APPENDIX

I

Ecological Impact Assessment

MAULES CREEK COAL PROJECT

Ecological Assessment

For:

Hansen Bailey

July 2011

Final Report

Cumberland Ecology
PO Box 2474, Carlingford Court 2118

Report No. 9125RP4

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

Approved by:	David Robertson
Position:	Project Director
Signed:	David Robertson
Date:	*22 July, 2011*

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Executive Summary

S1 Introduction

Cumberland Ecology was commissioned by Hansen Bailey on behalf of Aston Resources Limited (Aston Resources) to undertake an ecological impact assessment of the proposed Maules Creek Coal Project (the Project), which will facilitate the development of a 21 year open cut coal mining operation and associated infrastructure. The ecological impact assessment is to form part of an Environmental Assessment (EA) being prepared by Hansen Bailey to support an application for a contemporary Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of this report is to document the findings of an ecological investigation of the Project and to assess the impacts of the Project on current biodiversity values, including threatened species, populations and ecological communities protected under State and Commonwealth legislation.

The specific objectives of the report are as follows:

- Present and analyse the results of literature and database reviews;
- Present the results and describe the existing flora and fauna within the Project Boundary based upon the results of the latest survey information;
- Identify and consider the impacts of the Project upon threatened species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act) recorded in the Project Boundary or likely to be present therein; and
- Prescribe an avoidance, mitigation and offsetting strategy that will protect threatened flora and fauna and provide for a net gain of conserved woodland and forest habitats in the long term.

The ecological assessment examines the terrestrial and aquatic flora and fauna assemblages and their habitats within the Project Boundary (the footprint of the Project) and determines the biological impacts of the construction and operation of the Project. It also describes the proposed ameliorative measures as well as the assessments of significance required under Part 3A of the EP&A Act and the EPBC Act.

The ecological assessment followed the Environmental Assessment Requirements (EARs) of the Director-General of the NSW Department of Planning (DoP) for the Project. The Project requires approval from the NSW Minister for Planning under Part 3A of the EP&A Act.

The Commonwealth Department of the Sustainability, Environment, Water, Population and Communities (SEWPaC) has determined that the Project is a controlled action under the EPBC Act and will utilise DoP's assessment process to assess the Project. The Project requires the approval of the Commonwealth Minister for the Environment.

S2 Methodology

S2.1 Surveys Within the Project Boundary

The flora and fauna of the Leard State Forest and immediate surrounds have been subject to a series of surveys over many years. Consequently, the ecology of the Project Boundary and indeed the flora and fauna of the locality is relatively well known. There is an excellent baseline of flora and fauna data, including vegetation mapping, and information about individual species.

The most recent surveys by Cumberland Ecology built upon an existing database of flora and fauna information that included data from the 1970s, 1980s, 1990s and 2000s. Recent surveys are also available from nearby areas of the Project Boundary, including Leard State Forest and Leard State Conservation Area.

The environment within the Project Boundary was systematically surveyed in 2008 and 2010 by Cumberland Ecology. The assessment entailed database analysis, reconnaissance and field surveys. Field surveys included comprehensive flora and fauna investigations over a range of seasons. The flora surveys were conducted in accordance with the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (DEC (NSW), 2004).

The flora survey effort included: surveys of all recognisable plant communities; flora quadrats within 400 m^2 (20 m X 20 m) and 1000 m^2 (20 m x 50 m) (totalling 38 quadrats). Boundary walks, meander transects and opportunistic observations were also undertaken to maximise the detection of general, threatened and regionally significant flora species.

Comprehensive fauna surveys were conducted over 2008 and 2010 in five assessment periods that covered all four seasons. Surveys were undertaken within and surrounding the Project Boundary, cumulating over 6727 trap nights and over 130 person hours of fauna surveys. These surveys included: bat surveys (including echolocation recordings and harp trapping); reptile and amphibian surveys (including funnel and pitfall trapping), active searches (diurnal and nocturnal); bird surveys (diurnal and nocturnal); small mammal surveys (spotlighting, Elliott and cage trapping for included arboreal), fauna habitat assessment; systematic hollow-bearing tree assessment; and systematic koala habitat assessment.

S2.2 Surveys for Potential Offset Sites

Within a regional context, it is recognised that the Project will take place on land classified as Zone 4 under the *Brigalow and Nandewar Conservation Area Agreement* (BNC Agreement), which permits the development of the timber, gas, minerals and apiary sectors. Notwithstanding this, the Project Boundary is heavily wooded and impacts to native forests

and woodlands cannot be completely avoided, including habitat for threatened flora and fauna. For this reason, it was apparent at the outset that land to be designated as compensatory offsets would be required to address the ecological impacts of the Project. The latter part of the methods chapter of this report provides details about how proposed offset land was screened and how a proposed offset package was derived, including criteria for the selection of offsets.

S3 Results

The majority of the Leard State Forest within the Project Boundary comprises native forest and woodland communities with relatively few exotic species and high natural species diversity. However, these vegetation communities have often been structurally simplified, reflecting a history of disturbances consistent with forestry operations and thinning. The areas of the Project Boundary outside of Leard State Forest are largely cleared and affected by intensive agricultural land uses.

Over 200 plant species were recorded in the Project Boundary, of which a high proportion is native. No threatened plant species listed under the TSC Act or EPBC Act were recorded during surveys within the Project Boundary, though threatened plants have been found in adjacent areas. These include the vulnerable plant *Lepidium aschersonii* found in Leard State Conservation Area.

A suite of native ecological communities were mapped within the Project Boundary. Four communities have been identified as conforming to endangered ecological communities (EEC) listed under the TSC Act and critically endangered ecological communities (CEEC) under the EPBC Act. These include three woodland and open forest communities and one derived grassland community.

The faunal assemblage within the Project Boundary is dominated by a suite of bird species, and to a lesser extent, bats. Small ground dwelling native fauna (mammals, reptiles and amphibians) are not as well represented within the Project Boundary. These trends may reflect the high degree of modification to the understorey habitat and the abundance of feral animals, particularly foxes and feral pigs. A suite of threatened species is known to occur in the area, predominantly consisting of bird and bat species. These include the following Vulnerable bird species listed under the TSC Act:

- Spotted Harrier (*Circus assimilis*);
- Little Eagle (*Hieraaetus morphnoides*);
- Square-tailed Kite (*Lophoictinia isura*);
- Barking Owl (*Ninox connivens*);
- Masked Owl (*Tyto novaehollandiae*);
- Speckled Warbler (*Pyrrholaemus saggitatus*);

- White-browed Woodswallow (*Artamus superciliosus*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Diamond Firetail (*Stagonopleura guttata*);
- Painted Honeyeater (*Grantiella picta*);
- Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Hooded Robin (*Melanodryas cucullata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Turquoise Parrot (*Neophema pulchella*).

They also include the following Vulnerable bat species listed under the TSC Act:

- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*);
- Little Pied Bat (*Chalinolobus picatus*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under TSC Act and EPBC Act);
- Greater Long-eared Bat (*Nyctophilus timoriensis*); and
- Eastern Cave Bat (*Vespadelus troughtoni*).

Other threatened and migratory species are known to occur in the locality surrounding the Project Boundary and have potential to be impacted by the Project. These are discussed within the report. The only Nationally listed threatened species found within forests and woodlands of the study area was the Vulnerable bat Greater Long-eared Bat (*Nyctophilus timoriensis*). Other Nationally listed species have potential to occur, including Regent Honeyeater and Swift Parrot and these are assessed within the report.

S4 Impacts

The Project disturbance footprint will be approximately 2178 ha within the Project Boundary. Of this, the Project will remove approximately 1664.8 ha of native forest and woodland habitat. The remaining 513 ha includes various forms of semi-natural and exotic grassland. The following is a summary of the impact of the Project on threatened biodiversity within the Project Boundary:

- 1664.8 ha of forest and woodland habitat for various threatened species would be cleared, including two threatened species of plant and over thirty threatened animal species have been recorded or predicted likely to occur within the Project Boundary; and
- Up to an estimated 544 ha of White Box, Yellow Box, Blakely's Red Gum Woodland (Box Gum Woodland) and Derived Native Grassland as listed under the TSC Act and EPBC Act would be impacted.

The estimated 544 ha of Box Gum Woodland and Derived Native Grassland to be cleared is a conservative estimate of impact based upon a concept plan that entails buffers around some proposed infrastructure. The proponent has committed to aim to avoid impacts on Box Gum Woodland during the final design whereever possible. The actual impact on Box Gum Woodland is therefore expected to be lower than this figure.

Aside from the Project, other coal mining associated with the Boggabri Coal Mine is currently taking place in the southern part of Leard State Forest. The Boggabri Coal Mine is also proposing to continue mining for a further 21 years and will eventually mine a high proportion of the southern half of the Leard State Forest. Tarrawonga Mine is further to the southeast and will mine additional areas of forest. Collectively, when considered with the Project, a high proportion of the existing Leard State Forest will be subject to mining within the next two to three decades. Notwithstanding this, all of the mines propose to rehabilitate mined areas and return them to forest and woodland. The mined landscaped will be progressively returned as flora and fauna habitat in the medium to long term. Additionally, all of the mines have provisions for offsetting ecological impacts. All of the mines will or have purchased additional surrounding lands that contain forest, woodland and derived native grasslands. These will collectively and significantly increase the total areas of native vegetation that exist in the locality in the future and will significantly increase the total area of native vegetation within conservation reserves in the locality and the region.

The Project has potential to have a substantial impact on the ecology of the local area. In particular, without any amelioration, the Project would have a significant impact on the critically endangered Box Gum Woodland as listed under the TSC Act and EPBC Act. It would also impact significantly on threatened woodland birds and hollow-dependent microchiropteran bats within the locality and potentially the Regent Honeyeater.

S5 Amelioration Package

A number of amelioration measures have been designed to minimise the ecological impacts of the Project. The approach is based upon the following hierarchy of principles of avoidance, mitigation and compensation described within the Draft Discussion Paper for the use of environmental offsets under the EPBC Act:

- Avoid: developments should be designed to avoid or minimise ecological impacts, where possible;
- Mitigate: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development; and
- Compensate: the residual impacts of the Project, following the implementation of mitigation measures, should be compensated for in some way to offset what would otherwise be a net loss of habitat.

S5.1 Avoidance

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases. Significant modification to the design of the Project has led to improved Biodiversity outcomes. These included: not mining the entire area of the mining lease within the 21 years, relocating the northern overburden emplacement area to an area of grassland (Class 4 and 5 farming land) to reduce the area of woodland to be cleared, locating infrastructure on cleared land and locating the Namoi River pump station and pipeline in areas with exotic grassland understorey. These measures reduce clearance of threatened vegetation by over 100 ha. Further avoidance should be a key aim during detailed design.

S5.2 Mitigation Measures

All land disturbed for mining purposes for the Project should be progressively rehabilitated in accordance with an agreed mine closure plan. The majority of disturbed land should be returned to native forest and woodland habitat. The rehabilitation plan has been designed with the intention of providing a self sustaining native forestry operation as well as maintaining pre-mine biodiversity values.

A detailed Rehabilitation Management Plan should be developed for the Project that provides for the progressive rehabilitation of all mine disturbed areas. The key objectives of this plan should be restore, where possible, the pre-mining biodiversity within a safe and stable landform totalling 1664.8 ha of forest and woodland, including 544 ha of the threatened Box-Gum Woodland.

The following additional recommendations for mitigation are based on the findings of the report and should be adopted by the Project:

- Minimise disturbance of native vegetation during construction and ahead of mining operations.

- Prepare a Biodiversity Management Plan (BMP) that contains detailed mitigation measures. This plan should include (but not be limited to) information such as protocols for vegetation clearing including inspection of hollows, feral animal and pest control, rehabilitation objectives, further detailed design measures and ongoing monitoring.

- Implement a two stage clearing protocol for all hollow-bearing tree clearing. Mark all hollow-bearing trees to be felled and catalogue their species and approximate dimensions so that hollows or nest boxes can be affixed to similar standing trees located in offset, revegetation or rehabilitation areas. Undertake ongoing weed management and monitoring through a weed management plan.

- Prepare a rehabilitation/revegetation management plan which should include (but not be limited to):

    - planting a variety of locally occurring native species, including trees, shrubs and selected herbaceous plants to compensate for any impacts to habitat;

    - increasing the overall vegetation cover;

    - incorporating existing natural vegetation, where possible; and

    - establishing linkages between patches of remnant native vegetation.

- Develop a flora and fauna monitoring plan for the Project. This monitoring plan should enhance and complement the existing monitoring plan. This plan should also include monitoring of exotic weeds and feral animals.

- Prepare a sediment and erosion control plan which includes best practice erosion and sediment controls.

S5.3 Compensatory Habitat

A strategic and sizeable biodiversity offsets package (Biodiversity Offset Strategy) has been devised to compensate for ecological impacts of the Project and to help achieve a net gain in biodiversity in the long term. The Biodiversity Offset Strategy targets Box Gum Woodland and Derived Grasslands and other habitats (e.g. Ironbark Forest) for all threatened fauna known to occur in the Project Boundary. It has required the acquisition of large land holdings containing substantial remnant vegetation in the immediate vicinity of the Project Boundary and locality, including:

- **Western Offset Area:** properties west of the Project Boundary and in the vicinity of the Leard State Conservation Area, and the Namoi River riparian corridor on the western margins of the Project Boundary that have been, or will be acquired for conservation and farming purposes. Key design considerations are to form links or

"stepping stones" of habitat between rehabilitated lands that will be formed in the Project Boundary with Leard State Conservation Area and with the River Red Gum corridors along the Namoi River. The Leard State Conservation Area is currently 1176 ha in size. There is a commitment to contribute a further 600 ha of forest and woodland to conservation from the Western Offset Area, of which approximately 300 ha is likely to be Box Gum Woodland to increase the overall patch size of the forest and woodland adjacent to the Leard State Conservation Area;

- **Eastern Offset Area:** properties on the eastern and north eastern side of the Project Boundary that have been, or will be acquired for conservation and farming purposes. A primary objective of the management of forest within the Eastern Offsets will be to complement land already acquired by Boggabri Coal by adding to a "steppng stone" wildlife corridor from the remaining areas of the Leard State Forest to the east towards the Nandewar Ranges. The land selected for inclusion in the Biodiversity Offset Strategy will add at least 400 ha of forest and woodland to conservation, which will include approximately 200 ha of Box Gum Woodland;

- **Northern Offset Area:** properties to the north of the Project Boundary that have been acquired for use as compensatory habitat. These two properties, "Mt Lindesay" and "Wirradale", are extensively vegetated and link to each other and to adjacent forest lands, including Mount Kaputar National Park; and

- **Shared Properties:** Aston also possesses property in shared ownership with Boggabri Coal to the south west of the Project Boundary. Aston intends to incorporate this shared property into the Biodiversity Offset Strategy as it links well to the Western Offset Area and Boggabri Coal's other offset lands.

