wildlife corridors;
- erosion and soil loss;

- drawdown from water extraction;
- dust impacts;
- edge effects;
- noise and light impacts;
- mortality or injury of fauna from traffic and vegetation clearing; and
- pests and feral fauna.

Section 9.6.5 then examines impacts on conservation significant vegetation communities, plants and fauna.

9.6.1 Potential Impacts from Surface Facilities and Infrastructure

The potential impacts from surface infrastructure including Red Hill MIA, Red Hill accommodation village, conveyor, Red Hill CHPP, and proposed levee bank are discussed below. For each of these areas, any remnant vegetation within the footprint will be completely cleared. Areas of each vegetation unit and mapped regional ecosystem that will be cleared are shown in **Table 9-12**.

9.6.1.1 Flora and Vegetation Communities

Table 9-12 shows that the total of area disturbance from surface facilities is 264 hectares. This area comprises of 142.7 hectares of remnant vegetation.

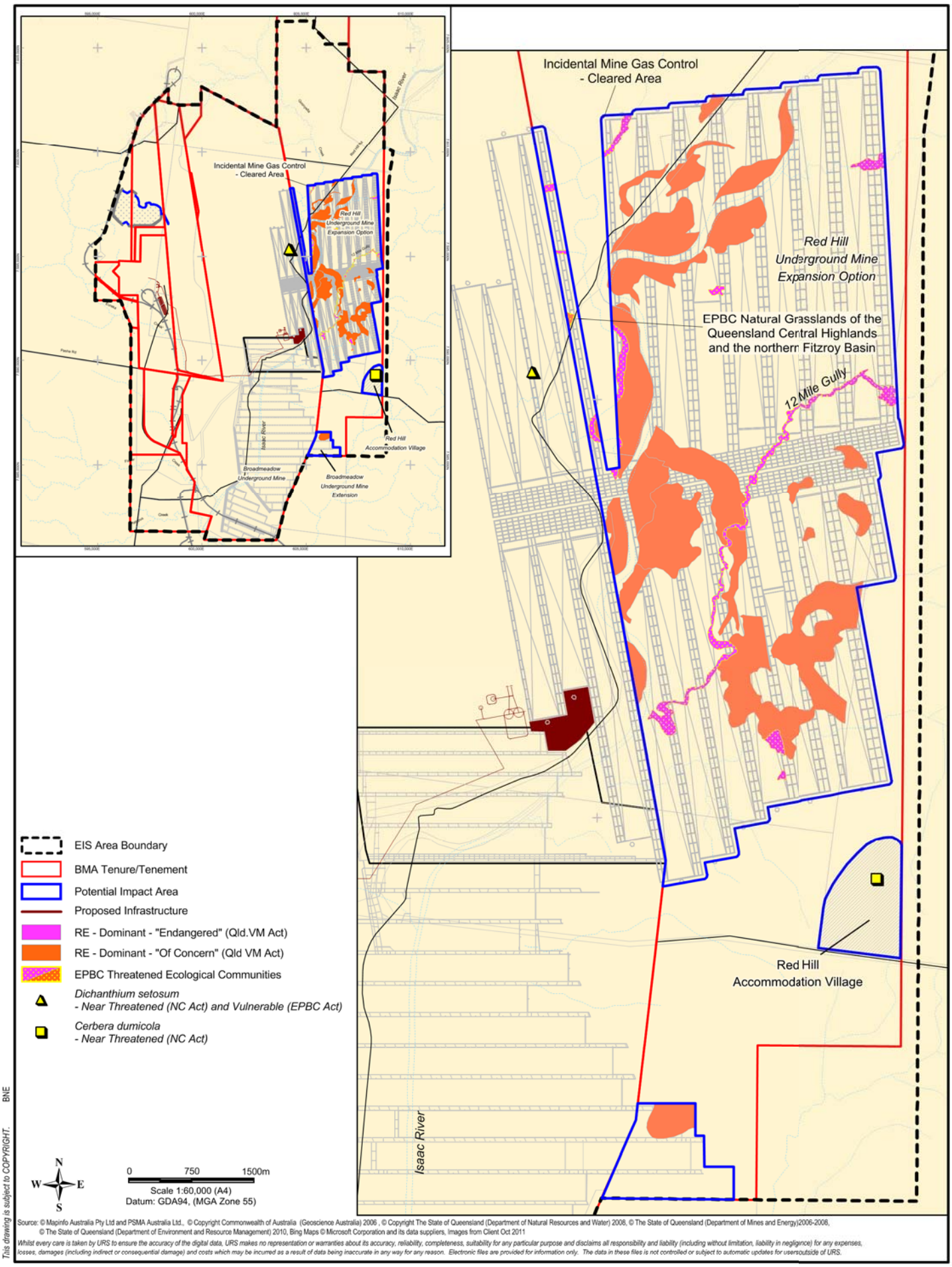
The construction of the Red Hill accommodation village will impact 109 hectares. The remnant vegetation within the Red Hill accommodation village footprint consists of three REs; all listed as least concern under the VM Act. They include 12.7 hectares of *Eucalyptus populnea* woodland and less than 0.1 hectares of *E. crebra* woodland.

The 2009 survey identified the presence of the conservation significant flora species, *Cerbera dumicola* within the proposed Red Hill accommodation village footprint. The impacts on this species are discussed below in **Section 9.6.5**.

The CHPP and conveyors are located within the existing GRM area and, while vegetation clearing is required for both of these, this vegetation is partly disturbed and fragmented. The MIA is located in a less disturbed area. Construction of these facilities will result in the disturbance of 51 hectares of REs. This disturbance is spread across nine REs of which five are considered conservation significant.

If required, the levee bank would be located on the west side of the Isaac River, between the Isaac River and the MIA, to protect the MIA and mine entrance from flooding. Although a location for the levee bank has been assumed for the purposes of flood modelling presented in **Section 7.3.4**, the final footprint has not been determined and can be located to minimise impacts on good quality riparian vegetation.

Potential for impacts on floral and vegetation community diversity is discussed in **Section 9.6.5.1**.



BNE

BHP Billiton Mitsubishi Alliance

RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

POTENTIAL IMPACTS ON VEGETATION COMMUNITIES AND FLORA

URS

TERRESTRIAL ECOLOGY

Figure: **9-13**

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Table 9-12 Potential Disturbance to Vegetation Communities

Unit	RE	Status [1]			Project Areas (ha)			Total Direct Impacts	
		EPBC	Biodiv	VMA	RHM [2]	Surface Facilities [3]	Broadmeadow Extension [4]	Total Impact Area (ha) [5]	% of sub-region [6]
1a	RE 11.3.1	E	E	E	59.1	-	-	59.1	0.81
1b	RE 11.3.2	NL	OC	OC	164.4	-	-	164.4	0.52
1c	RE 11.3.3	NL	OC	OC	7.0		-	7.0	1.42
1d	RE 11.3.4	NL	OC	OC	16.3	0.4	-	16.7	0.09
1di	RE 11.3.4a	NL	OC	OC	103.3	-	-	103.3	0.54
1e	RE 11.3.5	NL	OC	LC		-	-		0
1f	RE 11.3.7	NL	OC	LC	25.2	3.6	-	28.8	0.62
1g	RE 11.3.25e	NL	OC	LC	121.0	1.4	-	122.4	0.35
1h	RE 11.3.36	NL	OC	OC		-	-		0
2a	RE 11.4.2	NL	OC	OC	326.3	5.3	19.9	351.5	6.19
2b	RE 11.4.7	E	E	E	34.6	-	-	34.6	n/a[7]
2c	RE 11.4.8	E	E	E	35.0	17.1	-	52.1	1.79
2d	RE 11.4.9	E	E	E	73.8	14.4	-	88.1	0.89
3a	RE 11.5.3	NL	NCP	LC	388.1	42.5	6.2	436.9	0.58
3b	RE 11.5.9	NL	NCP	LC	-	<0.1	31.6	31.6	0.07
3c	RE 11.5.16	E	E	E	-	30.6	-	30.6	3.41
4a	RE 11.7.1	NL	OC	LC	-	-	-	-	0
4b	RE 11.7.2	NL	NCP	LC	-	27.4	-	27.4	0.13
5a	RE 11.8.11	E	OC	OC	78.6	-	-	78.6	0.36

Unit	RE	Status [1]			Project Areas (ha)			Total Direct Impacts	
		EPBC	Biodiv	VMA	RHM [2]	Surface Facilities [3]	Broadmeadow Extension [4]	Total Impact Area (ha) [5]	% of sub-region [6]
5b	RE 11.8.11/ with non-remnant component	-	-	-	35.7	-	-	35.7	0.16
6a	RE 11.9.1	E	E	E	0.2	-	-	0.2	<0.01
7a	Non –remnant grassland	NL	NL	NL	1604.0	27.5	33.7	1665.2	-
7b	Non –remnant shrubby regrowth	NL	NL	NL	368.2	93.8	-	461.9	-
7c	HVR analogous to 11.4.8/9	NL	NL	NL	25.2	-	-	25.2	-
Total					**3465.9**	**264**	**91.4**	**3821.3**	**NA**

Note 1: Status E – endangered; OC – of concern; LC – least concern; NCP – no concern at present; Non-remnant – non- remnant vegetation.
Note 2: Area to be impacted by the creation of RHM. Includes the area impacted by clearance for gas drainage infrastructure and the area impacted by subsidence. In reality, only around 50 per cent of these areas will be impacted as the gas drainage infrastructure will not likely cover the whole area of RHM.
Note 3: Area to be cleared for surface facilities including Red Hill MIA, Red Hill accommodation village, conveyor, and Red Hill CHPP. 100 per cent of these will be cleared.
Note 4: Area to be impacted by subsidence of the Broadmeadow extension.
Note 5: Total impact area = area impacted by RHM (clearance and subsidence) + area cleared for surface facilities + area impacted by subsidence at Broadmeadows extension.
Note 6: Indicates the per cent extent of the vegetation community within the northern Bowen Basin subregion as per as per Accad *et al* 2012 that will potentially be disturbed by the project.
Note 7: RE 11.4.7 is not present in the Northern Bowen Basin subregion as per Accad *et al* (2012).

9.6.1.2 Fauna

The proposed Red Hill accommodation village will potentially have direct impacts on fauna during vegetation clearing activities. Field surveys identified that the vegetation communities situated within the proposed Red Hill accommodation village footprint generally supported a low diversity of fauna species and were predominantly used by fauna dispersing through the landscape. The construction of the accommodation village may reduce fauna dispersal in the area. However, the impact is considered minimal due the presence of contiguous habitat to the south of the accommodation village.

The proposed access road to the accommodation village may cause some severance of fauna dispersal opportunities. The road alignment passes largely through modified grassland habitat however, the alignment is likely to follow an existing track alignment that bisects a patch of *Eucalyptus populnea* (poplar box) woodland. This is discussed further in **Section 9.6.4.6**.

The conveyors and CHPP are both located close to existing mining areas and while there is some remnant vegetation in the footprints of these facilities, this vegetation has limited connectivity and habitat value. Clearing associated with these facilities is not likely to have any adverse impacts on fauna species utilising the EIS study area.

The MIA footprint also contains woodland habitat adjacent to the Isaac River that is likely to be utilised by fauna moving along the Isaac River corridor. Clearing of this area will reduce fauna dispersal as well as food and roosting/nesting resources associated with this corridor.

Indirect impacts such as noise, dust and light may impact on fauna species in adjacent vegetation during both construction and operation of the Red Hill accommodation village, CHPP, conveyors and MIA. These impacts are discussed in **Section 9.6.4**.

Overall, fauna displaced from clearing due to surface facilities will generally be able to move into adjacent habitat and disperse from the area. The fauna species present are generally tolerant to disturbance and also exhibit relatively wide ranging habitat preferences which will assist these fauna in moving away from the areas of disturbance. Given the relatively small area of habitat to be disturbed and the availability of similar habitat within and adjacent to the EIS study area, impacts on fauna due to loss of this habitat are not expected to be significant.

9.6.2 Potential Impacts from the Incidental Mine Gas Drainage Network

9.6.2.1 Overview

Installation of the IMG drainage network will require clearing of vegetation for the construction of gas wells and corresponding infrastructure including gas pipelines, water pipelines and service roads. At this stage the exact layout of the IMG network is not known, however, it is expected to follow the layout described in **Section 3.8**, which will involve progressive construction of infrastructure in a grid-like pattern over the RHM and to a lesser extent, the Broadmeadow extension. Consequently, not all vegetation will need to be cleared, however remaining vegetation will occur in fragmented patches isolated by the gas drainage infrastructure, thus affecting connectivity and habitat functionality.

Table 9-12 shows the area of each vegetation unit and mapped regional ecosystems within the underground mine footprint for the proposed RHM. Calculations in **Table 9-12** relate to the total area of each vegetation unit present in the underground mine footprint, rather than the area that will actually

be cleared as part of the IMG management infrastructure. In reality, it is expected that no more than 50 per cent of the surface area will be cleared; however, the nature of the clearing required will mean that the area will be divided into a grid like pattern, with impacts on connectivity between remnant patches. It is expected that clearing within the remnant *Dichanthium setosum* grassland can be avoided, otherwise all threatened ecological communities and regional ecosystems within the underground mine footprint may be partially cleared.

The proportion of the surface area to be disturbed will be lower in the western part of the mine as IMG levels are predicted to be lower in this area, increasing towards the east where a higher density of IMG pre-drainage wells will be required.

Timing for installation of gas drainage infrastructure has not been finalised, as additional appraisal studies are required to quantify the amount of gas and time required to drain each longwall panel ahead of mining. It is expected that installation of gas drainage infrastructure will commence in the western-most panels early in the construction phase, then be progressively installed in a west to east direction ahead of mining. As coal depth and gas quantities increase to the east, infrastructure will need to be installed ahead of mining, possibly as much as 10 to 15 years ahead. At the same time, mining will have been completed in the western longwall panels, these areas will have subsided and rehabilitation will be occurring. Hence, surface disturbance from IMG drainage infrastructure will be staggered.

As rehabilitation of the post mining land surface is closely connected with subsidence effects, management of ecological impacts from IMG drainage requirements will be closely linked to the overall adaptive management approach to subsidence impacts. In particular, it is expected that remnant vegetation that is not directly affected by the IMG management network will become important in terms of ongoing management of subsidence impacts and rehabilitation.

9.6.2.2 Flora and Vegetation Communities

As depicted in **Table 9-12**, approximately 3,466 hectares of land will either be cleared or fragmented during the development of the gas drainage network. This disturbance area consists of 1,468 hectares across 19 REs, of which 12 are considered to be of conservation significance under either the EPBC Act and/or the VM Act.

In terms of total area of remnant vegetation cleared, the largest affected areas are of vegetation unit 3a: *Eucalyptus populnea* and/or *E. melanophloia* forest (RE 11.5.3) for which 436.9 hectares will be cleared or fragmented and unit 2a: Eucalyptus spp. and/or Corymbia spp. woodland (RE 11.4.2) of which 351.5 hectares will be cleared or fragmented. Vegetation unit 3a is considered least concern under the VM Act while vegetation unit 2a is of concern. In a regional context, 0.58 per cent of the sub-regional extent of RE 11.5.3 will be cleared and 6.19 per cent of the subregional extent of RE 11.4.2 will be cleared.

Of the brigalow communities within the EIS study area, approximately 270 hectares will be cleared or fragmented by IMG drainage and surface facilities development. This refers to those communities that are included under the *Brigalow (Acacia harpophylla dominant and co-dominant)* TEC. In terms of total area of remnant brigalow vegetation cleared, the largest affected area is of Vegetation unit 2d: *Acacia harpophylla* shrubby open woodland (RE 11.4.9) for which 88 hectares will be cleared or fragmented. This community is considered endangered under the VM Act. In a regional context, 0.89 per cent of the sub-regional extent of RE 11.4.9 will be cleared.

The implications of this clearing in terms of impacts on conservation significant REs across the EIS study area are discussed in **Section 9.6.5** below.

In addition to reduction in extent of ecological communities, disturbance to the riparian communities which border the Isaac River, 12 Mile Gully and Goonyella Creek must also be considered. Along the Isaac River, vegetation communities include *Eucalyptus* and/or *Corymbia* woodlands on alluvial plains (RE 11.3.2, RE 11.3.4, RE 11.3.4a and RE 11.3.25e). These REs form a north-south corridor within the EIS study area. This corridor is recognised as significant at the State level under the Biodiversity Planning Assessment for the Brigalow Belt (NRM 2013a).

While design of the layout of the IMG drainage infrastructure has not yet been finalised, it is intended to restrict the number of times that the infrastructure crosses the Isaac River to minimise direct disturbance to this corridor. The crossing on the main heading will be a bridged crossing and fauna passage will be possible under the bridge. One or two additional pipeline crossings will be required and these will be trenched crossings, with disturbed areas reinstated to stabilise the river bed and banks. It is not anticipated that these pipeline crossings will have permanent vehicle access.

With these design measures in place, riparian vegetation connectivity will largely be retained along the Isaac River during this phase of the project.

Impacts on Goonyella Creek from IMG management infrastructure will be minimal as the current mine plan does not extend under the creek due to the presence of faulting.

IMG management infrastructure will cross 12 Mile Gully and smaller tributaries and drainage a number of times as these creeks and drainage lines meander across the surface of the mine footprint. As described in **Section 3.8**, these crossings will consist of buried water and gas pipelines and either overhead or buried powerlines as well as a vehicle crossing.

Wherever possible, the wells required for IMG drainage will be installed outside of the riparian zone.

Measures to avoid riparian vegetation along 12 Mile Gully will also protect the endangered RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains) the occurrence of which on site is largely associated with these two creeks. RE 11.3.1 is an analogous RE of the *Brigalow* (*Acacia harpophylla dominant and co-dominant)* TEC.

Essential habitat for *Dichanthium setosum* is situated within the proposed gas drainage network footprint. This area of essential habitat supported the only known record for this species across all survey sites. Additionally, the RE which makes up this habitat (RE 11.8.11) is also considered an EPBC-listed TEC (*Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin*). This grassland area is located above a part of the mine that has relatively low gas levels, and hence surface disturbance for IMG drainage will be minimal. Subject to more detailed investigations, it is intended that gas drainage in this area can be achieved without disturbing this patch of grassland.

Woodland vegetation units 2b, 2c and 2d correspond to endangered REs 11.4.7, 11.4.8 and 11.4.9 and occur in the south-west corner of the proposed mine footprint. These vegetation units are also in a part of the mine that has relatively low gas levels and a lower level of surface disturbance is anticipated in this area.

As detailed in **Section 3.8**, the gas drainage network will be constructed in a grid like pattern. As a result vegetation will still occur in patches between the gas drainage infrastructure. While a number of patches of vegetation communities including TECs and REs will be retained within the grid formed by

the IMG management infrastructure, these patches will be isolated and fragmented and may not contribute significantly to the conservation of these vegetation communities at a local or regional level.

This high level of fragmentation will also result in edge effects on these communities. Examples of edge effects include weed invasion and altered microclimatic conditions. Further, the potential risk for weed invasion will increase as the network is developed due to increased activity within the disturbed area. Edge effects on vegetation communities are discussed below.

Indirect impacts such as dust from gas management infrastructure construction activities may result in the degradation of vegetation adjacent to works. These impacts are also discussed in **Section 9.6.4.3** below.

Note also that the footprint of the underground mine will be subject to subsidence as mining progresses from west to east. The effect of subsidence is discussed in more detail in **Section 9.6.3**.

9.6.2.3 Fauna

Impacts on fauna from installation and operation of the IMG drainage infrastructure may occur from:

- loss of habitat from direct clearing of vegetation, including habitat trees; restriction in ability to move across the site (**Section 9.6.4.1**); and
- injury or mortality to fauna present during vegetation clearing activities (**Section 9.6.4.6**).

Potential impacts on different habitat types across the site are discussed below.

Brigalow

Brigalow habitat on the site occurs largely as a riparian zone along Goonyella Creek and 12 Mile Gully. Disturbance to Goonyella Creek riparian zone is minimal; however, as identified in **Section 9.6.2.2**, IMG management infrastructure will be required to cross 12 Mile Gully at a number of locations, creating gaps in the brigalow habitat of 10 to 20 metres wide. This will reduce the extent of this habitat as well as reducing connectivity and restricting animal movement along 12 Mile Gully.

As outlined in **Section 9.4.2.4**, abundance and diversity of fauna in the Brigalow habitat was generally low; however, Brigalow habitat is associated with several reptiles of conservation significance.

Riparian corridors along 12 Mile Gully will be disrupted. While these corridors do not contribute significantly to overall connectivity across the EIS study area, movement of fauna around the site may be restricted.

Overall however, clearing of sections of Brigalow habitat along 12 Mile Gully is not likely to result in significant impacts on fauna.

Riparian and Alluvial Woodlands

Riparian and alluvial woodlands were identified as important habitat for a range of common arboreal mammals, and also form the majority of the State biodiversity listed corridor through the EIS study area. These habitats were identified during field surveys as supporting a high abundance and diversity of fauna, especially arboreal mammals. Detailed in **Section 9.4.2.4**, large, mature forest red gum (*Eucalyptus tereticornis*) trees present in riparian habitats frequently contained hollow limbs which provide denning sites for arboreal mammals and microbats and nesting sites for many bird species such as parrots, owls and dollarbird (*Eurystomus orientalis*).

Riparian and alluvial woodlands are largely associated with the Isaac River and as such, direct impacts will be limited to the crossings of the river. Placement of IMG infrastructure in riparian areas will also be avoided wherever possible. While crossings of the Isaac River will reduce connectivity by creating gaps of 20 to 50 metres in the case of the bridge and 10 to 20 metres in the case of pipeline crossings, overall loss of riparian habitat is minimal. Arboreal mammals will be able to move across the crossings provided that tall trees are retained on either side.

Fauna using the riparian corridor may also be discouraged by noise, light and other activity associated with the installation and management of the IMG drainage infrastructure, although such disturbance will be intermittent and noise levels are not predicted to be particularly significant (**Section 12**).

Overall, significant degradation of habitat values is not expected, and minor degradation of connectivity will occur.

Poplar Box Woodlands

Poplar box woodlands occur as a mosaic across the south-eastern quadrant of the proposed mine footprint and, as this is an area where gas incidence is quite high, it will be subject to relatively intense disturbance as a high density of gas management infrastructure will be required in this area.

Poplar box communities were identified as supporting a range of woodland bird species including the listed migratory bird rainbow bee-eater (*Merops ornatus*). Poplar box trees also readily form hollows that may support arboreal mammals.

The loss or fragmentation of this community may significantly reduce fauna dispersal across the site as it connects into riparian corridors along Isaac River and 12 Mile Gully. It will also reduce the availability of fauna habitat throughout the east of the EIS study area. Retention of habitat trees will reduce impacts by promoting dispersion and providing habitat resources.

Laterite Ridges

Laterite ridge habitat is not affected by IMG drainage infrastructure.

Dawson Gum Woodland

Small areas of this habitat occur over the south-western part of the proposed mine footprint. IMG incidence in this area is relatively low and disturbance is likely to be low and have minimal effect on faunal use and diversity of the site. Note this habitat is also affected by the MIA.

Modified Grassland

Large areas of modified grassland will be affected by the IMG management infrastructure. This habitat type is identified as having relatively low habitat values due to a lack of native vegetation. However, it is utilised by eastern grey kangaroos (*Macropus giganteus*), squatter pigeon (*Geophaps scripta scripta*) and other bird species such as brown quail (*Coturnix ypsilophora*) which do not have specific habitat preferences and utilise a wide range of native and modified habitats. Given the widespread extent of this habitat throughout the EIS study area and sub-region, it is unlikely that loss of this habitat will have any significant impacts on fauna.

Water Bodies

Impacts on water bodies from gas drainage infrastructure are expected to be minimal as the only water bodies within the proposed underground mine footprint are associated with the Isaac River and

12 Mile Gully and will not be obstructed or diverted by the proposed works. Water storage will be created for short term storage of production water from the gas extraction (refer to **Section 3.8**); however, this is not likely to provide important habitat as this will be used as a contingency only, and when used, will contain relatively saline water.

9.6.2.4 Summary

The above impacts on fauna are based on the area of vegetation cleared once the construction of the gas drainage network is completed. However, as mentioned previously, the gas drainage network will be undertaken progressively, such that loss of habitat values will be gradual and there will be opportunities for fauna to move into adjacent habitat or into areas that will have already undergone partial rehabilitation. Suitable habitat is available to the north, south and east of the proposed mining footprint. Competition for resources and territory within these new areas may affect some species; however, most species present on site are relatively resilient and do not have very specific habitat preferences. Additionally, an increase in predation may occur as a result of dispersing.

Many of the fauna species observed within the EIS study area are relatively tolerant to disturbed habitats and may continue to utilise remaining habitat in spite of fragmentation and noise, light and activity disturbance. As installation of the gas management infrastructure progresses, food and shelter resources will be diminished and density of fauna in the area may also diminish.

The main north-south corridor along the Isaac River will be largely retained and fauna use and movement along this corridor should remain possible.

Overall, impacts on fauna from the IMG management infrastructure are largely related to loss of habitat trees and reduced connectivity and are not likely to affect any species of conservation significance.

Areas affected by IMG infrastructure will also be affected by subsidence. This is discussed further in **Section 9.6.3**.

9.6.3 Potential Impacts from Underground Mining Operations at RHM and BRM

9.6.3.1 Overview

The mining of the RHM will occur progressively in a west to east direction. Once the coal seam has undergone pre-drainage of IMG, the gas drainage surface infrastructure will be decommissioned and above ground infrastructure removed. Longwall mining will then be undertaken in these areas. It should be noted that the period of time between installation of the gas wells and the commencement of underground longwall mining will vary. In some cases, an estimated 15 years may occur between the two activities. Mining of each longwall is expected to take one to two years, and subsidence will be progressive as mining advances.

The proposed underground longwall mining operations will result in a varying degree of ground surface subsidence. Current modelling indicates the potential of ground subsidence between zero and six metres. More information is provided in **Section 3.6.5.**

Subsidence does not require actual clearing of vegetation, but changes to local topography soils and hydrology as a result of subsidence can potentially affect vegetation, as discussed below.

9.6.3.2 Flora and Vegetation Communities

Prior to subsidence, vegetation will already have been disturbed by installation of IMG management infrastructure as described in **Section 9.6.2.2**, leaving a mosaic of remnant and modified vegetation across the proposed underground mine footprint as well as retained riparian zones along the Isaac River and 12 Mile Gully (Goonyella Creek is largely unaffected by subsidence as it is outside the mine footprint). Subsidence will cause a range of additional changes in remaining flora and vegetation communities as well as direct site rehabilitation:

- trees and other plants will be subject to localised changes in topography and tension cracking may occur at the surface, which could affect individual plant health; and
- localised changes in topography will alter drainage characteristics across the RHM footprint and could lead to water ponding within surface water drainage lines.

The vegetation communities within the predicted subsidence footprint include seven REs, of which four are considered conservation significant. RE 11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains) is considered endangered and is also an analogous RE of the Brigalow TEC. This RE occurs along all the minor eastern waterways with particular dominance along 12 Mile Gully. Of this RE, approximately 28.9 hectares may potentially be subjected to subsidence-related changes.