Based on preliminary mapping, the above offset properties are likely to contribute over 6400 ha of forest, woodland and grassland. These offset properties contain over 2200 ha of Box Gum Woodland and more than 1900 ha of Derived Native Grassland, which provides an offset to impacts ratio of over 8:1 for Box Gum Woodland and Derived Grasslands. The offset properties also include over 800 ha of various forms of Ironbark Forest, which constitute habitat for threatened birds and bats. Importantly, these properties would provide upfront mitigation of the Project's impacts on locally occurring biodiversity. The inclusion of these lands as potential biodiversity offsets would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented. Comprehensive surveys will be completed for these offset properties in the near future and this detailed information will be used to prepare a Biodiversity Offset Management Plan (BOMP) that will dictate appropriate land management and restoration activities for conservation.

The combined offsetting proposals for mines within Leard State Forest is likely to be substantial and is likely to have a significant net benefit to flora and fauna. The available data indicates that in the medium to long term the mining activities will result in a net increase in forest and woodland in and around Leard State Forest, and in the wider locality. Excluding mine rehabilitation, this is likely to include offsets in the order of 17320 ha, providing an offset to impact ratio of approximately 3.9:1. However, offsetting for CEEC will

be at a higher ratio. It is estimated that the combined offsetting will provide 8013 ha of Box Gum Woodland and Derived Grasslands at a ratio of approximately 5.3:1.

S6 Conclusion

When mining impacts and offsetting measures are considered overall, the Project will provide major net increases in native forest and woodland under conservation and in particular it will significantly boost the area of Box Gum Woodland and Derived Grassland under conservation in the locality and region.

Despite the impacts of past forestry and current mining activities within the Leard State Forest, the Project would have a substantial impact on the ecology of the local area if no mitigation and compensation measures were proposed, it would remove 1664.8 ha of native forest and woodland, including 544 ha of Box Gum Woodland and Derived Native Grassland.

The vegetation that is proposed to be cleared provides habitat for a range of threatened species. At least 30 threatened species listed by the TSC Act and/or the EPBC Act, were recorded or are likely to occur within the Project Boundary. Others have potential to occur.

In recognition of the potential ecological impacts of the Project, a substantial rehabilitation and offsetting package is proposed and should be implemented. All forest and woodland areas to be cleared by mining should be rehabilitated as forest and woodland in the long term using local native species, maintaining treed habitat in the locality. In addition to this over 6000 ha of forest, woodland and grassland habitat within the offset lands should be permanently conserved, including 4668 ha of Box Gum Woodland and Derived Native Grassland. In the long term, over 1900 ha of Derived Native Grassland within the offset land should be regenerated to Box Gum Woodland.

When the mitigation and offsetting package are considered, the Project will have a major ecological benefit in the long term. It will contribute to maintaining the total forest and woodland area of Leard State Forest through rehabilitation and it will substantially increase the area of forest and woodland under conservation tenure within the locality surrounding Leard State Forest and Leard State Conservation Area. Thousands of hectares of Box Gum Woodland and Derived Native Grassland, prime habitat for many threatened woodland species, will be added to conservation tenure. The ratio of Box Gum Woodland conserved to that cleared will exceed 8:1 for the Project, excluding areas to be rehabilitated within the Project Boundary; and 5.3:1 for cumulative offsets to impacts in the locality.

Chapter 1

Introduction

Cumberland Ecology was commissioned by Hansen Bailey on behalf of Aston Resources Limited (Aston Resources) to undertake an ecological impact assessment of the proposed Maules Creek Coal Project (the Project), which will entail the development of a 21 year open cut coal mining operation and associated infrastructure. The ecological impact assessment is to form part of an Environmental Assessment (EA) being prepared by Hansen Bailey to support an application for a contemporary Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The objectives of this report are to document the findings of an ecological investigation of the Project and to assess the impacts of the Project on current biodiversity values. Current biodiversity values include threatened species, populations and ecological communities protected under State and Commonwealth legislation.

1.1 Background

Aston Coal 2 Pty Ltd (Aston), a wholly owned subsidiary of Aston Resources owns the rights to mining tenements known as Coal Lease 375 (CL 375) and Authorisation 346 (A 346) and is seeking a Part 3A Project Approval under the EP&A Act for the Project. The Project is located in the catchment of the Namoi River in the Gunnedah Coal Basin and is considered to be one of only a few remaining Tier 1 undeveloped semi-soft coking and thermal coal assets in Australia.

The Project Boundary, which largely falls within CL 375 and A 346, is situated approximately 18 km north-east of the Boggabri township within the Narrabri Local Government Area (LGA). The Boggabri township is approximately 40 km and 60 km between Gunnedah and Narrabri respectively; these three townships are connected via the Kamilaroi Highway.

The Project Boundary includes a portion of the Leard State Forest and some adjacent private landholdings to the north and west. The Project Boundary covers approximately 3551 ha in area as shown in **Figure 1.1**.

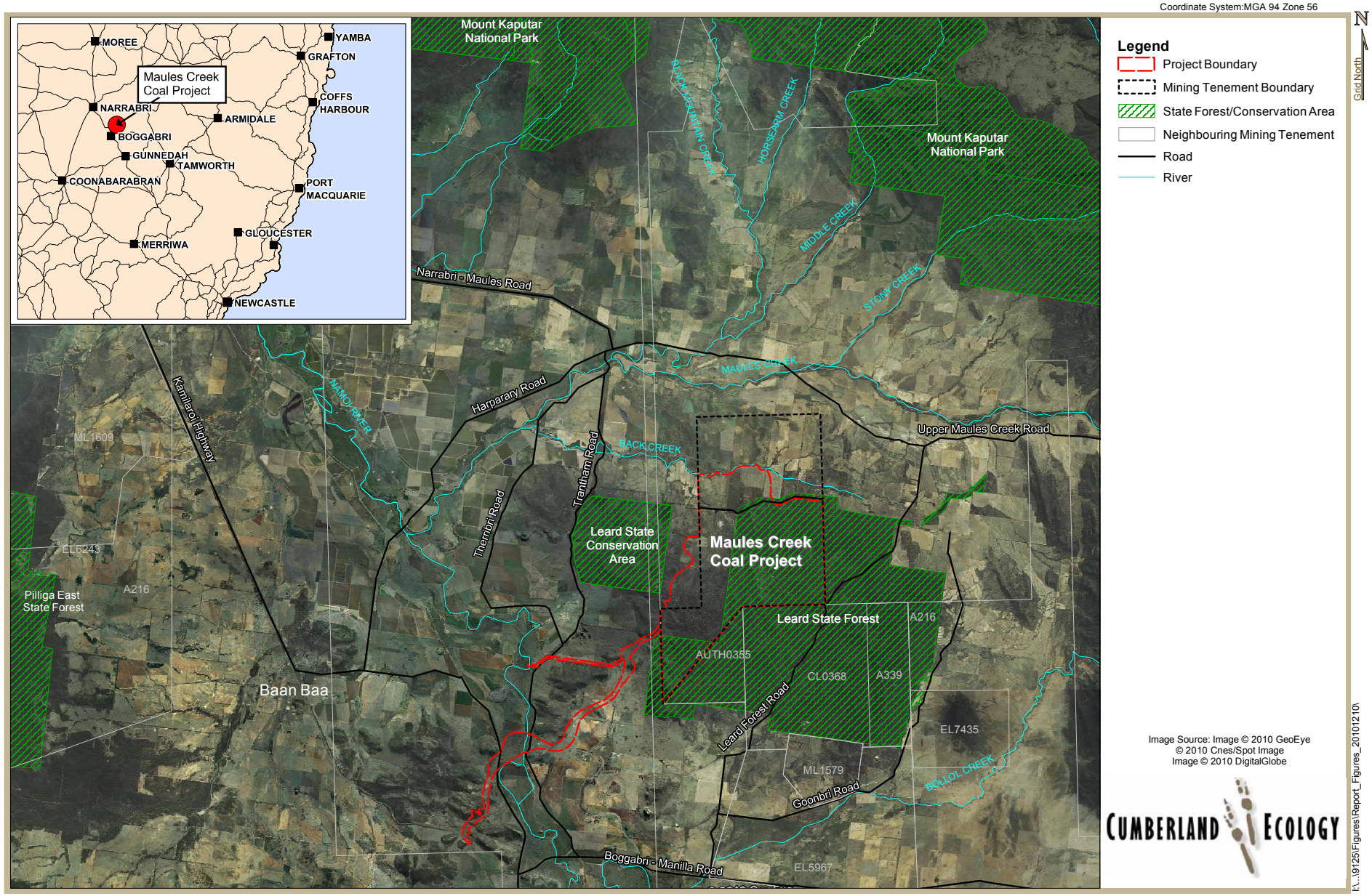

Figure 1.1 PROJECT LOCATION

1.1.1 Previous Study

The Leard State Forest was subject to an ecological study by James Croft and Associates in the late 1970s for the Amax Iron Ore Corporation (James B. Croft & Associates, 1979). In the late 1970s and mid 1980s the Project Boundary and surrounding area was subject to further study as part of a large exploration and prefeasibility investigation preceding the Environmental Impact Statement (EIS) that was prepared for the previously approved Maules Creek Coal Project. The EIS was submitted in 1989 on behalf of the Kembla Coke and Coal Pty Ltd (Kembla Coal & Coke Pty Ltd, 1989). The prefeasibility studies were extensive and included a number of soil studies, rehabilitation trials, vegetation surveys and fauna surveys (Dames & Moore, 1985, Dames & Moore, 1984, Dames & Moore, 1983a).

Although Development Approval was granted in 1990 (DA 85/1819) and the Development Consent was enacted in 1995 by the construction of a surface water dam, a full scale mining project has not yet commenced. This was mainly due to a depressed coal market in the early 1990s.

A significant time has lapsed since the surveys for the EIS were completed and changes in legislation particularly regarding threatened species have occurred. As such, Cumberland Ecology commenced work in 2008 on a detailed baseline ecological study of CL 375 and A 346 on behalf of Rio Tinto Coal Australia (RTCA) (previous holders of the mining tenements). The objectives of the study were to update current knowledge of the Leard State Forest with due reference to new legislation and to bring the survey effort in line with contemporary survey guidelines.

This Ecological Assessment builds upon and makes use of the earlier ecological work to provide an assessment suitable for supporting the EA.

1.1.2 Description of the Environment

i. Bioregional Context

The Project is located within the Brigalow Belt South bioregion, which is one of the largest recognised bioregions in Australia. The Brigalow Belt South bioregion is an area of 27196933 ha that covers a large longitudinal range through the heart of the western plains wheat belt, from southern Queensland to northern New South Wales. As such, the Brigalow Belt South bioregion is characterised by high environmental heterogeneity and ecological diversity (RACAC, 2000).

The vegetation of the New South Wales extent of the Brigalow Belt South bioregion has been reported to be mainly grassy woodland dominated by box eucalypts (*Eucalyptus albens*, *E. populnea* and *E. pilligaensis*) and ironbarks (RACAC, 2000). In the Liverpool Plains sub-bioregion, where the Project Boundary is located, the extensive black soil plains, undulating volcanic hills and alluvial floodplains once supported large tracts of closed grasslands dominated by *Austrostipa aristiglumis* (Plains Grass) together with an array of sub-dominant grasses (*Panicum* spp., *Austrodanthonia* spp., *Dichanthium* spp., *Bothriochloa* spp. and *Chloris* spp.). The heavier black soils also provided habitat for Belah-Wilga woodland thickets (*Casuarina cristata-Geijera parviflora*), within which a number of other

canopy trees could commonly be found (*E. albens*, *Callitris* spp., *Allocasuarina luehmanii*, *E. melliodora* and *E. blakelyi*). Although the Brigalow-Belah association of plant communities and species is more frequently encountered in the Queensland areas of the Brigalow Belt, *Acacia harpophylla* (Brigalow) is rarely encountered in the southern extent.

ii. Topography, Geology and Soils

The landscape around Boggabri is typified by extensive flat plains with the mountain ranges of the Nandewar rising in the east and gently undulating Pilliga country in the west. The Leard State Forest consists of a series of ridges and narrow gullies with the steepest areas occurring in the western portion. The ridges and hills of the Leard State Forest and surrounds is part of a restricted formation of Permian volcanics and sediments that have been recognised to occur around the Boggabri area (RACAC, 2000). This formation is unique because much of the wider bioregion is dominated by Quaternary alluvia, forming deep grey and brown cracking clays. In the Liverpool Plains sub-bioregion, the highly fertile, black cracking clay soils that occur over much of the landscape have been influenced by the basic alluvia and colluvia from surrounding Tertiary basalts.

In Leard State Forest, the Permian-aged geology of the Boggabri Volcanics is overlain by the carbonaceous clay sandstone and conglomerate of the Leard and Maules Creek Formations, from which the most common soils in the Project Boundary (yellow and brown solodics) have been derived. These solodics form duplex soils that occur throughout Leard State Forest in areas of gentler terrain. The steeper areas of the Project Boundary in the western portion of Leard State Forest are characterised by bleached, skeletal soils derived from the weathering of sandy conglomerates. In the south-western corner of the Project Boundary and to the west of Leard State Forest, the main substrate is black soils derived from the surrounding volcanic bedrock and alluvium/colluvium from the Tertiary basalts of the nearby Liverpool Ranges (James B. Croft & Associates, 1979, Dames & Moore, 1983b, Dames & Moore, 1991).

iii. Water Catchments, Drainage and Aquifers

One of the most significant river systems in the sub-bioregion is the Namoi River, which is a sizable watercourse that flows in a north westerly direction to the west of the Project Boundary. Downstream water levels at Boggabri are regulated by the release of water from major water storages upstream, namely Keepit Dam. Within the Project Boundary, surface water is naturally directed northwards through Leard State Forest along a network of small drainage lines towards Back Creek, which then flows into Maules Creek, a tributary of the Namoi River (**Figure 1.1**). Most of the drainages within Leard State Forest are ephemeral, remaining dry for most of the year except in times of high rainfall. The only permanent water source in the north-western portion of Leard State Forest is Lawler's Dam, a very small dam in the central portion of the Project Boundary.