Soil Movement and Tension Cracking

Tension cracks may develop adjacent to the pillars where slopes are greatest. These tension cracks form as the panel area subsides and the areas supported by the pillars remain in place. Movement in soil profiles and the formation of cracks and fissures can lead to stress on the roots of trees and shrubs and localised root shearing. These effects in turn can lead to the decline and death of trees/shrubs (Earth Tech 2006). Where cracking occurs in grassland, minimal impact is expected as root systems are small and restricted to the surface soil layers. This will be the case for the remnant grassland RE 11.8.11/ TEC *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin*.

For individual trees and shrubs, disturbance of the root ball from tension cracking, mechanical shaking during active subsidence, or ground tilt can all result in tree mortality or tree fall. Less immediate changes such as vegetation stress from either mechanical disturbance or water table change can result in foliar discolouration, partial defoliation or increased susceptibility to pathogenic attack (Coops *et al.* 2004). The effects of these changes are not always immediate (Ives 1995). Given the general resilience of Eucalypts to extreme environmental conditions (fire, drought, intense rainfall), subsidence effects associated with gradual changes may not become apparent for several years, but may be more likely in areas where moisture conditions are more critical, particularly in riparian corridors. Effects on vegetation condition as a result of subsidence, particularly in deep rooted canopy species, can take years to manifest, and may even go unnoticed until drought stress induces crown dieback (NSW Scientific Committee 2005).

The extent to which surface cracking and associated changes will occur at RHM and BRM is difficult to establish as this is influenced by a wide range of characteristics and hence it is difficult to estimate the extent to which vegetation may be adversely affected. As discussed in **Section 7.3.7.2**, observations at BRM are that where cracks have formed, these have rapidly in-filled, effectively self-sealing. Minimal observed changes to vegetation may have been offset by good rainfall in recent years.

While it may be possible to manage subsidence related effects to some extent, for example by repairing cracks in areas of native vegetation, some impacts will be unavoidable. In areas where earthworks are required in order to reduce surface cracking, vegetation may be impacted during the resurfacing process. Remnant woodland areas requiring infilling or grouting may be at risk of impacts from mitigation procedures.

Ongoing monitoring of the occurrence of and effects of surface cracking and rapid ground movement will be required to identify the potentially affected vegetation and to allow management measures to be implemented. As there will be permanent changes in the land surface, rehabilitation with the same species occurring pre-mining may not be practical.

Changes in Drainage Characteristics

Depression of the surface due to subsidence can lead to water ponding after heavy rain or in areas traversed by creeks or ephemeral streams. **Figure 9-14** shows the areas in which ponding is most likely to occur. More information on ponding is provided in **Section 7.3.7**. Vegetation in ponded areas will be inundated periodically or, in some areas, for longer periods of time. Where ponding is temporary, those species (such as *Eucalyptus tereticornis*) that can tolerate periodic inundation will remain (Jackson 2005). Where vegetation is not tolerant to this inundation (such as *Eucalyptus populnea*), it will die back and, in areas subject to temporary inundation, and may be replaced by more tolerant vegetation.

Subsidence will also affect the riparian corridors of Isaac River and 12 Mile Gully. A more detailed description of changes to these watercourses is provided in **Section 7.3.6**. In the short to medium term, these watercourses will become more pond-like in nature, with flows potentially restricted and changes in inundation levels along riparian zones.

Through a combination of erosion of pillars and the main heading and infilling due to sediment transport, the Isaac River channel is expected to re-establish over time (refer to **Section 7.3.6**). During this time, changes in riparian vegetation are expected as vegetation that is not tolerant to ponding will tend to die back in the subsided areas, potentially being replaced by vegetation more tolerant to inundation. Along the pillars and main heading, water availability to riparian vegetation may be reduced and erosion may also destabilise large trees along these sections of the river. An adaptive management program has been developed to address management of subsidence on the Isaac River. This is discussed in **Section 7.3.10.**

Ponded areas along 12 Mile Gully will infill more slowly as the catchment is relatively small and has lower sediment load. As substantial retention of low flow events in subsided areas is predicted, it is proposed to partially drain ponds in the 12 Mile Gully catchment by cutting channels through the main headings and pillars. This is detailed further in **Section 7.3.7.12.** The main riparian vegetation community along 12 Mile Gully is brigalow, which is relatively tolerant of varying hydrological conditions and likely to adapt to the changed conditions. The EPBC TEC *Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin* is located in an area where ponding is not expected to occur and, therefore, this community is unlikely to be affected.

Drawdown from Water Extraction

Vegetation within the EIS study area is not considered groundwater dependent. The majority of floral assemblages within the area are characterised by drought tolerant species with low physiological sensitivity to water availability. Froend and Loomes (2005) suggest that groundwater is of reduced

importance to vegetation when the water table is at depths greater than 10 metres. They assume, however, that at 10 to 20 metre depth there is still a probability of vegetation groundwater use, but this is thought to be negligible in terms of total plant water use. At depths of over 20 metres, groundwater use is expected to be minimal (Froend and Loomes 2005). The Tertiary and Permian sediments within the RHM have groundwater levels at depths between 25 to 80 metres (**Section 8**), considerably deeper than the known root zone of any of local vegetation communities. Open woodland communities at RHM would obtain groundwater from the soil moisture stored in the capillary fringe of predominantly clay soils. Riparian communities of the EIS study area utilise soil moisture retained in stream banks (alluvium material) from ephemeral flows.

The proposed underground mining and gas drainage operations will necessitate dewatering and depressurisation, however, underground mining will take place at depths of up to 500 metres and this is unlikely to have significant effects on the shallow perched groundwater resources associated with the Quaternary alluvium and Tertiary sediments (refer to **Section 8** for further details).

9.6.3.3 Fauna

Although much of the habitat within the proposed underground mine footprint will have been cleared or fragmented, as discussed in **Section 9.6.2.2**, it is likely that a number of native fauna tolerant to disturbance may still be present. As subsidence occurs, further changes to vegetation and habitats on the underground mine footprint may occur. These include:

- the loss of habitat trees that provide roosting and nesting habitat as well as food resources;
- the conversion of some areas from grassland or woodland to ponds; and
- modification of riparian zones along the Isaac River and 12 Mile Gully.

These changes are gradual and this may provide opportunity for fauna to move to adjacent areas to the north, east and south as food and nesting resources in the project area are diminished. Fauna may also be able to move into rehabilitated areas on the western side of the proposed underground mine footprint, however, availability of large trees in this area will be limited.

As detailed above, in areas of maximum subsidence, significant alteration to vegetation can occur, with surface cracking likely to result in root failure and premature death of individual trees. Vegetated areas at risk of subsidence include the *Eucalyptus* and *Corymbia* riparian woodlands along the Isaac River and 12 Mile Gully and the remaining vegetated patches situated between the gas drainage wells and associate infrastructure. As detailed in **Section 9.4.2.4** the riparian and alluvial woodlands provide important local habitat for a number of species, especially arboreal mammals such as the common brushtail possum (*Trichosurus vulpecula*) and the greater glider (*Petauroides volans*). These species were observed in high numbers along the Isaac River during the 2011 survey.

A number of ponds will be created as shown in **Figure 9-14**. These ponds will vary from areas of intermittent inundation to semi-permanent ponds. Ponds will potentially create new habitat opportunities for fauna including conservation significant species such as the cotton pygmy goose (*Nettapus coromandelianus*) and ornamental snake (*Denisonia maculata*), which were both recorded within the survey area. A relatively high diversity of amphibians was recorded in the EIS study area and an increase in aquatic habitats will benefit this fauna group. Cane toads (*Rhinella marina**) are present, and availability of aquatic habitat may increase cane toad numbers. The availability of

permanent water will also benefit larger fauna using the site, including eastern grey kangaroo (*Macropus giganteus*) and pest species such as feral pigs (*Sus scrofa**).

9.6.4 Related Impacts

9.6.4.1 Loss of Wildlife Corridors

The proposed mine development will result in several temporary infrastructure crossings of the Isaac River and a number of crossings of 12 Mile Gully as IMG drainage infrastructure is installed. As mining progresses, the Isaac River and 12 Mile Gully channels will subside (in places) and this is likely to result in marked changes to riparian vegetation as described in **Section 9.6.3.2**.

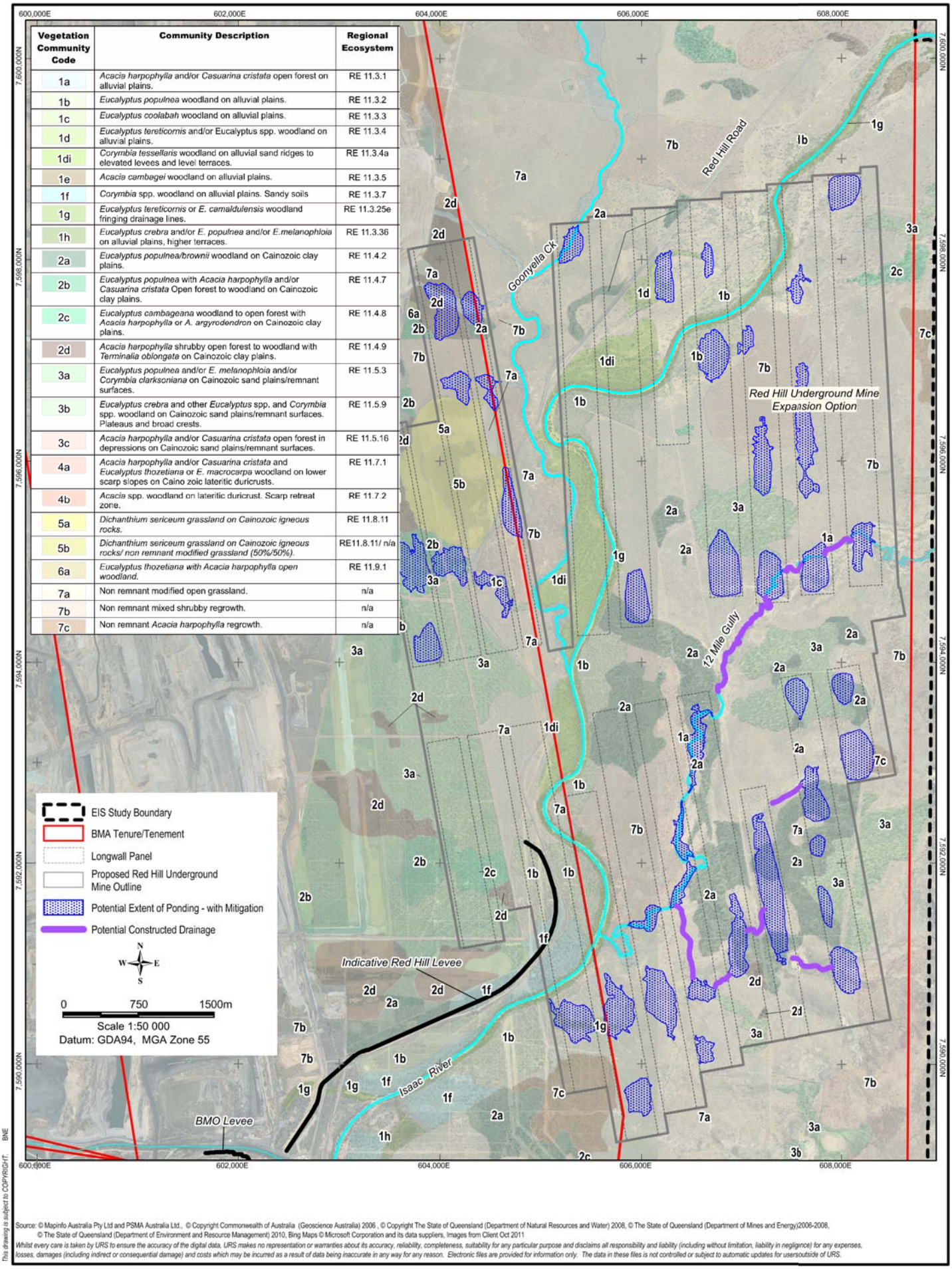
While these effects will be managed through an adaptive management program described in **Section 7.3.10**, it is likely that the nature of the wildlife corridor provided by the Isaac River will change significantly during the course of mining. In particular, a number of fauna habitat trees may be lost. This will affect the ability of arboreal mammals to disperse through the landscape. Generally bird species are highly mobile and will be able to fly over or through disturbed areas in order to access alternative habitat. Microbats will be able to continue to forage over disturbed areas if their roosts remain unaffected.

Ground dwelling fauna will be less affected as ground cover is not likely to be significantly affected and may in fact be increased if dead trees fall to the ground. Loss of shade trees may increase ground temperatures which may be problematic for some ground dwelling fauna, although reptiles are not likely to be particularly sensitive to this. Any exposed areas caused by vegetation clearing or die back will expose ground dwelling fauna to predation by native and non-native predators. Progressive rehabilitation of mined areas will offer alternative habitat to many fauna species and thus impacts may be reduced. However recolonisation of rehabilitated areas by ground fauna may be slow where feeder sources (such as remnant woodland) are isolated from the rehabilitated areas.

Ponding will increase the availability of water; however, this can have both positive and negative effects, as availability of water can also enhance habitat for pest fauna and non-native predators.

The Isaac River forms the dominant north to south vegetated corridor within the EIS study area and field surveys identified this corridor as supporting a high density of arboreal mammals and microchiropteran bat species. This corridor is recognised under BPA mapping as being of State significance.