Three aquifer systems are known to exist in the region including the alluvium aquifer system associated with the Namoi River floodplain and tributaries; weathered bedrock near the ground surface; and the coal seams of the Permian Maules Creek Formation.

iv. Land Use

The most prominent land use activities in the bioregion occur over the extensive areas of freehold land, these include agricultural, namely dry land and irrigation cropping as well as grazing and stock production. Other tenures that exist in the area include Crown reserves, dedicated conservation areas and forest reserves. Much of the Crown estate is represented by stock routes and stock reserves, which contain valuable remnant vegetation and are important for wildlife corridors. The conservation areas and forest reserves around the Project Boundary represent a sizable proportion of forested areas within the wider Namoi Valley and include (**Figure 1.2**):

- Leard State Forest;
- Leard State Conservation Area;
- The Nandewar Range, which incorporates:
  - Kelvin State Forest; and
  - Mt Kaputar National Park;
- Vickery State Forest;
- Kerringle State Forest;
- The Pilliga environs, which include:
  - Jacks Creek State Forest;
  - Bibblewindi State Forest;
  - Pilliga East State Forest; and
  - Pilliga Nature Reserve.

Leard State Forest is currently used for forestry, coal mining and recreational purposes. The surrounding freehold areas are predominantly used for dryland grazing and cropping. The primary timber harvest species in Leard State Forest are *Eucalyptus crebra* and *Callitris glaucophylla*; the latter is slower growing and is harvested less frequently.

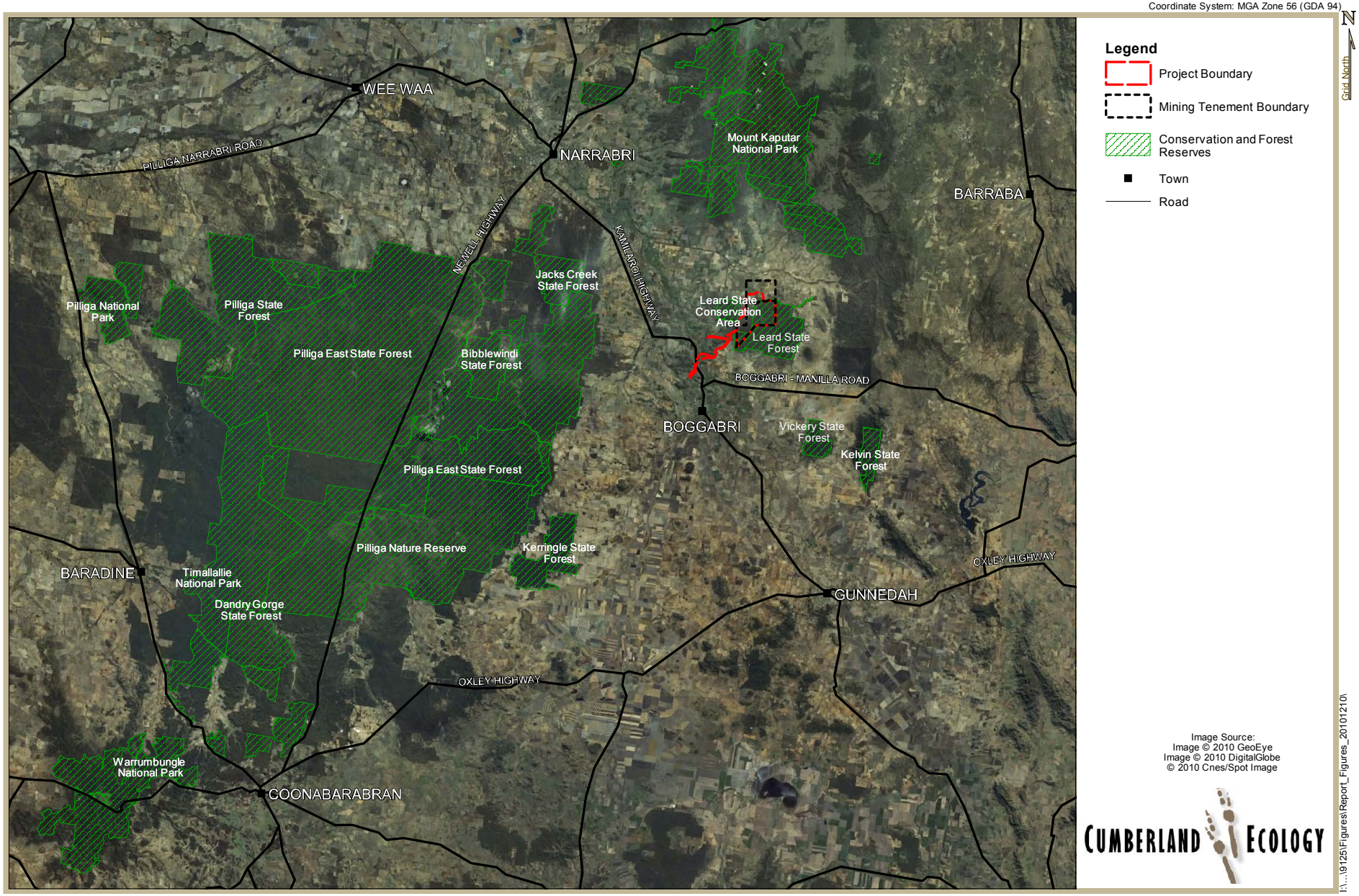

Figure 1.2 CONSERVATION AND FOREST RESERVES IN THE AREA

1.2 Project Description

The Project will entail open cut mining activities within its current mining tenements for a period of 21 years and the development of supporting surface infrastructure. The Project will replace the original Developmental Approval (DA 85/1819) with a different mine footprint and use of contemporary mining methods and practices to be implemented.

Specifically, the Project will consist of:

- Construction and operation of an open cut mine extracting up to 13 Million tonnes per annum (Mtpa) Run of Mine (ROM) coal to the Templemore Seam;
- Open cut mining fleet including excavator / shovels and fleet of haul trucks, dozers, graders and water carts with up to 470 permanent employees;
- Construction and operation of a Coal Handling and Preparation Plant (CHPP) with a throughput capacity of 13 Mtpa ROM coal;
- Construction and operation of Tailings Drying Area;
- Construction and operation of a rail spur, rail loop, associated load out facility and connection to the Werris Creek to Mungindi Railway Line (WCMR);
- Construction and operation of a Mine Access Road;
- Construction and operation of administration, workshop and related facilities;
- Construction and operation of water management infrastructure including a water pipeline, pumping station and associated infrastructure for access to water from the Namoi River;
- Installation of supporting power and communications infrastructure; and
- Construction and operation of explosive magazines and explosives storage areas.

A Pump Station is proposed for the Project on the Namoi River, where an existing High Security water licence for up to 3000 units of water per annum is held. The Project which involves the interception of Permian coal seam groundwater aquifers has the potential to influence surrounding groundwater. As discussed, this will not be impacted.

The Project layout is shown in **Figure 1.3**.

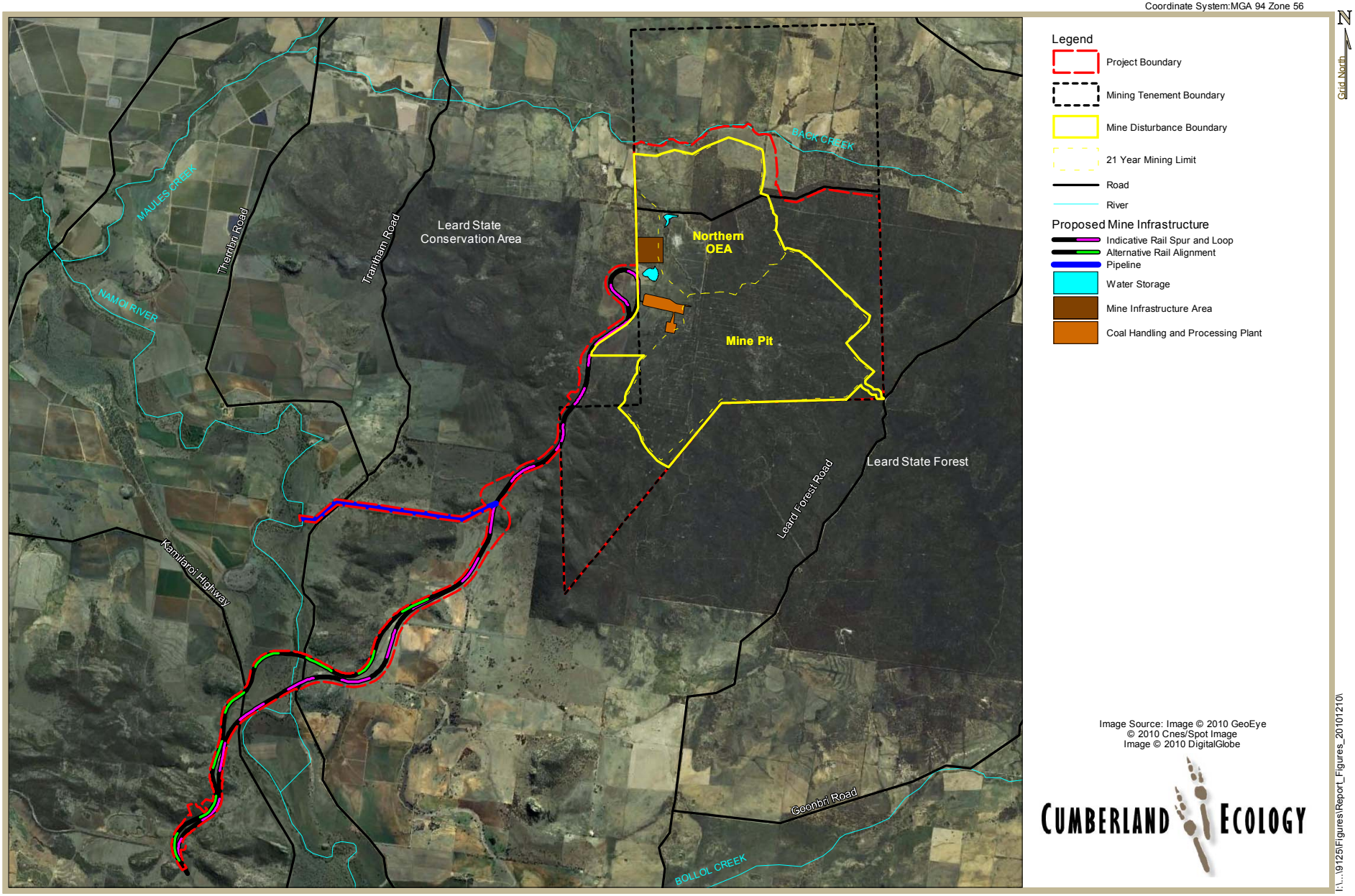

Figure 1.3 PROJECT LAYOUT

1.3 Relevant Legislation and Regional Planning

1.3.1 Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), any action (which includes a development, project or activity) that is considered likely to have a significant impact on Matters of National Environmental Significance (MNES) (including nationally threatened ecological communities and species, and listed migratory species) must be referred to the Commonwealth Minister for the Environment. The purpose of the referral is to allow a decision to be made about whether an action requires approval on a Commonwealth level. If an action is declared a "controlled action", then Commonwealth approval is required.

The Project was referred to the Commonwealth Minister for the Environment on 6, July 2010, and was declared a "controlled action" under the EPBC Act on 9 August 2010. As such the Project will require Commonwealth Government approval to proceed.

Further, the Commonwealth Government confirmed the Project will be assessed via an accredited process with the NSW DoP under Part 3A of the EP&A Act on 13 August 2010. The Commonwealth Minister for the Environment has provided input into the formation of the Director-General's Environmental Assessment Requirements (EARs) and thus, the requirements for Commonwealth assessment are encapsulated in the state process.

1.3.2 Environmental Planning and Assessment Act 1979

The EP&A Act is the overarching planning legislation in NSW. This Act provides for the creation of planning instruments that guide land use. The Act also provides for the protection of the environment, including the protection and conservation of native animals and plants. This includes threatened species, populations and ecological communities, and their habitats of biodiversity values, as listed in the *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act). The protection of the environment is addressed in Section 5A (Significant effect on species, populations or ecological communities or their habitats) and Part 3A (Major infrastructure and other projects).

Part 3A of the EP&A Act consolidates the assessment and approval regime for all major projects or state significant projects previously addressed under Part 4 (Development Assessment) or Part 5 (Environmental Assessment) of the Act. Part 3A developments are expected to deliver the following environmental outcomes (DEC (NSW), 2005l):

- Maintain or improve biodiversity values (ie. there is no net impact on threatened species or native vegetation);
- Conserve biological diversity and promote ecologically sustainable development;
- Protect areas of high conservation value (including areas of critical habitat);

- Prevent the extinction of threatened species;
- Protect the long-term viability of local populations of a species, population or ecological community; and
- Protect aspects of the environment that are matters of national environmental significance.

An EA is required for development proposals and must be prepared in accordance with the Director-General's EARs.

This report forms the ecological assessment component of the EA that is required to enable the Project to be assessed under Part 3A of the EP&A Act. EARs have been received from the Department of Planning (DoP) for the Project and include the following:

- Measures taken to avoid impacts on biodiversity;
- Accurate estimates of the proposed vegetation clearing;
- A detailed assessment of the potential impacts of the project on any:
    - Terrestrial or aquatic threatened species, populations, ecological communities or their habitats, including:
        - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland;
        - Regent Honeyeater; and
        - Swift Parrot;
- Regionally significant remnant vegetation, or vegetation corridors; and
- An offset strategy to ensure the project maintains or improves the biodiversity values of the region in the medium to long term (in accordance with NSW and Commonwealth policies).