The loss or degradation of wildlife corridors throughout the EIS study area will directly impact fauna dispersal as well as reducing availability of important habitat. Additionally, a loss of wildlife corridors may reduce fauna species diversity within the EIS study area. Fauna groups at most risk include ground mammals, reptiles and amphibians. Unlike birds, these groups generally have lower mobility and require the protection of vegetated corridors to disperse.



Vegetation Community Code	Community Description	Regional Ecosystem
1a	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	RE 11.3.1
1b	*Eucalyptus populnea* woodland on alluvial plains.	RE 11.3.2
1c	*Eucalyptus coolabah* woodland on alluvial plains.	RE 11.3.3
1d	*Eucalyptus tereticornis* and/or Eucalyptus spp. woodland on alluvial plains.	RE 11.3.4
1di	*Corymbia tessellaris* woodland on alluvial sand ridges to elevated levees and level terraces.	RE 11.3.4a
1e	*Acacia cambagei* woodland on alluvial plains.	RE 11.3.5
1f	*Corymbia* spp. woodland on alluvial plains. Sandy soils	RE 11.3.7
1g	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.	RE 11.3.25e
1h	*Eucalyptus crebra* and/or *E. populnea* and/or *E.melanophloia* on alluvial plains, higher terraces.	RE 11.3.36
2a	*Eucalyptus populnea/brownii* woodland on Cainozoic clay plains.	RE 11.4.2
2b	*Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* Open forest to woodland on Cainozoic clay plains.	RE 11.4.7
2c	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	RE 11.4.8
2d	*Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains.	RE 11.4.9
3a	*Eucalyptus populnea* and/or *E. melanophloia* and/or *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.	RE 11.5.3
3b	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains/remnant surfaces. Plateaus and broad crests.	RE 11.5.9
3c	*Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces.	RE 11.5.16
4a	*Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. macrocarpa* woodland on lower scarp slopes on Caino zoic lateritic duricrusts.	RE 11.7.1
4b	*Acacia* spp. woodland on lateritic duricrust. Scarp retreat zone.	RE 11.7.2
5a	*Dichanthium sericeum grassland on Cainozoic igneous rocks.*	RE 11.8.11
5b	*Dichanthium sericeum grassland on Cainozoic igneous rocks/ non remnant modified grassland (50%/50%).*	RE11.8.11/ n/a
6a	*Eucalyptus thozetiana with Acacia harpophylla open woodland.*	RE 11.9.1
7a	Non remnant modified open grassland.	n/a
7b	Non remnant mixed shrubby regrowth.	n/a
7c	Non remnant *Acacia harpophylla* regrowth.	n/a

BMA
BHP Billiton Mitsubishi Alliance

RED HILL MINING LEASE
ENVIRONMENTAL IMPACT STATEMENT

POTENTIAL PONDING AREAS AND REGIONAL ECOSYSTEMS

URS

TERRESTRIAL ECOLOGY

Figure: 9-14

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9.6.4.2 Erosion and Soil Loss

Soil erosion may occur in areas disturbed by activities associated with the project. Where these activities occur on dispersive soils and/or on slopes, mobilisation of sediment into watercourses can occur. Impacts to aquatic ecosystems can include build-up of sediment in waterholes with a resultant reduction in available microhabitat, and smothering of aquatic plants and substrate (refer to **Section 10.2** for further details).

Erosion can remove the most productive part of the soil profile, the topsoil, resulting in a greatly reduced opportunity for natural regeneration of vegetation communities (unless stock piled). Impacted areas most susceptible to erosion include floodplain areas and riparian vegetation associated with the Isaac River and 12 Mile Gully, as well as those vegetation communities associated with erosive sand or silt land zones.

Topsoil resources can be protected by removing topsoil altogether from areas of high disturbance and setting the topsoil aside for reuse in rehabilitation programs. Where topsoil is left *in situ* in disturbed areas, erosion and sediment control measures are required to minimise loss of topsoil. These are discussed in more detail in **Section 5.3.3**.

Prompt, progressive and monitored rehabilitation of disturbed areas is the key to prevention of and long-term management of erosion. Management strategies for the rehabilitation of cleared areas are provided in **Section 9.8.1.7** and **Section 5.5.**

9.6.4.3 Dust Impacts

Dust impacts generated during the construction and operation of the project may negatively affect vegetation.

Localised dust effects are likely to arise during the following activities:

- Vegetation clearing and earthworks associated with construction of surface facilities such as the Red Hill accommodation village and access road, Red Hill MIA, CHPP, proposed levee bank and conveyor. Dust from these activities will occur over a relatively short duration, typically several months. Dust plumes may affect vegetation adjacent to these areas.
- Vegetation clearing, earthworks and vehicle movements associated with installation of the IMG management infrastructure. This will occur at varying locations across the underground mine footprint throughout the life of the mine and will affect vegetation in the immediate vicinity of works for several months at a time.
- Dust from stockpiles at the Red Hill MIA, CHPP and train load out. Dust control measures are proposed as specified in **Section 3.7** and should minimise any significant dust impacts in adjacent areas.

The air quality impact assessment (**Section 11**) predicted minimal dust related impacts on sensitive human receptors from the project, during both construction and operation. However, deposition of airborne dust, sand and soil may have potential impacts on vegetation if excessive levels are sustained over extended periods. When dust settles on plant foliage, it can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Diminished ability to photosynthesise due to physical effects may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health.

The potential effects of dust deposition on vegetation are determined by a number of factors including:

- the characteristics of leaf surfaces, such as surface roughness, influencing the rate of dust deposition on vegetation;
- concentration and size of dust particles in the ambient air and its associated deposition rates; and
- local meteorological conditions and the degree of penetration of dust into vegetation.

Dust deposition for the operational phase of the project was modelled both for the project alone and in combination with existing open-cut operations. The dominant cause of dust relates to existing mining operations within and adjoining the EIS study area with the project operations making a minimal contribution. Nevertheless, some additional localised dust deposition across the proposed underground mine footprint may occur immediately adjacent to access roads, drilling pads and other areas disturbed by the IMG management infrastructure.

The dominant woodland species within the EIS study area typically exhibit physiological qualities that limit sensitivity to dust deposition. The sclerophyllous foliage of *Eucalyptus*, *Acacia* and *Corymbia* species is generally pendulous (i.e. points down), with a thick smooth cuticle that does not encourage particulate matter to remain on the surface. The dominant woodland species are also generally hardy and well adapted to adverse conditions such as extended dry conditions and low nutrient soils. Grassland species are generally more tolerant of dust due to the lack of surface area available for dust particles to settle on. Dust-related effects on vegetation from existing operations were not observed during field surveys undertaken within areas modelled to be affected by dust deposition.

Vegetation situated in close proximity to construction activities may become coated with dust and suffer some of the impacts discussed above; however, this will be short term and unlikely to cause any significant damage. Vegetation immediately adjacent to access tracks used for the IMG management network may also suffer some dust deposition from vehicle movements, however, will not be continuously exposed to dust.

Use of water sprays to control dust in exposed areas is likely to be sufficient to prevent any long term impacts.

9.6.4.4 Edge Effects

Fragmented vegetation communities will be subjected to increased edge effects, which when considered in combination can reduce the effective size of habitat fragments. The proposed IMG infrastructure will, in particular, lead to creation of a large number of habitat patches which may be subject to edge effects. To a lesser extent, construction of other surface facilities and infrastructure will also create edges adjacent to remnant vegetation patches.

Edge effects can include:

- increased risk of weed invasion from disturbed areas;
- increased exposure of fauna to predation due to increased visibility; and
- microclimatic changes associated with increased sunlight.

Weeds are already prevalent and distributed across the EIS study area; thus, impacts from weeds are unlikely to be exacerbated.

Ground dwelling fauna are most at risk from increased predation around the edges of remnant habitat as predators can more easily see and access prey. Although there is limited ground dwelling fauna present in the EIS study area, this may further reduce populations.

As most of the vegetation within the proposed underground mine footprint is open woodland to grassland, significant vegetation changes are not likely to occur as a result of increased exposure to sunlight along the edges of remnant vegetation.

9.6.4.5 Noise and Light Impacts

Secondary impacts to fauna include disturbance from noise and light during construction and operation of surface facilities and infrastructure and IMG management infrastructure. Fauna will generally move away from noise and light sources as these may be perceived as a threat. Acclimatisation by some species is likely to occur over the medium to long term and many of the species identified in the EIS study area are known to occur in areas subject to noise, light and general activity.

Construction and operation activities at the MIA take place in proximity to woodland and riparian habitat types which support higher densities of fauna within the EIS study area. However, this area is already somewhat impacted by noise and light from existing operations and the Red Hill Road. It is likely that fauna utilising this area are already habituated to noise and light. The proposed levee bank between the MIA and the Isaac River and associated riparian habitat will also minimise impacts of noise and light on this habitat.

Other surface facilities such as the CHPP and conveyors are located in modified habitat areas and noise and light from these areas is less likely to impact on fauna due to lower densities of fauna utilising these areas and in the case of the CHPP, due to noise and light impacts from existing operations.

The proposed Red Hill accommodation village is located adjacent to modified grassland and lower value lateritic ridge habitat, with some woodland habitat to the south. Noise and light emanating from the Red Hill accommodation village into this woodland may cause fauna to move away from the source of impacts to more secure habitat. However, it has been noted at a number of accommodation facilities in the Bowen Basin that microbats prey on insects attracted to the camp floodlights, thus offsetting a portion of their foraging habitat lost.

Construction of the IMG management infrastructure will result in noise disturbance and, in the case of well installation, which will occur as a 24 hour activity, light disturbance. This disturbance will be short term in each location as the infrastructure is installed progressively from west to east across the proposed mine footprint and fauna disturbed by noise or light will be able to temporarily move into adjacent habitat. During operation there will be some low level noise from the gas wells. However, fauna are expected to habituate to this noise. There will also be some activity and noise from maintenance activities but, as with construction works this will be relatively low impact in terms of noise levels and duration. Fauna present within the mine footprint area are expected to either habituate to the disturbance or temporarily move away.

Overall, some disturbance to fauna is expected across the proposed mine footprint and this may have short term impacts on feeding and resting behaviour which in turn can affect animal health. It is also possible that fauna particularly sensitive to noise and light will become locally extinct within the mine

footprint. Long term effects are not anticipated for most fauna species identified as these species are expected to habituate to low noise and light levels.

9.6.4.6 Mortality or Injury

Conflict between site traffic and fauna is expected to occur, particularly within the gas drainage footprint and at the Red Hill accommodation village area and access road.

Development of the gas drainage network will require the installation of access roads for installation and future maintenance of infrastructure. Construction and maintenance activities will be undertaken predominantly during daylight hours. Given this, reptiles are the fauna group most likely to be affected, as they utilise roads to gather warmth and seek prey. Macropods (kangaroos and wallabies) are more likely to be collided with at sunrise, sunset and periodically during the night.

Once operational, traffic to and from the accommodation village will increase, occurring both day and night. As a result, it is anticipated that mortality or injury to fauna will occur. As above, reptiles and macropods are the fauna groups most likely affected. Some birds, such as the squatter pigeon and the cumbersome pheasant coucal may also be involved in vehicle collisions.

Elsewhere on the project, internal roads are already formed and occur within disturbed areas. It is anticipated that fauna mortality from vehicle strikes will not significantly increase in these areas.

Clearing of vegetation can also result in injury or mortality of fauna, particularly ground dwelling fauna that may be crushed by machinery and arboreal mammals that may be trapped in trees as trees are felled. Fauna spotters will be required during clearing to mitigate this potential impact.

9.6.4.7 Pests and Feral Fauna

The survey area supports populations of rabbits, foxes, pigs, feral cats, dogs, and cane toads and it is unlikely that the proposed works will significantly result in the further proliferation of these species or the introduction of further feral vertebrate species.

The introduction of exotic ant fauna is a risk due to import of construction materials. Yellow crazy ants (*Anoplolepis gracilipes**) and fire ants (*Solenopsis invicta**) are exotic ants that have the potential to seriously affect native flora, fauna and ecological communities. These ants are capable of being transported from infested sites to new construction sites on equipment or within materials. While efforts to control spread of both of these ant species have been quite effective, the spread of ants to new areas is a potential issue and needs to be monitored. No exotic ants are known to occur within the EIS study area.

The construction of water storages, dams and borrow pits has the potential to create conditions suitable for a build-up of biting insects. Biting pests such mosquitoes can rapidly increase populations when appropriate breeding conditions are provided. Additional breeding areas can result from the pooling of water in depressions caused by earthworks or subsidence. These areas may also support other pest species already in the EIS study area such as feral pigs and cane toads.

9.6.5 Potential Impacts on Conservation Significant Flora and Fauna

9.6.5.1 Flora and Vegetation Communities

Regional Ecosystems

Conservation significant REs are those that are listed as endangered or of concern under the VM Act. **Table 9-12** lists the 12 conservation significant REs that were confirmed within the EIS study area during field surveys. All of these REs will experience impacts from the proposed activities. Impacts to endangered REs (11.3.1, 11.4.7 11.4.8, 11.4.9, 11.5.16 and 11.9.1) include disturbance to approximately 264.7 hectares which represents 6.9 per cent of the area of the endangered REs found within the sub region. Impacts to of concern REs (11.3.2, 11.3.3, 11.3.4, (including 11.3.4a), 11.4.2 and 11.8.11) include disturbance to 721.5 hectares, which represents 8.8 per cent of the area of the of concern REs found within the sub region. The greatest impact to an individual conservation significant vegetation unit is RE 11.4.2 (unit 2a).

Potential impacts to the of concern RE 11.4.2 will potentially affect approximately 351.5 hectares. When viewed in the broader context of impact to regional biodiversity, this disturbance constitutes 6.2 per cent of this vegetation community found within the Northern Bowen Basin subregion.