The DoP has also indicated that they would expect that cumulative impacts in the sub-region due to the expansion of coal mining in the Boggabri area are minimised and managed appropriately in concert with other companies operating in the area.

1.3.3 Brigalow and Nandewar Community Conservation Area Act 2005

The Project Boundary is located within the north western portion of the Leard State Forest, an area that has been zoned for mining and forestry under the *Brigalow and Nandewar Community Conservation Area Act 2005* (BNC Act).

Prior to 1999, conservation groups and government conservation agencies raised issues about the sustainability of forests and woodlands in the Brigalow and Nandewar bioregions

within NSW. In 1999 the NSW Government initiated a regional assessment of the Brigalow and Nandewar bioregions, the purpose of which was to provide a secure basis for a comprehensive, adequate and representative network of conservation areas that could be sustained in parallel with ongoing use of the natural resources of the area (RACAC, 2000).

The BNC Act was created with the following objectives:

> *(a) to reserve forested land in the Brigalow and Nandewar area to create a Community Conservation Area that provides for permanent conservation of land, protection of areas of natural and cultural heritage significance to Aboriginal people and sustainable forestry, mining and other appropriate uses, and*
>
> *(b) to give local communities a strong involvement in the management of that land.*

Following from the BNC Act, a series of environmental assessments known as the Western Regional Assessments were completed to inform the *Brigalow and Nandewar Community Conservation Area Agreement* (BNC Agreement), which was made between the Minister for Climate Change and the Environment and the Minister for Primary Industries (DECC and DPI, 2009). This agreement outlined the principles and strategic framework for the co-operative management of forests by the Department of Environment and Climate Change and NSW State Forests.

As a result of the BNC Act, three Community Conservation Areas (BNC Conservation Areas) (Border/Gwydir, Namoi, Central West) were established in the Brigalow and Nandewar bioregions with four management zone levels within which these BNC Conservation Areas would be managed (**Table 1.1**). These BNC Conservation Areas are considered to protect important conservation values in western New South Wales and ensure the long-term sustainability of the region's important timber, gas, minerals and apiary sectors (DECC (NSW), 2009). The BNC Conservation Areas and management zones were created under the BNC Act.

Table 1.1 Zones under the BNC Act

Zone	Purpose of Zone	Legislation
Zone 1	Conservation and Recreation	Managed under the National Parks and Wildlife Act 1974
Zone 2	Conservation and Aboriginal Culture	Managed under the National Parks and Wildlife Act 1974
Zone 3	Conservation, Recreation and Mineral Extraction	Managed under the National Parks and Wildlife Act 1974
Zone 4	Forestry, Recreation and Mineral Extraction	Managed under the Forestry and National Park Estate Act 1998 and Forestry Act 1916

Adapted from the Department of Environment, Climate Change and Water website (2010) http://www.environment.nsw.gov.au/forestagreements/cca.htm

In total 350000 ha of woodland within the Brigalow and Nandewar bioregions were conserved within the new BNC Conservation Areas (DECC (NSW), 2009) of which over 180000 ha was allocated to the Namoi CCA. The Leard State Forest is one of a suite of state forests within the Namoi CCA that was considered for inclusion within the BNC Conservation Area reserve network. Under the agreement, part of Leard State Forest was allocated to Zone 3 and is now within the National Parks estate. The remainder is in Zone 4, where mining and forestry activities are permitted. The section of Leard State Forest within the Project Boundary is Zone 4.

1.3.4 Other Relevant Legislation & Guidelines

Further NSW legislation and planning policies that are relevant to the protection of biodiversity are listed below:

- *Threatened Species Conservation Act 1995;*
- *National Parks and Wildlife Act 1974;*
- *Water Management Act 2000;*
- *Fisheries Management Act 1994;*
- *State Environmental Planning Policy 44 – Koala Habitat Protection;*
- *Narrabri Local Environment Plan 1992.*

For the development of offsetting strategies for the Project, the following documents were considered:

- *DECC (2008) Principles for the Use of Biodiversity Offsets in NSW Department of Environment and Climate Change, Hurstville, NSW.*
- *DEWR (2007) Draft Policy Statement: Use of Environmental Offsets under the Environment Protection and Biodiversity Conservation Act 1999, Department of the Environment and Water Resources, Canberra, ACT.*

1.4 Terms and Abbreviations

Table 1.2 Terms and Abbreviations Used In This Report

Terminology	Description
A 346	Authorisation 346
Aston Resources	Aston Resources Pty Limited
BNC Act	*Brigalow and Nandewar Community Conservation Area Act 2005*
BNC Agreement	Brigalow and Nandewar Community Conservation Area Agreement
BNC Conservation Area	Community Conservation Areas (Border/Gwydir, Namoi, Central West)
Box Gum Woodland and Derived Grasslands	NSW and Commonwealth listing for the critically endangered open woodland community 'White Box- Yellow Box- Blakely's Red Gum Woodland and Derived Native Grasslands'
CEEC	Critically Endangered Ecological Community
CHPP	Coal Handling & Preparation Plant
CL	Coal Lease
DECCW	NSW Department of Environment, Climate Change and Water. Note that most of the functions of this Department have been transferred to the Office of Environment and Heritage.
Development Consent DA 85/1819	Granted to Kembla Coal & Coke Limited on 12 June 1990 by the then Minister for Planning for the "*construction and operation of a surface and underground coal mine, associated transport and coal loading facilities and railway spur line*". The DA 85/1819 is now held by Aston Resources.
DoP	Department of Planning NSW
EARs	Director- General's Environmental Assessment Requirements (NSW DoP)
EA	Environmental Assessment
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning & Assessment Act 1979* (under which Project Approval for the Project is sought)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
LGA	Narrabri Local Government Area
Locality	Land within 20 km radius of the Project Boundary
Maules Creek Coal Project (the Project)	Aston seeks Project Approval under Part 3A of the EP&A Act for a contemporary Planning Approval to facilitate the development of surface infrastructure and open cut mining activities for the Project generally

Table 1.2 Terms and Abbreviations Used In This Report

Terminology	Description
	within the current mining tenements for a period of 21 years.
ML	Mining Lease
MNES	Matters of national environmental significance that are listed by the EPBC Act.
Mtpa	Million tonnes per annum
NP&W Act	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage, a division of the NSW Department of Premier and Cabinet.
Project Approval	Project Approval will be sought under Part 3A of the EP&A Act to facilitate the development of the required site infrastructure and the mining of the Project Boundary for a period of 21 years.
Project Boundary	When referring to whole site assessed
Project Disturbance Area	The total project footprint that will require clearing for mining or construction.
Region	Refers to the Brigalow Belt South bioregion.
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
TSC Act	*NSW Threatened Species Conservation Act 1995*

Chapter 2

Methodology

2.1 Assessment Approach

2.1.1 Surveys within the Project Boundary

The contemporary ecological study was initially intended to update existing knowledge of the biodiversity values within the Project Boundary in line with legislative changes, current survey guidelines and new protected species listings. It was also intended to capture and document any significant declines and increases in the flora and fauna of the Leard State Forest since the last studies were completed in the late 1980s and improve understanding of the vegetation community distribution of the Leard State Forest, which was noted as being highly complex (James B. Croft & Associates, 1979).

Detailed surveys were completed in 2008 to provide updated flora and fauna baseline data for the Project Boundary in compliance with the OEH guidelines for flora and fauna survey (DEC (NSW), 2004). Floristic sampling was designed to meet SEWPaC (formally the Department of the Environment, Water, Heritage and the Arts) guidelines for identifying the critically endangered Box Gum Woodland and Derived Grasslands (DEC (NSW), 2005n). The community known as Box Gum Woodland and Derived Grasslands was recorded within Leard State Forest in the EIS studies of the 1980s but was only gazetted in 2006.

Recently, during the preparation of this report, Parsons Brinckerhoff published an Environmental Assessment Report (EAR) for the proposed Continuation of Boggabri Coal Mine (Parsons Brinckerhoff Australia Pty Ltd, 2010). The Biodiversity Assessment that forms part of that EAR has entailed a greater or equal amount of flora and fauna survey work in the Boggabri Coal lease as has been completed by Cumberland Ecology within the Project Boundary (a similar sized area). The Leard State Forest is very similar in both leases, with the same flora and fauna habitats predominating. This effectively means that by reviewing and referring to the results of the Parsons Brinckerhoff EAR, Cumberland Ecology has been able to double the size of the flora and fauna database available for impact assessment purposes.

The study has since evolved into an ecological impact assessment and will require careful consideration of the Project impacts on threatened species, populations and ecological communities. The increasing importance placed by government agencies on the conservation of CEECs and Commonwealth protected matters prompted the need for a highly accurate vegetation map over the Project Boundary and thus a large proportion of the

most recent survey efforts have been dedicated to this purpose. For this same reason, matters such as the Weeping Myall Woodland, Swift Parrot (*Lathamus discolour*) and Regent Honeyeater (*Xanthomyza phrygia*) were also the particular foci of survey.

2.1.2 Surveys of Prospective Offset Sites

The Project Boundary is heavily wooded and it is not possible for open cut coal mining to occur without incurring impacts to native forests and woodlands, including habitats of threatened flora and fauna. For this reason, it was apparent at the outset that land to be designated as compensatory offsets would be required to address the ecological impacts of the Project. The latter part of this chapter, **Section 2.6**, provides details about how proposed offset land was screened and how a final offset package was derived, including criteria for the survey and selection of offsets.

2.2 Literature Review and Database Analysis

2.2.1 Literature Review

Relevant literature about flora and fauna of the Leard State Forest and its locality were reviewed to provide information for the Ecological Assessment.

The Leard State Forest and its surrounds have been subject to detailed flora and fauna studies since the late 1970s. The exploration and prefeasibility studies completed for the Kembla Coke and Coal EIS were reviewed to gain an understanding of the character and key environmental attributes of the Leard State Forest (Kembla Coal & Coke Pty Ltd, 1989, James B. Croft & Associates, 1979, Dames & Moore, 1983a).

To obtain a regional understanding of the environment of the Project Boundary, the key findings of the Western Regional Assessments of the Brigalow and Nandewar bioregions were reviewed (DECC (NSW), 2009).

There has been considerable ecological survey effort within the locality of Leard State Forest in recent times for baseline data by Government and Industry. The contemporary studies completed within Leard State Forest and within the locality were reviewed, including available literature of the flora and fauna of nearby national parks and state conservation areas (DEC (NSW), 2006b, Hunter, 2007, Harden, 2008, Butler, 2009, ELA, 2010, Parsons Brinckerhoff Australia Pty Ltd, 2010, OEH (NSW), 2011).

2.2.2 Database Analysis

Other existing information on the biodiversity values of the Project Boundary and its surrounds were obtained via interrogation of the OEH Atlas of NSW Wildlife database (DECCW, 2010a) and SEWPaC EPBC Protected Matters Search Tool (DSEWPC, 2010). The Protected Matters Search Tool provides a list of MNES that are predicted to occur based on the presence of suitable habitat, which was useful for informing threatened species searches during field survey.

The number and age of records of threatened species recorded within a 10 km radius of the Project Boundary provided a picture of the distribution for relevant species within the locality and was useful supplementary information when assessing the likelihood of occurrence of threatened species within the Project Boundary.

2.3 Terrestrial Survey

2.3.1 Dates of Survey by Cumberland Ecology

The most recent surveys built upon an existing database of flora and fauna information that included data from the 1970s, 1980s, 1990s and 2000s. Recent surveys are also available from nearby areas of the Project Boundary, including Leard State Forest and Leard State Conservation Area. A summary of earlier surveys is provided within **Appendix F**.

Field surveys took place over the 2008 Spring-Summer and 2010 Autumn-Spring periods and are summarised in **Table 2.1**. Much of the fauna work was concentrated in the warmer months but floristic surveys have been conducted throughout the survey period.

Table 2.1 Dates of Field Survey

Dates of Survey	Tasks completed
July 1-3, 2008	General flora and fauna reconnaissance
October 20-29, 2008	Fauna trapping
October 27-29, 2008	Vegetation mapping, targeted searches, quadrats
November 24 – December 4, 2008	Fauna trapping
December 1-5, 2008	Vegetation mapping, targeted searches, quadrats
April 15, 2010	Vegetation random meander
May 18-20, 2010	Vegetation random meander
June 8-9, 2010	Vegetation mapping, boundary walks, meander transects
June 21-22, 2010	Vegetation mapping, boundary walks, meander transects
July 14-15, 2010	Vegetation random meander
September 2-3, 2010	Vegetation mapping, boundary walks, meander transects
August 30 – September 4, 2010	Koala SAT, point searches, opportunistic observations
September 29 – October 1, 2010	Vegetation mapping, boundary walks, meander transects
October 18-22, 2010	Koala SAT, point searches, opportunistic observations
December 13-17 2010	Additional quadrat survey (8 sites) and random meander searches for threatened plants within the Project Boundary

2.3.2 Flora Survey

i. Vegetation Mapping

Vegetation maps provided by James B. Croft & Associates (1979) and Dames & Moore (1985) were used in the first instance to map the vegetation of the Project Boundary. The mapping was investigated in the field via the following methods:

- Quadrat sampling (20m x 50m) to characterise vegetation map units by their species composition and community structure;
- Meander transect surveys to obtain information on community distribution in the Project Boundary and surrounds; and
- Detailed walks of vegetation units and recording boundaries using a handheld Geographical Positioning System (GPS) unit.

The resultant information was synthesised using Geographical Information Systems (GIS) to create a spatial database that was used to interpret and interpolate the data to produce a vegetation map of the Project Boundary. Aerial, topographical and geological data were also used to interpret the survey data. Aerial data was obtained from 3-band Geo-Eye1 satellite imagery (Geoimage Pty Ltd, 2010). Mapping was completed using MapInfo Version 10.5 (Pitney Bowes Software Inc., 2010) on a Windows XP platform.

ii. Criteria for the Identification of Box Gum Woodland and Derived Grasslands

The EPBC Act Policy Statement for assessing Box Gum Woodland and Derived Grasslands (DEH, 2006) provides a prescriptive, detailed methodology for determining the presence of the CEEC.