Vegetation unit 1b (of concern RE 11.3.2) will be subjected to the second largest area of disturbance of the conservation significant communities within the EIS study area (approximately 164.4 hectares). When viewed in the broader context of impact to regional biodiversity, this disturbance constitutes 0.5 per cent of this vegetation community found within the Northern Bowen Basin subregion.

While it is expected that a number of patches of regional ecosystems will be retained over the proposed underground mine footprints, these patches will be fragmented by the IMG management infrastructure and, hence, the conservation value of these patches may be diminished. Further, these patches may subsequently be lost or modified due to subsidence effects as described in **Section 9.6.3.2**.

The area of potential impacts on all remaining conservation significant REs in context to the extent in which they occur across the subregion is less than one per cent.

EPBC Threatened Ecological Communities

Within the EIS study area, two EPBC TECs have been identified. These communities are:

- EPBC TEC *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* (of concern RE 11.8.11); and
- EPBC TEC *Brigalow (Acacia harpophylla dominant and co-dominant*) (endangered REs 11.3.1, 11.4.7, 11.4.8, 11.4.9, 11.5.16 and 11.9.1).

The *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* TEC will be subject to topographical changes. No earthworks will be undertaken within this area. As discussed in **Section 9.6.2.2** there is a relatively low incidence of gas in the area in which the grassland community occurs, and clearing in this TEC for installation of IMG management infrastructure will be avoided. As discussed in **Section 9.6.1.1**, grassland communities are relatively tolerant to subsidence as root structures are shallow and not affected by ground movements or cracking during subsidence.

Ponding is not predicted in the area in which this grassland community occurs; hence, it is likely that at the majority of this area may remain relatively intact.

The *Brigalow (Acacia harpophylla dominant and co-dominant)* TEC will be subjected to approximately 705.2 hectares of disturbance. This area represents 8.8 per cent of the TEC found within the sub region (**Table 9-12** gives the percentages for individual REs). Direct disturbance will arise from IMG management infrastructure crossings along 12 Mile Gully. As subsidence of 12 Mile Gully occurs, some further changes may affect viability of this TEC, although brigalow is generally relatively tolerant of periodic inundation.

Given the extent at which these TECs occur within the subregion, project-related impacts on the overall conservation status of these TECs are considered minimal.

Essential Habitat

Essential habitat for *Dichanthium setosum* (bluegrass) was identified within the EIS study area. Current project planning indicates that this habitat falls within the footprint for the RHM and gas drainage network; however, as for the *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* TEC, it is likely that the grassland community will remain relatively intact.

Flora Species of Conservation Significance

Two significant flora species were recorded within the EIS study area; *Dichanthium setosum* (bluegrass) and *Cerbera dumicola*. Two additional conservation significant species, *Dichanthium queenslandicum* (king blue grass) and *Digitaria porrecta* (finger panic grass), are considered likely to be present within the EIS study area (**Section 9.3.3.4**) although not identified in field surveys.

The one record of *Dichanthium setosum* from the EIS study area is located within the gas drainage network and RHM subsidence footprint (**Figure 9-8**). This species is listed as vulnerable under the EPBC Act. Suitable habitat for *Dichanthium setosum* was observed to extend approximately one kilometre to the north of its recorded location. It is likely that more specimens of *Dichanthium setosum* occur in the surrounding grasslands.

Dichanthium queenslandicum and *Digitaria porrecta* are known to inhabit similar areas to *Dichanthium setosum* and therefore may also potentially be present in the area of proposed vegetation clearance/subsidence. Impacts on this area would potentially result in the loss of these species. If these species are not impacted during the clearing phase of the gas drainage, it is likely that these species will not be affected by subsidence as grass species are relatively tolerant of soil movement and cracking, and the habitat area is not located within an area predicted to be subject to ponding.

Cerbera dumicola was identified during the 2009 surveys as a dominant shrub species at a single location in the accommodation village footprint in the south east corner of EIS study area (**Figure 9-8**). The species would be removed during the site preparation. As outlined below, additional field surveys will be conducted to confirm that this species is still present. If present, a species management plan will be developed to minimise this impact.

9.6.5.2 Fauna

A number of fauna species of conservation significance were identified from the literature review and field surveys as occurring or potentially occurring within the EIS study area (**Table 9-5**). These species and their likelihood of presence are presented in **Appendix K1.2**. As discussed below, there

should be no significant impacts on conservation significant fauna as a result of the works. This is either because species are mobile (birds), individual habitats will not be affected, or pre-clearing surveys will reduce the potential for harm. However, while these species will not be significantly impacted, they will be subject to impacts such as loss of dispersal corridors and suitable habitat as well as indirect impacts such as noise and dust during all project activities. Comments on potential impacts to these species are given below.

Squatter Pigeon

(EPBC Act: vulnerable; NC Act: vulnerable)

Squatter pigeons were observed in the EIS study area. This species has been recorded in numerous surveys of central Queensland and is generally considered fairly common in the region. The squatter pigeon is a wide-ranging bird known to utilise disturbed habitats. The squatter pigeon is known to occur within open woodland and grassland habitats, including modified habitats. It is considered that habitat loss or modification arising from the project will not directly threaten the population either locally or regionally due to the availability of suitable habitat outside the EIS study area.

Because the squatter pigeon is commonly recorded on farm tracks and road verges, mortality from vehicle strikes may potentially occur. However, given the numbers of this species within the area, this is not anticipated to have a significant impact on the species.

Cotton Pygmy-Goose

(EPBC Act: migratory; NC Act: near threatened)

The cotton pygmy-goose was observed on artificial dams within the EIS study area. This type of habitat will not be adversely affected.

Rainbow Bee-Eater

(EPBC Act: migratory; NC Act: not listed)

The rainbow bee-eater is not particularly dependent upon specific habitat types as it is migratory and seeks prey in a range of environments. This bird is relatively common across the region and no impact to the species is expected as core areas of habitat are unlikely to be disturbed.

Great Egret

(EPBC Act: migratory; NC Act: not listed)

The great egret is another species that may benefit from the creation of additional dams and ponds within the EIS study area. The great egret does not depend on intact woodlands or non-native grasslands and, thus, impacts to this species will be negligible.

White-Bellied Sea-Eagle

(EPBC Act: migratory; NC Act: not listed)

The white-bellied sea-eagle was observed utilising artificial water bodies within EIS study area. It is considered likely that the white-bellied sea-eagle would also utilise the Isaac River riparian woodland. Consequently, potential habitat trees and foraging vegetation may be lost as a result of subsidence impacts. However, with the presence of extensive suitable habitat within the EIS study area and surrounding region, it is not anticipated that the white-bellied sea-eagle will be adversely impacted at a

regional level by the proposed works. Additionally, the subsidence ponds may provide habitat opportunities for the species.

Black-Necked Stork

(EPBC Act: not listed; NC Act: near threatened)

The black-necked stork is currently listed as near threatened under the NC Act and was observed flying over the Isaac River on the east of the EIS study area. Preferred habitat for black-necked storks include creeks, rivers, billabongs and farm dams and hence, it may utilise Isaac River, 12 Mile Gully and Goonyella Creek during and after the wet season. While some changes to the Isaac River and 12 Mile Gully will occur as a result of the project, habitat suitability for black-necked stork will be retained and, hence, the proposed project is unlikely to negatively impact the black-necked stork. Conversely, additional habitat may be created for this species with the occurrence of ponding within subsided areas.

Latham's Snipe

(EPBC Act: migratory/marine; NC Act: not listed)

The Latham's snipe is a marine and migratory listed species that was recorded within the EIS study area during the 1998 and 2000 WBM fauna surveys. Latham's snipe migrates from Japan to Australia between July and November (DSEWPaC 2011b). The preferred habitat for Latham's snipe is permanent and ephemeral wetlands. While no critical habitat for the Latham's snipe was identified during field surveys, watercourses such as the Isaac River and its tributaries, ephemeral wetlands following heavy rain and artificial dams may provide temporary stopover opportunities during dispersal to preferred habitat. It is possible that disturbance adjacent to wetlands within the EIS study area may deter the species from utilising the habitat. However, impacts from the project to this species in a regional context are considered minimal.

White-Throated Needletail

(EPBC Act: migratory/marine; NC Act: not listed)

The white-throated needletail is listed under the EPBC Act as migratory and was identified during the WBM 2002 and Ecoserve 2006 surveys. This species breeds in northern Asia and migrates to Australia during early October (DSEWPaC 2012b). The white-throated needletail occupies open spaces of sky over almost any habitat. This species is not expected to suffer from habitat loss impacts.

Fork-tailed swift

(EPBC Act: migratory/marine; NC Act: not listed)

The fork-tailed swift is a non-breeding migrant to Australia and exclusively aerial, spending day and night on the wing. This species flies above a wide range of habitats and may potentially occur in the airspace across the EIS study area but is not associated with particular habitat types. Similarly to the white-throated needletail, this species is not expected to suffer from habitat loss impacts.

Rufous Fantail

(EPBC Act: migratory/marine; NC Act: not listed)

The rufous fantail is a marine and migratory listed species under the EPBC Act. This species is a winter migrant and prefers rainforest, dense eucalypt woodland and fringing riparian habitat and, hence, may utilise riparian vegetation along the Isaac River. The rufous fantail has previously been recorded in the EIS study area, and changes to the Isaac River associated with subsidence may potentially reduce habitat availability. However, this species is common throughout the area and there is suitable, alternative habitat available elsewhere in the regional landscape.

Marsh Sandpiper

(EPBC Act: migratory/marine; NC Act: not listed)

The marsh sandpiper is a summer migrant to Australia and is a marine and migratory listed species under the EPBC Act. This species was last recorded in the EIS study area in 2000 (WBM 2000). The marsh sandpiper is known to occur in fresh or brackish wetlands which are not well represented in the EIS study area at present due to the ephemeral nature of streams. This species is not likely to be impacted by the project but may benefit from water habitat created by potential subsidence ponding.

Oriental Cuckoo

(EPBC Act: migratory/marine; NC Act: not listed)

The oriental cuckoo is a migratory bird species that can be found from southern NSW to northern Queensland. The oriental cuckoo prefers dense eucalypt forest, riverine thickets and mangroves (Morcombe 2004) which are not well represented in the EIS study area except along the Isaac River. This species is considered uncommon for the area and was last recorded on the EIS study area in 2002 (WBM 2002). Changes to habitat associated with IMG management infrastructure and subsidence are not likely to affect characteristics preferred by the oriental cuckoo and this species is unlikely to experience any negative impacts due to the presence of suitable, alternative habitat elsewhere in the landscape.

Brigalow Scaly-Foot

(EPBC Act: not listed; NC Act: vulnerable)

The brigalow scaly-foot has a preference for *Acacia harpophylla* and Eucalypt woodlands in the Bowen basin. One specimen was located in 1998 within *Eucalyptus populnea* woodland to the immediate east of the GRM. This area has subsequently been subjected to intensive exploration and mine development activities, and may no longer act as suitable habitat for the species.

In spite of targeted reptile searches, the brigalow scaly-foot has not been recorded in subsequent surveys, implying that disturbance of preferred habitat types caused by grazing pressure and buffel grass infestation may have reduced opportunities for it to proliferate. If the brigalow scaly-foot is still present within the EIS study area, it may exist in such small numbers that it is extremely difficult to detect.

While a number of habitat changes will occur across the underground mine footprint as a result of the project, some suitable habitat is likely to remain. Additionally, *Acacia harpophylla* woodlands along Goonyella Creek are not proposed to be disturbed.

It is considered that regional impacts to this species as a result of the project are likely to be minimal.

Ornamental Snake

(EPBC Act: Vulnerable; NC Act: Vulnerable)

The ornamental snake (*Denisonia maculata*) was recorded by URS during the May 2011 autumn survey. The specimen was identified in the east of the EIS study area, occupying spoil dredged from an adjacent constructed farm dam. The ornamental snake was also recorded adjacent to the west of the EIS study area during pipe trenching operations for the North Queensland Gas Pipeline in 2004 (S. Wilson pers. comm., 17 February 2012). This data was used to map essential habitat for this species along the pipeline in the northwest of the study site, external to the EIS study area (**Figure 9-10**) (EHP 2012d).

Habitat preferences for the ornamental snake are deep-cracking clay soils and clayey and sandy loam soils and it may utilise woodland and shrubland areas, including brigalow (*Acacia harpophylla*).

Negative project related impacts on the ornamental snake may arise from habitat loss due to clearing and mortality or injury during vegetation clearing and from vehicle traffic. Subsidence is not likely to further affect ornamental snake habitat and creation of subsidence ponds may potentially increase numbers of prey (frogs) within the area.

An additional survey will be conducted 12 months prior to the commencement of construction activities on the RHM underground expansion option footprint. If this survey identifies that any habitat areas on the site are providing important habitat for the ornamental snake, further mitigation measures may need to be developed to minimise impacts on this habitat type. Where practicable, this may include restrictions on clearing for IMG management infrastructure.

Little Pied Bat

(EPBC Act: not listed; NC Act: near threatened)

The little pied bat was identified using microchiropteran call analysis in the survey area within brigalow woodland, riparian woodland, and laterite communities and around water bodies. The bat requires large tree hollows for roosting, and although roost sites were not identified in the EIS study area, the woodland communities could potentially act as roost habitat for this species due to presence of large, hollow bearing trees. Approximately 684.7 hectares of available habitat may be impacted or partly impacted by the proposed project. This indicates that although almost a third of the on-site habitat may be impacted by the project; a significant area (1,772 hectares) of woodland is still available for this species. Additional habitat also exists beyond the EIS study area and this species is known to forage in disturbed areas. Given the above, impacts are considered to be minimal to the bat population. The incremental nature of development and progressive mining and rehabilitation activities will also assist in reducing overall loss of foraging area for the little pied bat.