The flow chart that summarises the SEWPaC method for identifying Box Gum Woodland and Derived Native Grasslands is reproduced in **Appendix A**. It demonstrates that to confirm the presence of this CEEC as listed under the EPBC Act, it is firstly essential to confirm the presence or historical presence of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*) within the area of interest. Then, if one or more of these trees are present or was historically present as dominants, a quadrat should be completed within a plot of 1000 m^2 (0.1 ha). SEWPaC has published a list of plants characteristics of Box Gum Woodland and Derived Native Grasslands: if the survey plot contains 12 native herb species (excluding native grasses) and at least one is an "important" native plant as signified in the list of characteristic species, then the plant community is said to be present.

There is no such prescriptive methodology to identify Box Gum Woodland and Derived Native Grasslands under the TSC Act. A detailed description that defines the Box Gum Woodland and Derived Native Grasslands is included in the Final Determination made in 2004 by the NSW Scientific Committee to list Box Gum Woodland and Derived Native

Grasslands as a CEEC under the TSC Act. The presence of the community is determined on the basis of its consistency with the community described within the Final Determination.

iii. Floristic Census and Targeted Surveys

The flora assemblage within the Project Boundary was recorded by quadrat sampling, random meander surveys and through targeted searches for threatened species. All vascular plants recorded or collected were identified using keys and nomenclature provided in Harden (1990-1993). Other references used to assist identification of selected plant taxa include Richardson *et al* (2006) and Brooker and Kleinig (1990). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust, 2010). Any specimens that were not readily identifiable were lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney.

iv. Quadrat Sampling

A total of 38 quadrats were sampled in 20 x 50 metre plots as recommended by SEWPaC identification guidelines for Box Gum Woodland Policy Statement (DEH, 2006). The locations of these quadrats were chosen so that sampling was conducted in areas most representative of the condition and composition of the vegetation patch. These quadrat locations are shown in **Figure 2.1**. Flora quadrat data is provided in **Appendix G**. In each quadrat, the following information was recorded as a minimum:

- All vascular flora species present within the plot or directly adjacent to the plot;
- The stratum in which each species occurred;
- The relative frequency of occurrence of each plant species;
- Vegetation structural data (i.e. height and percentage cover of each stratum);
- A waypoint to mark the location of the quadrat, using a handheld GPS; and
- Photographs of the quadrat.

The relative abundance and cover of each species within the quadrat was approximated using a scoring system based on the Braun-Blanquet scoring system (Braun-Blanquet, 1927). The scores used are provided in **Table 2.2**.

Table 2.2 Modified Braun-Blanquet Scores Used In Quadrat Surveys

Class	Cover-abundance	Notes
+	Rare (less than 1 % cover)	Herbs, sedges and grasses: within 4 m^2 Shrubs and small trees: less than 5 individuals.
1	Few Individuals (less than 5 % cover)	Herbs, sedges and grasses: within 20 m^2

Table 2.2 Modified Braun-Blanquet Scores Used In Quadrat Surveys

Class	Cover-abundance	Notes
		Shrubs and small trees: 5 or more individuals Medium - large overhanging tree.
2	5 - less than 25 % cover	-
3	25 - less than 50 % cover	-
4	50 - less than 75 % cover	-
5	75 - 100 % cover	-

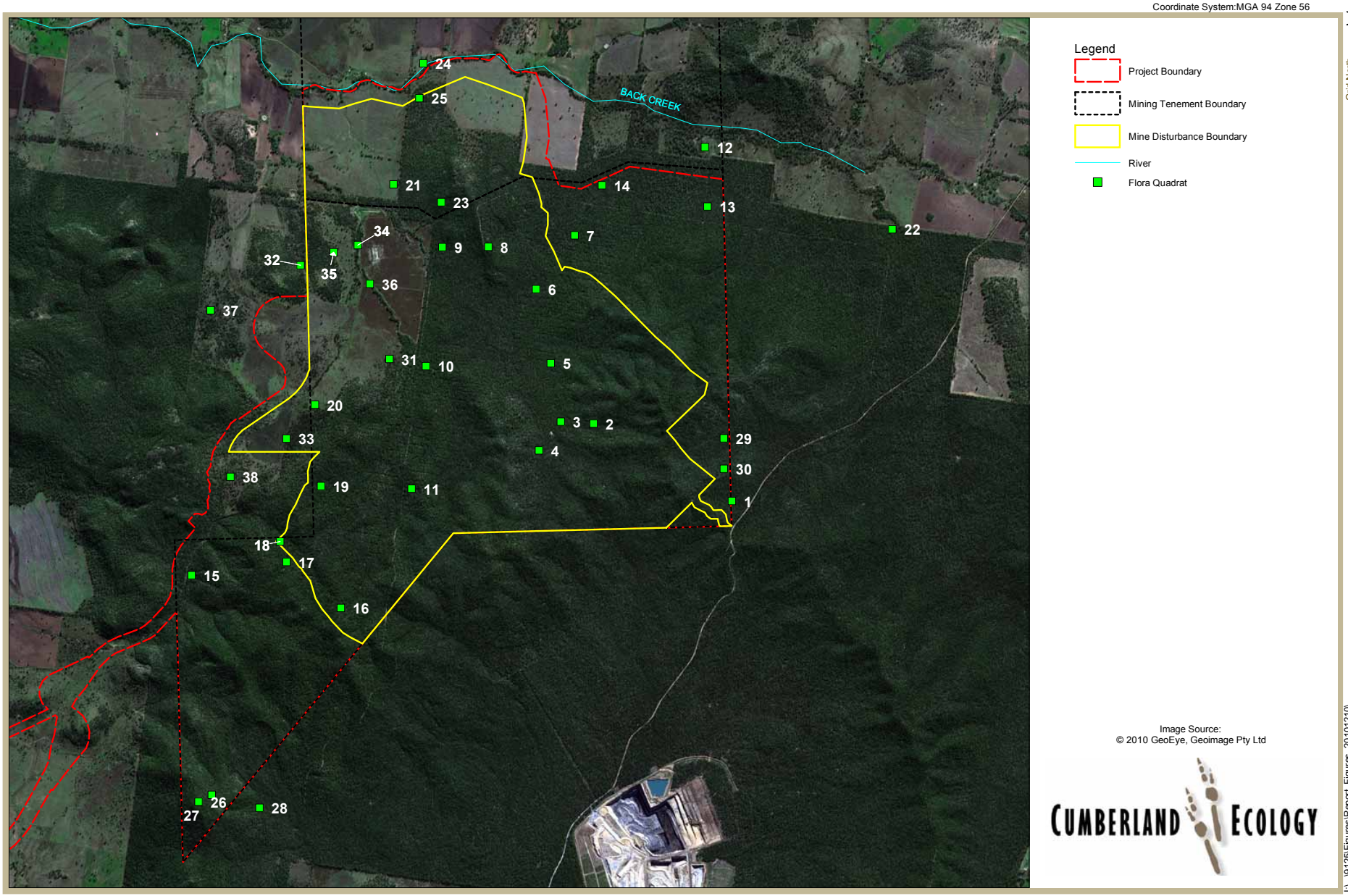

Figure 2.1 FLORA SURVEY LOCATIONS (CUMBERLAND ECOLOGY 2008, 2010)

2.3.3 Fauna Survey

Fauna surveys were conducted, where possible, in accordance with OEH guidelines for ecological assessment (DEC (NSW), 2004). Surveys were undertaken over several survey sessions to increase the seasonal range of sampling to maximise detection (DEC (NSW), 2004). Trapping surveys took place over two sessions in the warmer months of the year (see **Table 2.1**) and involved a number of different trapping methods

As OEH survey guidelines are based upon stratification units, the Project Boundary was stratified using vegetation units as a surrogate for fauna habitat and survey effort was allocated accordingly. Based on the mapping available at the time, grassy and shrubby box woodlands covered approximately two thirds of the Project Boundary and the drier ironbark forests dominated the remaining area. For this reason, an approximate ratio of 2:1 was employed for apportioning survey efforts in box woodlands and ironbark forest communities to meet the OEH survey effort requirements.

A summary of sampling method and effort used are provided in **Table 2.3**. Fauna survey locations are shown in **Figure 2.2**.

Table 2.3 Fauna Survey Methods and Effort (Cumberland Ecology 2008, 2010

Survey Method	CE Survey Effort in Project Boundary
Amphibians	
Systematic day habitat search	8 hours
Night habitat search of damp and watery sites	8 hours
Nocturnal call playback	4 nights
Night watercourse search	8 hours
Reptiles	
Habitat search	10 x 30 minutes (2 x 30 mins on 5 separate days)
Pitfall traps with drift nets	270 trap nights (54 traps for 4 nights, 18 traps for 3 nights)
Spotlighting	10 hours (1 hour on 10 separate days)
Diurnal Birds	
Systematic grid based census	13.5 hours (10 min x 81 sites)
Area search	6 days
Water source census	30 minutes
Nocturnal Birds	

Table 2.3 Fauna Survey Methods and Effort (Cumberland Ecology 2008, 2010

Survey Method	CE Survey Effort in Project Boundary
Call playback	12 nights (30 minutes each night, 1 site per night)
Day habitat search	Throughout survey period
Non-flying Mammals	
Small Elliott (A) traps	1125 trap nights
Medium Elliott (B) traps	450 trap nights
Arboreal Elliott (B) traps	320 trap nights
Wire cage traps	270 trap nights
Pitfall traps with drift nets	270 trap nights
Hair tubes	2000 trap nights
Arboreal hair tubes	2000 trap nights
Spotlighting on foot	16 hours (8 x 2 hours per night)
Spotlighting from vehicle	16 hours (8 x 2 hours per night)
Call playback	12 nights
Search for scats and signs	6 hours
Infrared cameras	40 survey nights
Collection of predator scats	Throughout survey period
Koala grid based SAT (spot assessment technique)	81 sites
Bats	
Harp trapping	22 trap nights
Ultrasonic call recording	26 nights
Triplining	1 night

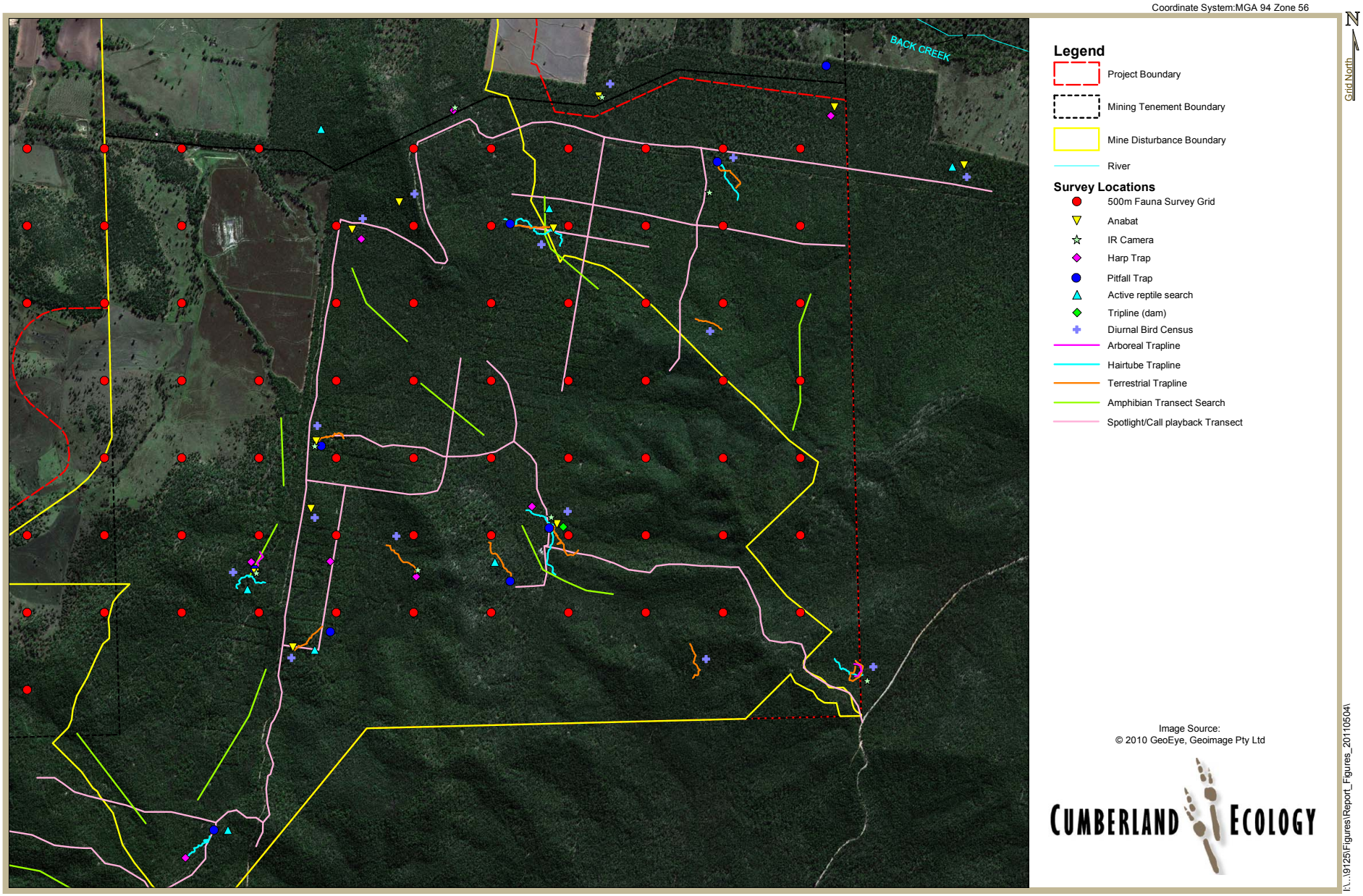

Figure 2.2 FAUNA SURVEY LOCATIONS (CUMBERLAND ECOLOGY 2008, 2010)

i. Trap Lines

Trapping was used to detect arboreal and terrestrial fauna occurring in the Project Boundary. The following traps were utilised:

- Medium Elliot (B) traps for small to medium sized arboreal and terrestrial fauna;
- Small Elliot (A) traps for small terrestrial fauna; and
- Wire Cage traps for large terrestrial fauna.

a. Arboreal Traps

Arboreal trap lines were established with Elliot B traps and set approximately 20m apart depending on available habitat. During the first trapping session, 20 arboreal traps were established at one location and left for a period of eight nights (checked 2 times per day). During the second trapping session, arboreal traps were established for eight nights at two locations; with each transect comprising 10 traps.

The traps were placed on platforms attached to habitat trees at a height of approximately two metres. They were baited with a mixture of peanut butter, honey and rolled oats. Each tree was sprayed with a honey and water mixture.

The entire survey period involved a total of 320 trap nights.

b. Terrestrial Traps

Terrestrial trap lines were established using both Elliot A and Elliot B traps and set approximately 20m apart at various locations throughout the Project Boundary. A total of 12 trap lines were established over the duration of the field study. Each trap line contained 25 Elliot A and 10 Elliot B traps. The trap lines were set over four trapping sessions, with traps opened for no less than three continuous nights and no longer than four continuous nights each time.

The Elliot A and B traps for terrestrial trap lines were baited in the same manner as the arboreal traps, with the exception that the Elliot B traps also contained sweet potato and/or apple to target small-medium sized mammals.

The entire survey period involved a total of 1125 trap nights using Elliot A traps and 450 trap nights using Elliot B traps.

c. Cage Traps

In addition to the Elliott traps, six cage traps were placed along each of the terrestrial trap lines to target medium-large sized mammals. The cage traps were opened for the same number of nights as the Elliott traps.

Traps were baited with chicken, sweet potato, apple and a ball of peanut butter, honey, rolled oats and diced bacon. Trapping lines were checked early morning, and any fauna captured were identified and released.

The entire survey period involved a total of 270 trap nights.

ii. Pitfall Lines

Pitfall lines were established at nine locations throughout the Project Boundary. Each pitfall line consisted of six pitfall buckets placed approximately five metres apart. Drift fencing was erected along each pitfall line. Pitfall lines were checked early morning, and any fauna found were identified and released.

iii. Hair Tubes

'Faunatech' hair tubes were used during field surveys to detect arboreal and terrestrial mammals. In the first trapping session, two transects of 100 hair tubes were established. In the second trapping session, four transects of 50 hair tubes were established. One hair tube was placed on the ground and one on a tree along the transects. Hair funnels were baited with rolled oats, peanut butter, honey and diced bacon. A total of 400 hair tubes were deployed for a period of 10 days and nights, giving a survey effort of 4000 trap nights – half of which were terrestrial and half arboreal. Hair samples were analysed by Georgeanna Story of 'Scats About'.

iv. Infra-Red Cameras

Infra-red (IR) cameras were set up at a number of locations throughout the Project Boundary. The cameras were attached to trees and the focal point of the camera was on a stake in the ground. The cameras begin recording when fauna activates the motion sensor. The stakes were baited with steak or chicken, sweet potato and apple, and rebaited when necessary. Eight cameras were used and left for up to five nights. Recorded footage was later analysed to determine fauna species that were detected.

v. Bat Surveys

Microchiropteran bats (microbats) were surveyed using a combination of methods. The following detection methods were utilised during the survey period:

- Ultrasonic bat recordings using Anabat Z-caim units;
- Harp traps; and
- Trip lining.

Anabat Z-caim units were employed on most survey nights to record calls of microbats. Where possible, Z-caim units were left at each survey location for two nights. Anabats were set before dusk each evening and switched off after dawn. Anabats were also utilised during

release of captured microbats to verify visual identification. Calls recorded on each anabat were analysed to determine which species were present within the Project Boundary.

Harp traps were employed at several locations to trap microbats at night along suitable flyways. When possible, harp traps were left for two nights at each survey location. Bats were collected from harp traps at dawn and the bat species subsequently identified.

One location within the conceptual mine footprint, a dam, was suitable for the triplining detection method. Trip lining was conducted on 25 October 2008, with the survey beginning at dusk. A network of triplines was erected above the dam to capture microbats as they were drinking in flight. Captured bats were identified and then released.

vi. Diurnal Searches

a. Diurnal Bird Surveys

Visual observation and call identification of diurnal birds was carried out during each survey period. Dawn and dusk surveys were conducted at trapline locations throughout the Project Boundary. Diurnal birds were also identified and recorded as they were encountered throughout the Project Boundary during the survey periods. In addition, call playback was used to elicit a response from threatened diurnal bird species at several points throughout the Project Boundary. GPS readings were taken near sightings of any threatened bird species.

In the most recent survey sessions, a 10 minute observation block was carried out at each of 81 grid-based census points across the Project Boundary. The census points were 500 metres apart and were also used for targeted Koala surveys (see **subsection ix** below).

b. Reptile and Amphibian Active Searches

In addition to pitfall trapping, diurnal searches were conducted of suitable habitat for amphibians and reptiles throughout the Project Boundary. Diurnal active searches were conducted at various points for a set period of 30 minutes per sample site. Active searches of suitable habitat were also conducted during other diurnal activities throughout the Project Boundary. Searches involved lifting of bark, fallen logs, bushrock and scraping of top soil. Captured animals were identified and then released.

vii. Nocturnal Searches

a. Spotlight Surveys and Call Playback

Spotlighting was conducted for nocturnal mammals, birds and reptiles. Nocturnal surveys were conducted using a hand-held spotlight while walking or from a slow moving vehicle. Spotlighting transects were spread throughout the Project Boundary, and incidental spotlighting was also conducted while travelling between transects at night.

During spotlighting surveys, call playback of nocturnal mammal calls were broadcasted using a megaphone to illicit a response from targeted threatened nocturnal species. *Phascolarctos*

cinereus (Koala), *Dasyurus maculatus* (Spotted-tailed Quoll) and *Petaurus norfolcensis* (Squirrel Glider) were targeted by broadcasting taped calls through an amplifier. Calls were played for two minute periods at five minute intervals. This was followed with quiet listening and spotlighting.

b. Nocturnal Bird Surveys

Nocturnal bird surveys were undertaken throughout the survey period over several nights for all threatened bird species detected within the Narrabri LGA (from Government database searches including the Wildlife Atlas). The presence of *Tyto novaehollandiae* (Masked Owl), *Ninox strenua* (Powerful Owl) and *Ninox connivens* (Barking Owl) were targeted by broadcasting taped calls through an amplifier. Calls were played for two minute periods at five minute intervals. This was followed with quiet listening and spotlighting. Global positioning system readings were taken near sightings of any threatened bird species.

c. Amphibian Surveys

Amphibian searches included night habitat searches of damp and watery sites including watercourses and nocturnal call playback. Species targeted in the call playback included *Crinia slonaei* (Sloane's Froglet) and *Litoria booroolongensis* (Booroolong Frog).

viii. Incidental Observations

Any incidental vertebrate fauna species that were heard calling, observed or otherwise detected on the basis of tracks or signs were recorded and listed in the total species list for the subject site. Incidental records of threatened flora and fauna from areas adjacent to the Project Boundary have also been included.

ix. Koala Assessment – Regularised Grid Based Spot Assessment Technique

A survey of koala activity was conducted using methodology that is generally consistent with the Regularised Grid-Based Spot Assessment Technique (RGB-SAT) protocol developed by Biolink (Biolink , 2008).

A total of 81 sampling points, each 500 metres apart were surveyed across the Project Boundary. Searches of two minutes in duration were made within the dripline of each of 20 trees for koala scats and/or scratches. Where there were no suitable feed trees present, an appropriate habitat tree within a 100m radius of the sampling point was chosen. Trees that were targeted included those listed in **Table 2.4**.

Table 2.4 Koala Feed Trees for the Western Slopes and Plain KMA (Koala Recovery Plan, 2008)

Scientific Name	Common Name
Primary Food Tree Species	
Eucalyptus camaldulensis	River Red Gum

Table 2.4 Koala Feed Trees for the Western Slopes and Plain KMA (Koala Recovery Plan, 2008)	
Scientific Name	**Common Name**
Eucalyptus coolabah	Coolabah
Secondary Food Tree Species	
Eucalyptus chloroclada	Dirty Gum
Eucalyptus populnea	Poplar Box
Eucalyptus pilligagensis	Narrow-leaved Grey Box
Eucalyptus conica	Fuzzy Box
Eucalyptus macrocarpa	Western Grey Box
Eucalyptus albens	White Box
Eucalyptus melliodora	Yellow Box
Eucalyptus dwyeri	Dwyer's Red Gum
Eucalyptus dealbata	Tumbledown Gum
Eucalyptus blakelyi	Blakely's Red Gum
Eucalyptus bridgesiana	Apple Box
Eucalyptus largiflorens	Black Box
Eucalyptus nandewarica	Mallee Red Gum
Eucalyptus vicina	n/a
Euclayptus volcanica	n/a
Eucalyptus polyanthemos	Red Box
Eucalyptus prava	Orange Gum
Supplementary Species	
Eucalyptus macrorhyncha	n/a
Eucalyptus sparsifolia	Narrow-leaved Stringybark

(DECC (NSW), 2008b)

2.3.4 Habitat Assessment

The characteristic attributes of different types of fauna habitat generally influences the assemblage of fauna species that can be found within each habitat and also affects the general value of the habitat for fauna. The Project Boundary contains four broad habitat types that vary in their value for fauna. These are:

- Remnant woodland and open forest;
- Wetland;
- Riparian vegetation associated with minor tributaries and drainage lines; and

- Grassland.

Habitat condition was assessed by noting ground, shrub/understorey and canopy cover, number and size of hollows present, habitat features such as bush rock and fallen trees, and signs of fauna usage such as scats and scratches.

Fauna habitat assessments also included consideration of important indicators of habitat condition and complexity including the occurrence of microhabitats such as tree hollows, fallen logs, bush rock and wetland areas such as creeks and soaks. An assessment of the structural complexity of vegetation, the age structure of the forest and the nature and extent of human disturbance throughout the Project Boundary was undertaken and considered.

i. Hollow Assessment

Hollows are used as a general indication of habitat quality for arboreal fauna, and hollow-dependent birds and bats. Hollows observed during surveys were recorded and the general vegetation condition and tree maturity were used to predict whether trees on site are likely to contain hollows. Indirect indicators of fauna use of the site such as droppings, diggings, footprints, scratches, nests, burrows, paths and runways were also noted.

A regularised hollow assessment was also conducted at each of the 81 grid-based sampling points used for the above Koala assessment described above. At each sampling point, searches for hollow-bearing trees were made within a 20m x 50m quadrat. For each hollow-bearing tree identified the (1) species; (2) height and diameter at breast height (DBH); (3) number of hollows; and (4) size class of hollows were recorded. Hollow size classes are defined in **Table 2.5** below. Data obtained was used to determine densities of tree hollows per ha of habitat proposed to be cleared.

Table 2.5 Tree Hollow Class Size

Class	Diameter (cm)
1	<5
2	5-10
3	11-15
4	16-20
5	21-25
6	26-30
7	>30

2.4 Weather Conditions for Surveys by Cumberland Ecology

This report draws upon information collected by numerous ecologists over many years, including studies done across Leard State Forest and both the Project Boundary and adjacent mining leases. Surveys have therefore been conducted in all seasons and in a wide variety of weather conditions. This means that the resultant database of ecological information is detailed and reliable.

Weather conditions during surveys by Cumberland Ecology were generally appropriate for detection of a wide variety of flora and fauna, and due to high rainfall in spring 2008 and 2010, were generally very good for flora survey.

A summary of weather conditions in the locality of the Project Boundary during the 2008 surveys is provided in **Table 2.6**. Weather conditions for the two survey periods varied from cool to hot with the daily maximum temperature varying from 21.3°C to 38.0°C. Two days saw a relatively high amount of rainfall, with most other days remaining dry.

Conditions leading up to and during the first 2008 survey period (20-29 October 2008) were generally warm and dry, although conditions became cold (3.7°C) on one of the survey evenings. Conditions leading up to the second 2008 survey period (24 November to 5 December 2008) were generally warmer. There was significant rainfall leading up to this survey, and heavy rainfall in the upper catchment during the second period of survey. This caused flooding along the Namoi Valley and minor flooding of streams in the Project Boundary during the latter survey period, making conditions optimal for conducting frog surveys.

Table 2.6 Survey Weather Conditions

Survey Weather Conditions			
Date	**°C min**	**°C max**	**Rain (mm)**
02/07/2008	2	18	0
03/07/2008	3	20	0
04/07/2008	2	21	0
20/10/2008	12.2	32.4	0
21/10/2008	14.1	30.4	0
22/10/2008	10.2	22.7	0
23/10/2008	3.7	21.3	0
24/10/2008	8	24.1	0
25/10/2008	6	28.2	0
26/10/2008	8.1	30.2	0
27/10/2008	16.9	32.4	0
28/10/2008	20.2	32.4	0
29/10/2008	19.9	34.9	0

Table 2.6 Survey Weather Conditions

Survey Weather Conditions			
Date	**°C min**	**°C max**	**Rain (mm)**
30/10/2008	25.8	33.8	0
31/10/2008	23.3	38	0
24/11/2008	11	28	0
25/11/2008	13.9	30.9	0
26/11/2008	17.9	29.3	0
27/11/2008	14.7	29.9	31.8
28/11/2008	20.5	32.8	0.6
29/11/2008	20.9	27.7	19
30/11/2008	12	26.2	0
01/12/2008	12	30.7	0
02/12/2008	18	34.1	0
03/12/2008	19.7	34.2	0
04/12/2008	16.5	34	0
05/12/2008	19.8	31.8	0
15/04/2010	10.1	27.9	0
18/05/2010	3.6	21.0	0.2
19/05/2020	6.7	21.5	0
20/05/2010	8.8	22.9	0
08/06/2010	3.3	19.5	0.2
09/06/2010	0.8	17.4	0
21/06/2010	4.1	20.2	0
22/06/2010	8.8	19.8	0
14/07/2010	11.6	16.9	14.2
15/07/2010	6.3	15.6	0.2
30/08/2010	5.5	20.6	0
31/08/2010	4.4	22.7	0
01/09/2010	11.2	23.9	0
02/09/2010	15.0	25.6	0
03/09/2010	16.0	22.9	0
04/09/2010	16.8	22.6	6.2
29/09/2010	10.1	20.5	0
30/09/2010	5.1	21.6	0
01/10/2010	7.3	23.4	0

Table 2.6 Survey Weather Conditions

Survey Weather Conditions			
Date	**°C min**	**°C max**	**Rain (mm)**
18/10/2010	4.4	23.4	0
19/10/2010	9.0	24.9	0
20/10/2010	11.5	27.2	0
21/10/2010	12.8	24.3	0
22/10/2010	11.9	26.5	0
13/12/2010	Data not available	31.1	0
14/12/2010	17.3	31.4	0
15/12/2010	16.8	33.1	0
16/12/2010	17.4	30.4	16.8
1712/2010	19.2	Not available	1.2
15/04/2010	10.1	27.9	0
18/05/2010	3.6	21.0	0.2

2.5 Survey Limitations

Adequate ecological data exists for the assessment of the ecological impacts for the Project. There are no significant limiations to the data available.