Should fauna spotter/catchers identify roost sites for little pied bat prior to or during vegetation clearing, further measures may be implemented to provide artificial roost boxes.

Koala

(EPBC Act: vulnerable; NC Act: special least concern)

The koala was recorded within poplar box woodland in the mid-west of the survey area during nocturnal surveys. It has not historically been detected within the EIS study area, however suitable habitat (poplar box woodlands, forest red gum riparian woodlands) exists for this species. Although it is unlikely that koalas are present, there may be a slight risk that they could experience the following impacts:

- loss and fragmentation of habitat;
- mortality or injury during vegetation clearing and vehicle strikes; and
- increased predation risk.

A fragmented landscape will result in koalas being required to travel on the ground in order to traverse between habitats. This will increase their risk from predators such as wild dogs and increase the potential for mortality from vehicle strikes. Mortality during vegetation clearing may also occur. However, the use of mitigation measures such as fauna spotter-catchers will assist in reducing impacts during clearing of potential koala habitat.

While koalas will be able to move away from the progressive disturbance arising from the IMG management infrastructure, the overall fragmentation, loss of habitat and disturbance may make their continued presence untenable within the EIS study area. If the koala is identified during pre-clearing survey, further management measures may be required.

Koala populations have recently been reclassified by DSEWPaC as vulnerable under the EPBC Act. It is also recognised as a species of special concern under the NC Act due to its importance to the community. Koala population numbers are not likely to be affected as a result of the project.

Short-beaked Echidna

(EPBC Act: not listed; NC Act: special least concern)

Echidnas may range across the EIS study area as they are not habitat specific. They do, however, tend to prefer rocky areas where there is suitable shelter, and evidence of this species was found to the north-west of the site on laterite hills. As the majority of this habitat type is unaffected by the proposed operation, impacts to this species should be minimal.

9.7 Potential Impacts on ESAs

Section 9.5.3.1 detailed the ESAs within the EIS study area and surrounding region. Except where ESAs may occur downstream of the EIS study area, ESAs more than 100 kilometres from the EIS study area have been excluded from further consideration. Described below are the potential impacts of the project on ESAs.

9.7.1 Overview of Impacts

Ten ESAs were identified as occurring within the EIS study area or within 100 kilometres of the EIS study area. Additionally, five ESAs were identified as occurring downstream of the project. **Table 9-13** below details these ESAs and the likelihood that the project may potentially impact them.

Table 9-13 Likelihood of Impact on ESAs from the Project

ESA	Classification	Likelihood of Impact	Potential Impact
National Parks	Category A	Impacts on national parks are considered unlikely due to distance from the EIS study area and lack of connective vegetation.	Nil
Conservation Park	Category A	Impacts on conservation parks are considered unlikely due to distance from the EIS study area and lack of connective vegetation.	Nil
Great Barrier Reef Marine Park	Category A	The Fitzroy River discharges to the GBRMP 689 km downstream of the EIS study area. The potential for changes in water quality or flows arising from the project to affect the GBRMP is discussed in **Section 7.3.5**. Unlikely – project may make a minor contribution to cumulative impacts associated with water quality in the GBRMP, although there are a number of weirs downstream of the site. Water quality impacts are not likely to be detectable. BHP Billiton is separately assessing potential impacts of shipping from its Bowen Basin activities on GBRMP values. This assessment includes shipping related to all future BMA projects and has been presented separately to relevant Commonwealth Government regulators.	Secondary
World Heritage Areas	Category B	Unlikely - project may make a minor contribution to cumulative impacts associated with water quality in the GBRMP but this is not likely to be detectable. BHP Billiton is separately assessing potential impacts of shipping from its Bowen Basin activities on GBRWHA values. This assessment includes shipping related to all future BMA projects and has been presented separately to relevant Commonwealth Government regulators.	Secondary
Endangered Regional Ecosystems	Category B	Confirmed - (67.8 ha within disturbance footprint).	Direct and Secondary
Referable Wetlands	Category C	Unlikely – Referable wetlands occur downstream of the EIS study area. Water quality changes are expected to be negligible and well within naturally occurring ranges.	Secondary
Nature Refuges	Category C	Unlikely due to distance from the EIS study area and lack of connective vegetation.	Nil
Resource Reserves	Category C	Unlikely due to distance from the EIS study area and lack of connective vegetation.	Nil

ESA	Classification	Likelihood of Impact	Potential Impact
State Forests	Category C	Unlikely due to distance from the EIS study area and lack of connective vegetation.	Nil
General Use Zones of a Marine Park	Category C	Unlikely –project may make a minor contribution to cumulative impacts associated with water quality in the GBRMP although there are a number of weirs downstream of the site. Further discussion provided in **Appendix I8**.	Secondary
Selma Weir	Category C	Unlikely - due to distance from the EIS study area.	Nil
EPBC MNES	Other	Likely - loss of habitat within RHM and gas drainage footprint.	Direct and Secondary
Flora and Fauna species declared under NC Act	Other	Likely - loss of habitat within RHM and gas drainage footprint.	Direct and Secondary
Important Wetlands	Other	Unlikely - Important wetlands occur downstream from the EIS study area. Water quality changes are expected to be negligible and well within naturally occurring ranges.	Secondary
Isaac River	Other	Likely – River occurs within RHM and gas drainage network.	Direct and Secondary

It is considered that national parks, conservation parks, nature refuges, resource reserves, state forests and important wetlands will not be impacted by the project due to the distance of these areas from the EIS study area and the lack of connectivity in relation to wildlife movement.

9.7.2 ESAs within the EIS Study Area

As noted in **Table 9-13**, six ESAs occur within the EIS study area will be potentially impacted by the project. **Figure 9-12** depicts the proposed expansion footprint and the location of each ESA situated within the EIS study area. The potential impacts on these ESAs have been discussed previously within the flora and fauna component of the report. The relevant sections in which the potential impacts on these ESAs have been discussed are listed below.

- endangered REs (**Section 9.6.5**);
- EPBC MNES (**Section 9.6.5**);
- flora and fauna species under the NC Act (**Section 9.6.5**); and
- the Isaac River (**Sections 9.6.1.2 and 9.6.4.1**).

9.7.3 Great Barrier Reef Marine Park

The GBRMP boundary lies approximately 690 kilometres downstream of the EIS study area offshore from the mouth of the Fitzroy River. The zoning in this area is general use. Given the distance between the EIS study area and the GBRMP, direct impacts on the GBRMP will not occur, however indirect impacts associated with changes in water quality, which might subsequently affect marine ecosystems of the GBRMP, must be considered. In particular, it is noted that discharges from the

Fitzroy Basin have been identified as a significant influence on water quality in the marine park, particularly in relation to sediment inputs (GBRMPA 2009).

Section 7 of the EIS discusses the impacts on water quality and flows in the Isaac River from the project. **Section 7** concludes that changes in both flow and water quality in the Isaac River will be negligible when considered at a sub-basin scale, and also undetectable when considered in the context of the Fitzroy Basin. Produced water will be integrated with and managed by GRM in accordance with an existing EA. No change to current release conditions is proposed.

While the predicted water quality impacts from the project are expected to be negligible, the project may make a very small contribution to overall levels of salt and possibly some metals in waters of the Fitzroy Basin. The location of the project towards the head of the catchment, and the number of weirs downstream of the project mean that sediment inputs are not likely.

Overall, it is unlikely that the proposed project will contribute to degradation of water quality in the GBRMP.

9.7.4 Great Barrier Reef World Heritage Area

The GBRWHA was prescribed as a world heritage area on the basis of it being:

- an outstanding example representing the major stages in the earth's evolutionary history;
- an outstanding example representing significant ongoing ecological and biological processes;
- an example of superlative natural phenomena; and
- containing important and significant habitats for *in situ* conservation of biological diversity.

The GBRWHA boundary lies 689 kilometres downstream of the EIS study area. As with the GBRMP, the distance from the project means that direct impacts on any of the GBRWHA values will not occur.

Any cumulative contribution to degradation of water quality in the lower Fitzroy River may in turn impact ecological and biological process and biological diversity. While the predicted water quality impacts from the project are expected to be negligible, the project may make a very small contribution to overall levels of salt and possibly some metals in waters of the Fitzroy Basin. As noted above, produced water will be integrated with and managed by GRM in accordance with an existing EA. No change to current release conditions is proposed.

Very significant quantities of sediment, or significant changes in flows could also affect geomorphological processes and obscure information contained in the GBRWHA regarding the earth's evolutionary processes. The location of the project at the head of the catchment, the management of water and sediment controls and the number of weirs downstream of the project mean that sediment inputs to the overall discharge from the Fitzroy River are not likely and calculations indicate that changes in flows in the Isaac River will be undetectable downstream.

Section 7 of the EIS provides more information on impacts on water quality and flows in the Isaac River from the project. **Section 7** concludes that changes in both flow and water quality in the Isaac River will be negligible when considered at a sub basin scale, and also undetectable when considered in the context of the Fitzroy Basin. As discussed in **Section 21**, the project is not expected to significantly worsen cumulative impacts.

Overall, it is unlikely that the project will alter or degrade any of the world heritage values for which the GBRWHA was prescribed.

BHP Billiton has separately assessed potential impacts of shipping from its Bowen Basin activities on the Great Barrier Reef WHA and Marine Park values.

9.7.5 Referable Wetlands

Referable wetlands (mapped as wetland management areas) are located within the EIS study area and downstream of the project. Wetland management areas are not applicable to this project as they are not triggered under the *State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments* (EHP 2013b). However, downstream aquatic habitat possesses significant values which may be prone to impacts from the project. **Section 7** of the EIS discusses the impacts on water quality and flows in the Isaac River from the project. **Section 7** concludes that changes in both flow and water quality in the Isaac River will be negligible when considered at a sub basin scale and will not be discernible from natural fluctuations.

As discussed in **Section 21**, the project is not expected to significantly worsen cumulative impacts.

9.7.6 Directory of Important Wetlands

Table 9–13 details the important wetlands which occur downstream of the EIS study area or are in close proximity to the mouth of the Fitzroy River. These wetlands occur across a number of catchments. It is considered that only the wetlands found within Fitzroy Basin may experience limited cumulative impacts from the project. All other wetlands are situated too far from the mouth of the Fitzroy River to be impacted. Given the above, the following wetlands will be potentially impacted:

- Fitzroy River Delta;
- The Narrows; and
- Fitzroy River floodplain.

These wetlands are at a considerable distance from the site and analysis of changes in flows or water quality indicates that changes will be negligible in the lower Fitzroy River and adjacent estuarine and coastal areas and not discernible from natural fluctuations.

9.8 Mitigation Measures, Monitoring and Offsets

The application of mitigation measures will minimise impacts from the project on flora, fauna and ESAs. Where impacts are unable to be avoided or mitigated (e.g. clearing of vegetation) offsets may be required. Mitigation measures associated with the potential impacts from each activity are presented below.

9.8.1 Mitigation Measures for Flora and Fauna

9.8.1.1 Mitigation Measures Specific to Surface Facilities

Flora and Vegetation Communities

When clearing vegetation for any of the surface facilities, the following mitigation measures will be utilised:

- Areas for clearing will be clearly delineated to avoid inadvertent clearing.
- If habitat trees can be retained without compromising safety, these will be identified and clearly marked.
- Habitat features such as felled trees and logs will be considered for relocation to other areas where practical to provide microhabitat.
- Vehicles and equipment will be cleaned to remove weed seeds before being brought to the site.
- Workers will be made aware of management requirements in induction training and through work instructions.

The construction of the Red Hill accommodation village will directly impact vegetation through clearing. One record for *Cerbera dumicola* was identified that within the accommodation village footprint. Targeted surveys for this species will be undertaken prior to construction. These surveys will determine:

- if the species is still present within the accommodation village footprint;
- if present, determine its extent of occurrence; and
- if present, develop suitable mitigation strategies based on extent of occurrence.

Throughout construction, the following mitigation measures will be utilised to manage impacts from construction activities:

- vehicles and equipment will be cleaned to remove weed seeds before being brought to the site;
- topsoil will be removed and used to rehabilitate existing disturbed areas;
- erosion and sediment control measures will be installed and maintained as set out in **Section 7**; and
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Following construction in each area, disturbed areas not required will be stabilised and rehabilitated consistent with the rehabilitation plan. For the bridge across the Isaac River, this will include rehabilitation of riparian vegetation. Otherwise, revegetation around surface infrastructure will generally involve establishing of pasture grass as it will not generally be appropriate to establish native woodland or shrub land very close to surface facilities.

Weed monitoring and management will be ongoing throughout construction and operation, as will dust suppression measures.

As it will not be possible to avoid impacts on vegetation communities of conservation significance, offsets will be required to mitigate residual impacts. Offsets are discussed further in **Section 9.8.4**.

Fauna

Measures set out above to minimise impacts on flora and vegetation communities will also assist to some extent in minimising impacts on fauna. Offsets will also assist in providing habitat for species. Other measures which will be undertaken include:

- Spotter/catchers will be required during clearing.
- Spotter/catchers will hold appropriate permits under the NC Act.
- When working in other areas, workers will be provided with contact details in the event that fauna is present and needs to be removed, or fauna are accidentally injured. This will be covered in induction training and work instructions. Vehicles will not be allowed to traverse vegetated areas outside designated construction zones, but will be required to remain on existing tracks.
- During detailed design, lighting will be designed such that light spill into adjacent habitat areas is minimised. This will be particularly important for the proposed Red Hill accommodation village.
- A speed limit of 60 kilometres per hour will be observed for the access road to the accommodation village.
- If fauna are injured by vehicles during operations, the RSPCA or local wildlife carers will be contacted for assistance. Fauna killed on roads within the mining lease areas will be dragged to the side immediately, and then removed and disposed of on a regular basis to prevent carrion eaters from also being exposed to vehicle strike.