The flora and fauna of the Leard State Forest and immediate surrounds have been subject to a series of surveys over many years. Consequently, the ecology of the Project Boundary and indeed the flora and fauna of the locality is well known. There is an excellent baseline of flora and fauna data, including vegetation mapping, and information about individual species.

Recently, during the preparation of this report, Parsons Brinckerhoff published an Environmental Assessment Report (EAR) for the proposed Continuation of Boggabri Coal Mine (Parsons Brinckerhoff Australia Pty Ltd, 2010). The Biodiversity Assessment that forms part of that EAR has entailed greater than or equal to the amount of flora and fauna survey work in the Boggabri Coal lease as has been completed by Cumberland Ecology within the Project Boundary (a similar sized area). The Leard State Forest is very similar in both leases, with the same flora and fauna habitats predominating. This effectively means that by reviewing and referring to the results of the Parsons Brinckerhoff EAR, Cumberland Ecology has been able to double the size of the flora and fauna database available for impact assessment purposes. The key advangages of using the recently prepared Parsons Brinckerhoff EA material are:

- The combined data sets for flora and fauna survey of Cumberland Ecology and Parsons Brinckerhoff exceed all of the requirements for targeted survey within the recent flora and fauna survey guidelines of OEH (DEC (NSW), 2004); and

- The Parsons Brinckerhoff findings for all plant communities and threatened species are very similar to the findings made by Cumberland Ecology providing verification for key findings of this EAR.

The most recent surveys built upon an existing database of flora and fauna information that included data from the 1970s, 1980s, 1990s and 2000s. Recent surveys are also available from nearby areas of the Project Boundary, including Leard State Forest and Leard State Conservation Area.

At the time of the 2008 and 2010 surveys by Cumberland Ecology, and in the months before, the weather conditions had been favourable for plant growth and reproduction. Features such as flowers and fruits required for identification of most plants to species level was available. Grasses, herbs and creepers were readily identifiable in most instances.

The assessments made of the occurrence of flora and fauna in the Project Boundary were based on the spring 2008 survey data. This has been supplemented by data collected during other surveys within and adjacent the Project Boundary the locality (land within 20 km radius of the Project Boundary) to build a comprehensive flora and fauna species list for the Project Boundary.

A range of threatened flora is known to occur in the locality. These threatened flora were not detected in the Project Boundary during the surveys to date however, the habitats that are present in the Project Boundary have potential to support the species. For this reason, where potential habitats were present, it was assumed that impacts to the species could occur, despite negative survey results.

The fauna surveys, while undertaken according to OEH guidelines (DEC (NSW), 2004) have limitation in that they are a “snapshot” investigation in time and illustrate a view of the fauna that were active during the time of the surveys. The data produced by the surveys is intended to be indicative of the types of species that could occur and not an absolute census of all flora and fauna species of the Project Boundary. Subsequent seasonal surveys and ongoing monitoring are planned to build on these “snapshots”.

The State and Commonwealth listed threatened *Lathamus discolor* (Swift Parrot) and *Polytelis swainsonii* (Superb Parrot) are relatively rare, semi-nomadic and only present in winter time. Over the years an adequate survey effort has been made for such species. Targeted surveys were made for the birds in 2009 by Parsons Brinckerhoff (Parsons Brinckerhoff Australia Pty Ltd, 2010). Other general bird surveys have been conducted in Leard State Forest during winter in past surveys (Dames & Moore, 1984, Dames & Moore, 1983a, James B. Croft & Associates, 1979). Consideration of available information, including existing database records (DECCW, 2010a) and background information on migratory habits and known breeding strongholds (Higgins, 1999, Higgins et al., 2001), have shown

that the Leard State Forest is not a major area for either species, as described in further detail in **Chapter 3**.

2.6 Surveys of Potential Offset Sites

At the time of preparing the flora and fauna assessment, it was apparent that broad areas of forest, woodland and threatened species habitat would be cleared as a result of the Project. The impacts would include:

- Areas of Box-Gum Woodland Critically Endangered Ecological Community (CEEC) (which is also potential habitat for Regent Honeyeater and Swift Parrot);
- Broad areas of non-CEEC Ironbark Forest, Dwyer's Red Gum Woodland and other vegetation types that also need offsetting;
- Potential habitat for EPBC listed fauna Regent Honeyeater, Swift Parrot, Spotted-tail Quoll, Koala as well as microchiropteran bat species; and
- Known habitat for numerous TSC listed threatened fauna species including Speckled Warbler, Brown Tree-creeper, Turquoise Parrot, Diamond Firetail.

The objectives of the offsets work therefore included:

- Acquiring options to purchase land that contains or could be regenerated to provide Box Gum Woodland;
- Acquiring options to purchase land that contains or could be regenerated to provide Ironbark Forest, Dwyer's Red Gum Woodland and other non-EEC vegetation;
- Providing land that includes habitat for all relevant threatened flora and fauna species that could be impacted by the Project;
- Providing land that contributes to an existing regional biodiversity conservation strategy;
- Obtain data on all offset lands to demonstrate that they contain suitable vegetation and other habitat, and to assist with future land management; and
- Prepare an Offsets Strategy, for inclusion in the Ecological Impact Assessment for the EAR.

For this reason, broad searches were commenced for appropriate land that could compensate for the clearance of flora and fauna habitats within the Project Boundary. Candidate properties were assessed for whether they could:

- Build onto existing conservation areas;

- Form new, or improve existing ecological corridors;
- Be like for like in terms of bioregion, topography, soils, aspect, flora and fauna and habitat values;
- Contain or link to sustainable ecological features (particularly permanent water sources);
- Build corridors between woodland areas, such as:
    - Between Leard State Forest and Leard State Conservation Area;
    - Leard State Forest west towards the Pilliga;
    - Leard State Forest east toward the Nandewar;
    - Along Back Creek, Maules Creek and the Namoi River;
- Link to rehabilitated mining areas to existing vegetation;
- Focus on current Aston land as well as land within the predicted zone of affectation; and
- Avoid land in the vicinity of other mining tenements.

The highest priorities for consideration as offsets are the closest properties with suitable vegetation to the mine lease. The highest priorities for inclusion in the offset package are along the edge and to the immediate west of the existing Mining Lease area. Their value lies in the potential to build onto the Leard State Conservation Area to enhance existing blocks of remnant vegetation in the vicinity of the Project and to secure/consolidate land around Leard State Forest.

i. Prioritised List of Properties for Investigation

Cumberland Ecology completed the following tasks to obtain a list of candidate properties for investigation to purchase:

1. Mapping of candidate habitats in the locality;
2. Overlaying potential vegetation areas with cadastral maps to show ownership (Lot and DP numbers);
3. Desktop estimation of broad areas of Box Gum Woodland and derived native grassland;
4. Prioritising a list of properties for investigation.

Once the Proponent investigated potential vendors and short listed properties for purchase, limited field studies were made to validate the vegetation.

ii. Field Studies

Cumberland Ecology has to date conducted preliminary site inspections of over 300 properties between September 2010 and May 2011, in order to develop a short list of candidate properties for further consideration. The on ground survey has therefore been limited to making notes and conducting rapid assessments of the vegetation type and condition, to enable production of a preliminary vegetation map of the candidate properties. Additional notes were made about threatened species or their habitat, key habitat features (rock outcrops, streams, etc), weed infestations, etc. This work was supplemented with a desktop review of available information of threatened species occurrences in the vicinity of each property.

More detailed survey of the offset properties that are likely to be acquired for the offset is imminent. All the data collected, subsequent analysis and discussion of the offset properties will be incorporated as baseline information in a Biodiversity Offset Management Plan (BOMP) that will be drafted to guide the improvement and management of the offset properties for conservation. Further discussion on the BOMP is made in **Chapter 6**.

iii. Biodiversity Offsets Strategy

The Biodiversity Offset Strategy is explained in **Chapter 6** of this report. It aims to describe the features of land within the offset package and to explain how the offsets address the predicted ecological impacts of the Project.

A summary of the vegetation communities and other relevant habitat elements (such as permanent streams) is provided in **Chapter 6**. An outline the rationale for purchase of each parcel of land (e.g. presence beside National Parks, values as linkages, values for supplying access to permanent water, or because of current high quality) and preliminary vegetation maps of the potential offset properties are also provided in **Chapter 6**.

Chapter 3

Results

The Project Boundary is predominantly forested by native vegetation communities. The original character of the vegetation has been greatly altered as a result of previous land uses including agricultural and forestry activities. The vegetation has also been shaped by mining exploration, and weed and feral animal invasion.

Comprehensive lists of flora and fauna recorded within the Project Boundary during the survey are provided in **Appendix B** and **Appendix C**. The majority of threatened fauna species detected are associated with the box and ironbark woodland communities of Leard State Forest. Small patches of remnant vegetation occur throughout the predominantly cleared northern portion of the Project Boundary, especially the riparian vegetation along Back Creek. This is also likely to provide valuable habitat for a range of flora and fauna species, albeit to a lesser extent than for the more extensive woodland habitats of Leard State Forest.

3.1 Vegetation Communities

The broad vegetation formations within New South Wales have been mapped and described by Keith (2004). Vegetation formations are broad classes of vegetation that include a few to many recognisable vegetation communities. Within the locality of the Project Boundary, two of the formations described by Keith predominate:

- Western Slopes Grassy Woodlands; and
- Western Slopes Dry Sclerophyll Forests.

The Western Slopes Grassy Woodlands were once dominant and widespread across the fertile soils throughout the western slopes of the Great Dividing Range. Often referred to as "grassy white box woodlands" they occur in areas with between 550 and 800 mm annual rainfall on lands below 700 m elevation. The tree canopy is generally up to 20 metres tall and tussock grasses dominate the ground stratum (Keith, 2004). Soil fertility is the most important environmental factor influencing the distribution of this vegetation formation.

The dominant trees within the various communities of the Western Slopes Grassy Woodlands formation include White Box (*Eucalyptus albens*), Kurrajong (*Brachychiton populneus*), White Cypress Pine (*Callitris glaucophylla*), Blakely's Red Gum (*E.blakelyi*), Yellow Box (*E. melliodora*) and Narrow-leaved Grey Box (*E. pillagaensis*) (Keith, 2004).

The Western Slopes Grassy Woodland formation has been extensively cleared for agriculture. This formation includes the critically endangered Box Gum Woodland and Derived Native Grassland community listed by the TSC Act and EPBC Act.

Western Slopes Dry Sclerophyll Forests occur on sandstone peneplains and granite outcrops that produce shallow, sandy, infertile soils. These soils produce a broad array of forest types. These communities generally occur between 500 and 800 mm rainfall (Keith, 2004).

The Western Slopes Dry Sclerophyll Forests are characterised by trees with straight trunks including irobark eucalypts and cypress pines 10-25 metres in height. The abundance of sclerophyll shrubs and scarcity of grasses and herbs typify this formation type and differentiate them from the grassy woodlands (Keith, 2004).

Trees that are typical of this formation within the locality of the Project Boundary include Black Cypress Pine (*Callitris endlicheri*), White Cypress Pine and Narrow-leaved Ironbark (*E. crebra*) (Keith, 2004).

The main economic value of the Western Slopes Dry Sclerophyll Forests was as a timber source and so such forests have been extensively harvested for timber and firewood (Keith, 2004). Despite this, they are relatively well conserved and well represented in conservation reserves. Such plant communities are not endangered, but they do provide habitat for threatened species, particularly threatened birds.

3.1.1 General Vegetation Associations

The vegetation within the Project Boundary is characterised by a mixture of grassy and shrubby open forests and woodland types that typify the wider landscape of the Namoi Valley. Earlier ecological studies recognised that there are three broad associations that represent the vegetation of Leard State Forest: ironbark/cypress pine forests, box woodlands and box/Belah woodlands (James B. Croft & Associates, 1979, Dames & Moore, 1985). An array of intermediate associations was described by various authors and includes a mixture of ironbark, cypress pine and box units as well as rarer pockets of scrub vegetation on outcrops containing rainforest elements such as *Ficus*, *Alphitonia*, *Alectryon* and *Atalaya* species (James B. Croft & Associates, 1979, Dames & Moore, 1985, RACAC, 2000). In broad terms, there are several associations that frequently occur within the Project Boundary:

- Ironbark/Cypress Pine (Eucalyptus crebra, E. melanophloia, Callitris glaucophylla and C. endlicheri);
- Red Gum/Ironbark (E. dwyeri and E. crebra);
- Pilliga Box/Poplar Box/Belah (E. pilligaensis, E. populnea and Casuarina cristata);
- White Box/Belah (E. albens and Casuarina cristata);
- White Box/Cypress Pine (E. albens and C. glaucophylla); and

- Yellow Box/Red Gum (E. melliodora and E. blakelyi).