9.8.1.2 Mitigation Measures Specific to the Gas Drainage Network

Flora and Vegetation Communities

While the extent of infrastructure required for IMG drainage will mean that impacts on significant vegetation communities and plants are unavoidable, there are a range of measures that will be taken to potentially reduce the level of impact of clearing and manage associated impacts. These include:

- Avoiding placement of IMG extraction wells and infrastructure within RE11.8.11/TEC *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* where practical. Where unavoidable, offsets will be sourced.
- Avoiding placement of IMG extraction wells and infrastructure within Endangered REs 11.4.7, 11.4.8 and 11.4.9 where practical. Where unavoidable, offsets will be sourced.
- If clearing in the area of RE11.8.11/TEC *Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* is required, conducting pre-clearing surveys for *Dichanthium setosum, Dichanthium queenslandicum* and *Digitaria porrecta*.
  - If these grasses are identified, clearing should be avoided in these areas wherever possible, with slashing preferred to gain access.
  - If clearing is required, individual plants may be collected and relocated and topsoil will be carefully removed and set aside to protect seed banks. Topsoil will be replaced over pipelines as soon as practicable.
- Designing and constructing IMG management infrastructure to minimise disturbance to riparian zones along the Isaac River and 12 Mile Gully and avoiding placement of wells within 50 metres of these waterways wherever possible.

- Wherever practical, locating infrastructure alignments and gas drainage wells to avoid remnant vegetation.
- Minimise river crossings, relying on the Isaac River bridge.
- Selecting river and creek crossings where natural breaks in vegetation occur wherever possible, recognising that crossing locations must align with the pillars between each longwall panel.
- Clearly delineating clearing areas so that inadvertent clearing of additional areas does not occur. This will be covered in induction training and work instructions to crews undertaken vegetation clearing.
- Cleaning of vehicles and equipment to remove weed seeds before equipment and vehicles are brought to the site. Weed washdowns on vehicles and equipment will also be undertaken when leaving a known weed infested area.
- Monitoring weed levels and actively managing weeds around the edges of vegetation fragments.
- Dust suppression measures will be undertaken to minimise dust deposition on vegetation adjacent to tracks and construction areas. Frequently trafficked surfaces will be gravelled to reduce dust generation, otherwise water trucks will be used to suppress dust.
- Utilising erosion and sediment control measures as set out in **Section 5.3.3** for all ground disturbance activities and stream crossings.
- Rehabilitating buried pipeline alignments consistent with the Rehabilitation Plan (**Section 5.5**).
- Rehabilitating drill pads once wells are installed consistent with the Rehabilitation Plan (**Section 5.5**).

Even with these mitigation measures, the ecological function of most vegetation communities within the proposed underground mine footprint will be severely affected due to the extent of fragmentation, and offsets are expected to be required to mitigate any residual impact after taking into account potential effectiveness of rehabilitation. This is discussed further in **Section 9.8.4**.

Fauna

The primary impacts on fauna during construction of the gas drainage network are the loss of habitat and potential risk of mortality associated with the works.

Measures to reduce habitat impacts will include:

- Restricting crossings of the Isaac River to a bridge crossing on the main headings, and one to two pipeline crossings, unless detailed design indicates that additional crossings cannot be avoided for safety reasons.
- Selecting already disturbed areas for crossings of creeks and drainage lines wherever possible.
- Minimising the width of clearing required for crossing, and particularly retaining tall trees on either side of crossing locations wherever this is safe to do so.
- Minimising placement of gas wells in riparian and woodland areas wherever possible.

Mitigation measures proposed for flora and vegetation communities will address loss and degradation of habitat to some extent, however as noted above, offsets will also be sourced as required.

Spotter/catchers will be required during all clearing activities. Spotter/catchers will hold appropriate permits under the NC Act. When working remote to the spotter/catchers, workers will be provided with contact details for the spotter/catchers in the event that fauna is present and needs to be removed, or are accidentally injured. This will be covered in the induction training and work instructions. Vehicles will not be allowed to traverse vegetated areas but will be required to remain on existing tracks. A speed limit of 40 kilometres per hour (or otherwise as indicated) will be placed on all roads and tracks associated with the IMG management network.

If lighting is required, lighting will be directed away from vegetated areas where practical.

9.8.1.3 Mitigation Measures Specific to Mining of the RHM and BRM

Adaptive management will be incorporated into management strategies, which will include lessons learnt from the adjacent Broadmeadow subsidence monitoring results.

Flora and Vegetation Communities

Where works are required to repair surface cracks from subsidence, this will be done with minimal clearing or damage to vegetation. Use of smaller machinery will be preferred. Grasses and other groundcover will be slashed rather than cleared to allow access.

Where machinery is required to repair cracks or construct subsidence pond drainage channels, vehicles and equipment will be cleaned of all weed seeds and other potential contaminants before entering the site.

Weed monitoring and management programs will be ongoing throughout the mining period.

Rehabilitation will be undertaken as soon as practical as detailed in **Section 9.8.1.7**.

Fauna

No particular mitigation measures are required to address impacts of subsidence on fauna. Management of vegetation and rehabilitation along the Isaac River and 12 Mile Gully corridors will assist with minimising impacts of habitat loss on fauna.

Progressive rehabilitation of impacted areas as the RHM progresses will reduce long term impacts on fauna. In areas where subsidence causes permanent ponds, rehabilitation efforts should be tailored toward developing sustainable wetland habitats.

9.8.1.4 Mitigation Measures Specific to Conservation Significant Fauna Species

As detailed within **Section 9.6.5**, the majority of conservation significant fauna will not experience direct impacts. Due to the availability of suitable habitat elsewhere in the EIS study area or surrounding region, the loss of suitable habitat from the project is not expected to have significant regional impact on any conservation significant fauna species. Additionally, the adoption of the mitigation strategies identified from the above project activities should reduce the potential for adverse impacts on these fauna. Seventeen fauna species of conservation significance were identified from the literature review and field surveys as occurring or potentially occurring within the EIS study area, Of these, only two have been the subject of a recovery plan (draft Queensland Brigalow Belt Reptile Recovery Plan 2008 – 2012): the brigalow scaly-foot (*Paradelma orientalis*) and ornamental snake

(*Denisonia maculata*). Mitigation measures presented in this EIS are not inconsistent with the objectives of the recovery plan.

Habitat in which the ornamental snake (*Denisonia maculata*) was recorded could potentially be altered as a result of subsidence. A targeted field survey of this location and adjacent habitat will be undertaken 12 months prior to the commencement of construction of the RHM underground expansion option to determine the presence and extent of the ornamental snake habitat within this area. If any areas within the disturbance footprint are deemed as significant habitat, a threatened species management plan will be developed. This plan will outline:

- the level of activity that the habitat can sustain;
- the remediation procedures if tension cracking or vegetation loss occurs; and
- further monitoring requirements.

The threatened species management plan will aim to mitigate the long term impacts on this species within the EIS study area.

9.8.1.5 Weed and Pest Management

Weed management strategies will be implemented for controlling the spread of weeds and potential proliferation of pest fauna. Weed and pest management measures will be incorporated into the site and construction management plans, and will include:

- identification of the origin of construction materials, machinery and equipment;
- vehicle and machinery wash down; and
- staff/operator education programs.

The weed management plan will cover construction, rehabilitation and operation periods and will include:

- management methods to control spread of declared weed species (in particular *Parthenium hysterophorus**), in keeping with regional management practice or Queensland Department of Agriculture, Fisheries and Forestry pest control prescriptions;
- ongoing monitoring of the EIS study area to identify any new incidence of weed infestation;
- provision of information for project staff on the identification of declared weeds and their dispersal methods;
- wash down protocols for any vehicles or machinery entering and leaving site;
- methods for weed eradication from the site in accordance with local management practice from the Isaac Regional Council and/or the Queensland Government Pest Fact sheets (DAFF 2011);
- promotion of awareness of weed management, by inclusion of weed issues, pictures and procedures into the project's site induction program; and
- monitoring of weeds and pests throughout the EIS study area will be undertaken (**Section 9.8.2**).

9.8.1.6 Continued Vegetation Assessment

Impacts to vegetation from mining operations are based on a current description of vegetation communities and their associated conservation values as assessed at the time of the survey. The majority of vegetation communities surveyed have been impacted from past land use, and as such are not climax communities but are still in a state of advancing ecological succession. Additionally, changes in designated biodiversity values occur over time.

Accordingly, if development of the proposed mine is delayed by more than five years after this impact assessment, an update of the ecological assessment should be undertaken.

9.8.1.7 Rehabilitation of Disturbed Areas

Post construction rehabilitation

Following construction activities associated with the IMG management infrastructure and the surface facilities, any unused areas will be stabilised and rehabilitated promptly. This will include the majority of the area of drill pads for the gas drainage wells, as well as land over buried pipelines installed for IMG drainage.

Rehabilitation of these areas will involve:

- ripping of compacted soils;
- replacement of topsoil; and
- planting of native grass and pasture grass species.

Post-construction rehabilitation measures are discussed further in **Section 5.5.**

It will not be possible to re-establish woodland vegetation in these areas. Deep rooted species of trees and large shrubs cannot be planted over buried pipelines as roots may interfere with the pipelines. It will not be appropriate to re-establish woodland vegetation too close to the accommodation village, MIA or gas drainage wells as this may present a fire risk. Planting of trees and large shrubs at the base of any dam wall is also not appropriate as this may interfere with required inspections of the wall, and also lead to root invasion into the base of the wall.

Post-Subsidence Rehabilitation

Post subsidence revegetation is expected to involve managing remaining native vegetation on the site and re-establishing vegetation consistent with the proposed post mining land use.

In relation to managing remaining native vegetation, management during the life of the mine and post closure period will include weed management and selective enhancement of vegetation communities with native planting. These areas will also provide seed stock for revegetation of other areas. Once mine closure is complete, it is currently anticipated that the land will be returned to the landholder and ongoing management of these areas will be at the discretion of the landholder and subject to any laws in place at the time in relation to vegetation clearing and management.

In relation to revegetation, the majority of the site will be revegetated with pasture species consistent with ongoing grazing land use. Revegetation with native trees and shrubs will take place:

- along the Isaac River channel, with a particular focus on re-establishing riparian woodland communities;

- along 12 Mile Gully, with a particular focus on re-establishing brigalow communities;
- between patches of vegetation cleared during the gas drainage construction; and
- around the edges of permanent ponds to create useful wetland habitat.

The proposed subsidence management plan described in **Section 7.3.10** sets out the adaptive management approach to management of subsidence impacts on watercourses. Management of remaining native vegetation along watercourses and planting of new vegetation will be incorporated into this management plan.

As this rehabilitation will not take place for some time, specific methods are not proposed as new information and methods may be available in future. However, wherever possible, local provenance seed stock will be used for direct seeding and to generate tube stock for planting. Rehabilitation of bushland areas will be undertaken with the intent of establishing floral assemblages in keeping with vegetation communities mapped as occurring on the site, taking into consideration changes in local conditions that may have arisen from subsidence and associated hydrological changes.

Should grazing of the underground mine footprint commence before all subsided areas are stabilised, fencing or other techniques may be used to exclude cattle from unstabilised areas.

Revegetation will be progressive as subsidence occurs, however, full restoration of the Isaac River corridor may not occur until the channel has re-established. Further details are included within **Section 5.5.**

9.8.2 Monitoring

9.8.2.1 Vegetation Monitoring

Monitoring of retained vegetation areas will be undertaken throughout the life of the project. As the subsidence ultimately changes the hydrology of the area, a floristic change will naturally occur over time in areas of retained vegetation. Monitoring will need to focus on whether this change can occur naturally through regrowth of native vegetation from seed stock, or whether intervention is required to replace plants that die at a greater rate than natural reestablishment.

Remnant vegetation will be monitored for foliar discolouration, partial defoliation, increased pathogenic attack, or tree death as signs of vegetation impacts from subsidence. Tree deaths and regrowth in areas affected by subsidence will be monitored to assess whether rehabilitation is required. In areas where natural regrowth is not sufficient to replace dead trees, replanting will be undertaken.

9.8.2.2 Vegetation Rehabilitation Monitoring

Monitoring and evaluation of the rehabilitated areas will be undertaken to ensure long term viability and allow adaptive management of rehabilitation strategies where necessary.

For areas rehabilitated as grazing land, monitoring will focus on establishment of ground cover and invasion with declared weeds.

In areas to be rehabilitated as bushland, monitoring will involve:

- establishment of monitoring sites in rehabilitated areas and, wherever possible, reference sites to allow comparison;

- establishment of photographic transects; and
- annual surveys in rehabilitated areas and associated reference sites to establish dominant species present in each strata, heights of each stratum, relative abundance of each species and stem counts.

Further information on rehabilitation monitoring is provided in **Section 5.5** of the EIS.

9.8.2.3 Weed and Pest Monitoring

Weed and pest monitoring will include the following:

- Observations by site personnel for weeds of management concern.
- A post-construction weed audit of the surface facilities, well sites, pipeline routes and access tracks at the end of the first wet season after completion of construction activities in each area.
- Monitoring for pest plants and fauna within subsided areas where ponding occurs will be undertaken to determine the need for management.
- Where treatment is required, follow up monitoring within three months to determine the success of the weed or pest eradication program. Additional treatment will be undertaken where eradication is unsuccessful.
- Maintenance of monitoring records for a period of at least five years to aid in the assessment of the long term success of the project's weed management program.

9.8.2.4 Ornamental Snake Monitoring

As detailed above, the ornamental snake is a cryptic conservation significant fauna species known to occur within the EIS study area. A targeted survey will be undertaken prior to the construction of the RHM underground expansion option to provide a greater understanding of the presence and potential distribution of ornamental snake across the site and to provide a basis for determining the significance of habitat on the site to ornamental snake populations. Following this survey, if it is determined that the site contains potentially significant ornamental snake populations and habitat, more targeted mitigation measures will be able to be developed. This is likely to also include ongoing monitoring to track ongoing population status and responses to impacts and mitigation efforts.

9.8.3 Mitigation Measures for Environmentally Sensitive Areas

As detailed in **Section 9.7.2** 11 ESAs were identified as potentially directly impacted by the project. Of these ESAs, mitigation measures have been discussed previously in either the flora or fauna mitigation measures sections. These ESAs and the section of the report in which mitigation measures have been discussed are provided below:

- endangered REs (**Section 9.8.1**);
- EPBC MNES (**Section 9.8.1** and **Section 9.8.1.4**);
- flora and fauna species under the NC Act (**Section 9.8.1** and **Section 9.8.1.4**); and
- the Isaac River (**Section 9.8.1.1** and **9.8.1.3**).

The remaining four ESA categories which will be possibly impacted due to their occurrence downstream from the project include:

- GBRMP (general use zone);
- the GBRWHA;
- referable wetlands; and
- directory of important wetlands.

Provided that mitigation measures identified in **Section 7** of the EIS are implemented, impacts on these ESAs are not expected and no further mitigation or monitoring is proposed.

9.8.4 Offsets

9.8.4.1 Offset Strategy

While mitigation and management measures for impacts on terrestrial ecology focus on maximising retention of vegetation across the underground mine footprint, offsets may be required for those areas where vegetation clearing is unavoidable, and in relation to fragmentation due to IMG management infrastructure and potentially from subsidence effects. On this basis, initial identification of offset requirements is based on offsetting of all remnant vegetation and high value regrowth within the immediate footprint of the underground mine and associated surface infrastructure and facilities.

As a level one mining activity, the project will be subject to the Queensland Government BOP. BMA proposes to provide land based offsets though a staged offset strategy which will be finalised at issue of the environmental authority (mining) for the project and will be based on determination of actual clearing areas as mining and associated IMG management and subsidence progresses. This staged offset strategy will be aligned to BMA's mine planning cycle to allow accurate identification of actual offsets required in each stage of mining. BMA currently conducts mine planning on a five year cycle.

It is expected that the offsets may be staged as set out in **Table 9-14**.

A vegetation condition monitoring program with baseline performance targets will be conducted to support and inform this approach. This program will allow BMA to establish state significant biodiversity values prior to clearing and subsidence and then, post subsidence; identify the net loss of values. This will be done on a five yearly cycle as set out in **Table 9-14**. As part of this program, BMA will establish the ecological equivalence of state significant biodiversity values prior to any disturbance to inform replacement of these values either through rehabilitation or land based offsets.

Table 9-14 Staged Offsets Approach

Timing	Offset Requirement
Construction	Offsetting of state significant biodiversity values in areas to be disturbed by construction of the MIA, CHPP, accommodation and other infrastructure.
Mining – years 1 to 5	Offsetting of state significant biodiversity values (vegetation) cleared for planned IMG management infrastructure in years one to five.
Mining – years 5 to 10	Offsetting of state significant biodiversity values (vegetation) cleared for planned IMG management infrastructure in years 6 to 10. Rehabilitation or offsetting of state significant biodiversity values (vegetation) degraded by subsidence in years 1 to 5.
Mining – years 11 to 15	Offsetting of state significant biodiversity values (vegetation) cleared for planned IMG management infrastructure in years 11 to 15. Rehabilitation or offsetting of state significant biodiversity values (vegetation) degraded by subsidence in years 6 to 10.
Mining – years 16 to 20	Offsetting of state significant biodiversity values (vegetation) cleared for planned IMG management infrastructure in years 16 to 20. Rehabilitation or offsetting of state significant biodiversity values (vegetation) degraded by subsidence in years 11 to 15.
Mining – years 20 to 25	Rehabilitation or offsetting of state significant biodiversity values (vegetation) degraded by subsidence in years 16 to 20.
Mining – rehabilitation phase	Rehabilitation or offsetting of state significant biodiversity values (vegetation) degraded by subsidence in years 20 to 25.

9.8.4.2 Values Requiring Offsets

State significant biodiversity values within the footprint of the mine and surface facilities and infrastructure and therefore potentially affected by the project, and the proposed approach to offsetting each of these values is shown in **Table 9-15**. Note that there are no legally secured offset areas present within the disturbance footprint.

Some of the values present in the proposed underground mine footprint are difficult to offset. In particular, the riparian zone of the Isaac River contains several State significant biodiversity values including remnant vegetation, watercourse and connectivity values and it is unlikely that it will be possible to directly offset disturbance to the Isaac River. BMA therefore proposes to proactively manage the Isaac River throughout the mining activity to minimise disturbance to the river and associated riparian vegetation. Direct clearing of riparian vegetation and disturbance to the bed and banks of the Isaac River will be limited to a bridge spanning the river and up to three trenched pipeline crossings to convey IMG and water.

An assessment of the effects of subsidence on the Isaac River has been undertaken (**Section 7.3.6** and **Appendix I6**) and concluded that, with the proposed adaptive management approach, the Isaac River channel can be managed to largely avoid negative impacts of subsidence such as erosion, bank instability and avulsion.

The rehabilitation strategy presented in **Section 5.5** includes retention and enhancement of vegetation along the Isaac River to maintain the riparian zone and associated connectivity. This may include provision of artificial habitat features to assist with mobility of ground and tree dwelling fauna.

On this basis, offsets for the biodiversity values associated with the Isaac River are not proposed.

Similarly, the area of native grassland which also provides essential habitat for the vulnerable plant *Dichanthium setosum* is not proposed to be offset as disturbance can be restricted to slashing.

Otherwise, BMA will seek to minimise disturbance in areas of state significant biodiversity values, particularly in relation to clearing and fragmentation due to IMG management infrastructure.

9.8.4.3 Offset Principles

BMA is developing a portfolio wide offsets strategy which will allow it to coordinate offsets across its Bowen Basin activities. It is anticipated that this approach will lead to enhancement of the environmental outcomes compared to offsetting for individual projects as it may lead to larger contiguous areas being proposed as offsets. It is likely that an advanced offsets program will form the basis of this strategic approach in accordance with the BOP.

Offsets provided by BMA will meet the requirements of the BOP, including:

- Meeting ecological equivalence requirements as set out in Appendix 8 of the BOP. Where ecological equivalence requirements cannot be fully met, the offset ratio may be increased.
- Providing for a legally binding mechanism to secure the offset area, typically either as declaration of an area of high conservation value under the VM Act or a covenant under the *Land Act 1994*. BMA will avoid areas subject to mining leases as far as possible, but as the entire Bowen Basin and adjacent areas are subject to exploration leases, it will not be possible to avoid all mining tenure. In the event that mining is proposed in these areas in future, the BOP contains a requirement that legally secured offset areas provided under State legislation be further offset.
- Being identified, managed and delivered under a management plan for each offset or group of offsets that meets the requirements of Part A3 of the BOP. The management plan will:
  - demonstrate how the offset proposed meets the requirements of the BOP;
  - set out how the offset will be managed; and
  - specify the management costs and activities.
- Meet the offset rules set out in Part B1 of the BOP.

Table 9-15 Values Requiring Offsets

State Significant Biodiversity Value	Description	Impact	RE	Biodiv. Status	VMA Status	Area in Mine Footprint (ha)[1]	Approach
Remnant endangered regional ecosystems	11.3.1: *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Direct clearing for creek crossings and potential subsidence impacts.	11.3.1	E	E	37.5 (27 ha are within 100 m of Isaac River high bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.4.7: *Eucalyptus populnea* with *Acacia harpophylla* and/or *Casuarina cristata* Open forest to woodland on Cainozoic clay plains	Minor direct impact for drift construction and potential subsidence impacts.	11.4.7	E	E	34.5	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.4.8: *Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Minor direct impact for drift construction and potential subsidence impacts.	11.4.8	E	E	52	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.4.9: *Acacia harpophylla* shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains	Direct clearing for MIA and drift access, potential subsidence impacts.	11.4.9	E	E	94	Minimise direct disturbance as far as practicable. Offset unavoidable impacts as direct land based offsets.
	11.5.16: *Acacia harpophylla* and/or *Casuarina cristata* open forest in depressions on Cainozoic sand plains/remnant surfaces	Direct clearing for CHPP, stockpiles and train load out.	11.5.16	E	E	30.5	Minimise direct disturbance as far as practicable. Offset unavoidable impacts as direct land based offsets.

State Significant Biodiversity Value	Description	Impact	RE	Biodiv. Status	VMA Status	Area in Mine Footprint (ha)[1]	Approach
Remnant endangered grassland ecosystems	Not present						
Remnant of concern regional ecosystems	11.3.2: *Eucalyptus populnea* woodland on alluvial plains	Potential subsidence impacts.	11.3.2	OC	OC	158.5 (26 ha are within 100 m of Isaac River high bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.3.3: *Eucalyptus coolabah* woodland on alluvial plains	Potential subsidence impacts.	11.3.3	OC	OC	6.9 (0.4 ha are within 100 m of Isaac River high bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.3.4: *Eucalyptus tereticornis* and/or Eucalyptus spp. woodland on alluvial plains	Clearing and fragmentation for IMG management infrastructure.	11.3.4	OC	OC	16.5	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.3.4a: *Corymbia tessellaris* woodland on alluvial sand ridges to elevated levees and level terraces	Clearing and fragmentation for IMG management infrastructure.	11.3.4a	OC	OC	98.4 (30 ha are within 100 m of Isaac River high bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
	11.4.2: *Eucalyptus spp*. and/or *Corymbia spp*. grassy or shrubby woodland on Cainozoic clay plains	Clearing and fragmentation for IMG management infrastructure. Potential subsidence impacts.	11.4.2	OC	OC	333 (13 ha are within 100m of Isaac River high bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.

State Significant Biodiversity Value	Description	Impact	RE	Biodiv. Status	VMA Status	Area in Mine Footprint (ha)[1]	Approach
Remnant of concern grassland regional ecosystems	11.8.11: *Dichanthium sericeum* grassland on Cainozoic igneous rocks	Potential subsidence impacts. Grasslands should be resilient to subsidence. Ponding not expected in this area.	11.8.11	OC	OC	78.5	Avoid direct disturbance and manage to restore native grassland values.
High value regrowth vegetation containing endangered regional ecosystems	11.4.8/11.4.9 HVR: Non remnant *Acacia harpophylla* regrowth	Clearing and fragmentation for IMG management infrastructure. Potential subsidence impacts.	11.4.8/11.4.9 HVR	NL	NL	25	Minimise direct disturbance as far as practicable and manage subsidence impacts to retain values. Offset unavoidable impacts as direct land based offsets.
High value regrowth vegetation containing of concern regional ecosystems	Not present						
Threshold regional ecosystems	Not present						
Critically limited regional ecosystems	Not present						
Essential habitat	Essential habitat for *Dichanthium setosum* (bluegrass).	None expected.				NA	Contained within Remnant of concern grassland regional ecosystems (11.8.11). Avoid disturbance and manage to restore native grassland values.

State Significant Biodiversity Value	Description	Impact	RE	Biodiv. Status	VMA Status	Area in Mine Footprint (ha)[1]	Approach
Essential regrowth habitat	Not present						
Wetland (*Vegetation Management Act 1999*)	Not present						
Significant wetland (*Vegetation Management Act 1999*)	Not present						
Watercourses	Isaac River (Order 4)	Direct clearing for bridge and pipeline crossings. Potential subsidence impacts.				266 ha (based on 100 m from top of bank)	Minimise direct disturbance as far as practicable, manage subsidence impacts to retain riparian corridor values where possible and maintain and enhance connectivity.
	12 Mile Gully (Order 3)	Direct clearing for creek crossings and potential subsidence impacts. Creation of additional (effectively) permanent ponds.				145 ha (based on 100 m from top of bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts.
	Goonyella Creek (Order 2)	Direct clearing for creek crossings and potential subsidence impacts.				14.5 ha (based on 50 m from top of bank)	Minimise direct disturbance as far as practicable and manage subsidence impacts.

State Significant Biodiversity Value	Description	Impact	RE	Biodiv. Status	VMA Status	Area in Mine Footprint (ha)[1]	Approach
Connectivity	Isaac River (State BPA)	Direct clearing for bridge and pipeline crossings. Potential subsidence impacts.				NA (This area is contained in calculations above)	Minimise direct disturbance as far as practicable, manage subsidence impacts to retain riparian corridor values where possible and maintain and enhance connectivity.
Protected Animals	Squatter pigeon (V) Ornamental snake (V)	Possible loss or fragmentation of habitat.				NA Contained in areas above	Offset requirements met through offsetting of remnant vegetation communities. Ornamental snake may benefit from ponding in subsidence troughs.
Protected plants	*Cerbera dumicola* (NT)	Potential clearing.				NA	Species management plan to be developed once further surveys are conducted. Offset if species cannot be managed *in situ* (note that this species appears to be an opportunistic coloniser and it may not be practicable to replant it close by.

LC = least concern, OC = of concern, E = endangered, V = vulnerable, N/A = not applicable, NL = not listed, NT = near threatened
Note 1: Actual to be offset will depend on clearing and degradation due to subsidence