The distribution of the associations is controlled largely by soil type and topography. Ironbarks and cypress pines are largely found on well-drained soils, particularly on ridges and rises, whilst the box species have an affinity with the lower-lying parts of the landscape on more fertile soil derived from colluvial wash off the sandstone hills in the Project Boundary. The presence of Belah trees (*Casuarina cristata)* typically indicates black soils derived from basalts and/or alluvium and, since much has been cleared for croplands, is commonly observed as fragmented remnant vegetation on the fringes of cropping land.

3.1.2 Vegetation Communities Recorded in the Project Boundary

There is a suite of forest and woodland units that have been mapped across the Project Boundary (**Figure 3.1**). Cultivated areas and grasslands derived from the clearing of native forests and woodlands have also been distinguished to provide an indication of the historical extent of native vegetation across the Project Boundary.

The most extensive vegetation communities within the Project Boundary are *Narrow-leaved Ironbark - White Cypress Pine shrubby open forest* and *White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest* (**Table 3.1**). The latter community conforms to the CEEC Box Gum Woodland and Derived Grasslands, which is a protected ecological community under both the EPBC Act and TSC Act. Other variants of the CEEC have been mapped but are represented by minor occurrences only. The units that conform to the CEEC Box Gum Woodland and Derived Grasslands are indicated in **Figure 3.2** and **Table 3.1** below.

Table 3.1 Vegetation Communities Within The Project Boundary

Associations	Vegetation Communities	Area (ha)
Red Gum/Ironbark forests	Dwyer's Red Gum woodland	3.59
	Dwyer's Red Gum - Ironbark woodland	159.75
	Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	1008.14
	Silver-leaved Ironbark heathy woodland	394.52
RF elements	Cliff and scree Thickets (Rainforest Species)	0.13
Riparian forests	Melaleuca riparian forest	11.44
	River Red Gum riparian woodlands and forests	11.96
	White Box - Blakely's Red Gum - Melaleuca riparian forest^	17.20
White Box, Yellow Box, Blakely's Red Gum woodlands	White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest^	766.82
	White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	261.44

Table 3.1 Vegetation Communities Within The Project Boundary

Associations	Vegetation Communities	Area (ha)
	White Box - White Cypress Pine grassy woodland^	1.30
	Yellow Box - Blakely's Red Gum grassy woodland^	25.92
Belah associations	Belah woodland	4.21
	Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland	27.22
	White Box - Wilga - Belah woodland^	34.11
Total forest and woodland		**2727.77**
Grasslands	Plains Grassland*	0.99
	Derived Native Grassland^	98.99
	Derived Native Grassland (Low Diversity - Ironbark Woodland)	11.74
	Derived Native Grassland (Low Diversity - White Box Woodland)	365.40
	Derived Native Grassland (Low Diversity - with scattered Poplar Box trees)	167.85
	Exotic grassland	63.57
Total native grasslands		**644.97**
Cultivated areas	Wheat Field (with scattered Ironbark trees)	14.22
	Wheat Field (with scattered Poplar Box trees)	32.13
	Wheat Field (with scattered White Box trees)	6.54
	Crop land on basalt soil (with scattered White Box)	61.61
TOTAL AREA		**3550.80**

^*Conforms to Box Gum Woodland and Derived Grasslands, a Critically Endangered Ecological Community protected under the Commonwealth EPBC Act and the NSW TSC Act.*

******Conforms to EPBC Act listed* Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland *and NSW TSC Act* Native vegetation on cracking clay soils of the Liverpool Plains.

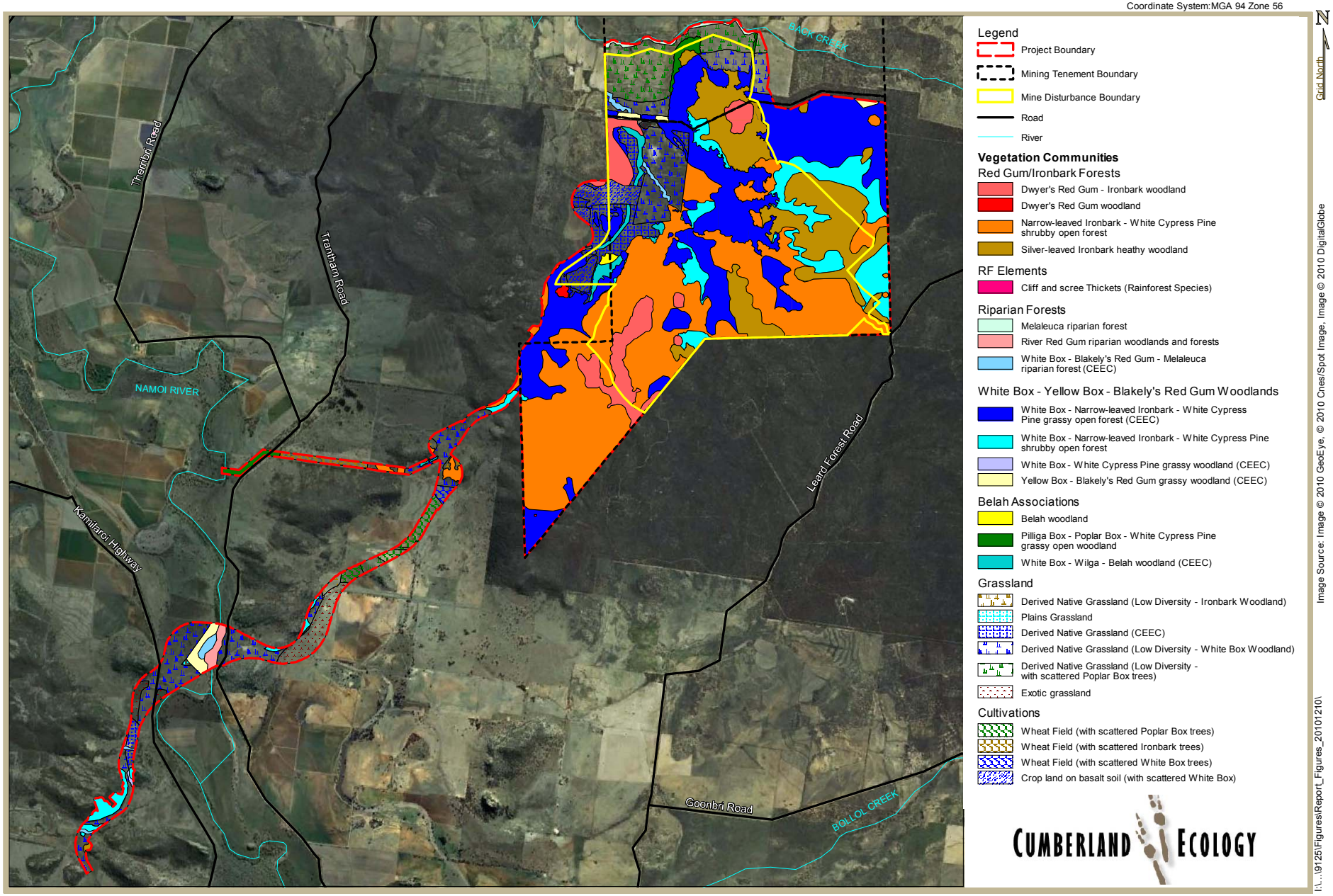

Figure 3.1 VEGETATION COMMUNITIES WITHIN THE PROJECT BOUNDARY

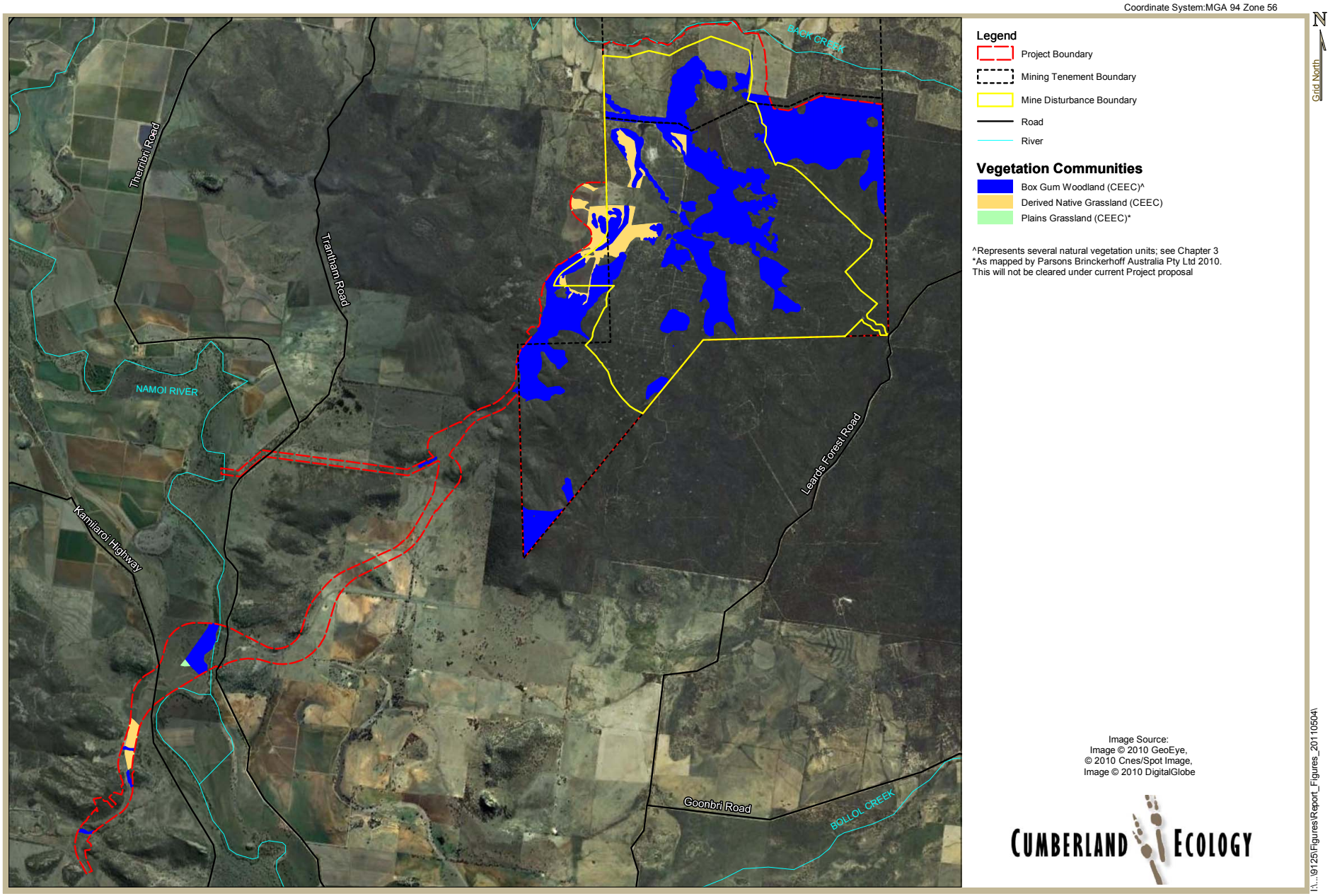

Figure 3.2 EPBC LISTED ECOLOGICAL COMMUNITIES IN THE PROJECT BOUNDARY

3.2 Vegetation Community Descriptions

3.2.1 White Box, Yellow Box, Blakely's Red Gum Woodlands and Open Forests

The White Box, Yellow Box and Blakely's Red Gum woodland/open forest (Box Gum Woodland) complex is a floristically diverse complex of communities that occupy a range of landscape positions on a gradation of semi-fertile to fertile soils. These communities are dominated by one or a combination of the following tree species: *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum).

Eucalyptus albens largely occupies gentle slopes and more elevated areas on valley floors. Generally, *Callitris glaucophylla* (White Cypress Pine) was found to co-occur with *E. albens* on alluvial flats and valley floors where there are deeper soils; whilst *E. crebra* (Narrow-leaved Ironbark) was found as a subdominant constituent on lower to mid-valley slopes with shallower soils. *Eucalyptus melliodora* and *E. blakelyi* are generally confined to low points within the landscape, including on terraced flats above creek lines and drainages.

The understorey across these communities is variable. At lower points in the landscape, the understorey is largely grassy with a sparse shrub stratum dominated by *Swainsona galegifolia* (Smooth Darling Pea), *Geijera parviflora* (Wilga) and *Dodonea viscosa* ssp. *angustifolia* (Sticky Hop-bush). At higher reliefs approaching shallower soils on ridgelines, the understorey becomes denser as it grades into ironbark open forests.

The ground stratum is generally contiguous but varies in the frequency and abundance of grassy cover over topographical and geological gradients. The ground stratum comprises a diversity of forbs such as *Eremophila debilis* (Winter Apple), *Brunoniella australis* (Blue Trumpet), *Stackhousia viminea* (Slender Stackhousia), *Calotis lappulacea* (Yellow Burr-daisy) and *Rostellularia adscendens var. adscendens*. The dominant grass species present are *Cymbopogon refractus* (Barb-wire Grass), *Dichanthium sericeum* (Silky Blue-grass), *Austrodanthonia induta* (Wallaby Grass) and *Aristida vagans* (Three-awn Speargrass); although a number of other grass species are present in low numbers.

Brief descriptions of the defining characteristics of each community are presented in the following sections.

i. White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

This community is one of the most extensive communities occurring within the Project Boundary and is recorded on mid to lower valley slopes on sedimentary or basaltic soils. In the Project Boundary, it comprises semi-mature woodlands as a result of past logging and contains few hollow-bearing or old growth trees (**Photograph 3.1**). It has a predominantly grassy understorey with localised patches of shrubs, with *Geijera parviflora*, *Notelaea microcarpa var. microcarpa* (Native Olive) and *Callitris glaucophylla* in the small tree stratum.

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

Photograph 3.1 **White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest**

ii. White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest

Status: Not listed.

This community occurs on the mid-upper slopes on skeletal soils. It is generally recorded upslope of *White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest* and grades into *Narrow-leaved Ironbark - White Cypress Pine shrubby open forest* on the ridgetops. It is marked by a dense shrub stratum of *Dodonea viscosa* ssp. *angustifolia* and/or *Beyeria viscosa* (Sticky Wallaby Bush) occurring in frequencies above 30% projective foliage cover (**Photograph 3.2**). Due to the density of the shrub cover, this community does not conform to the EPBC Act and TSC Act listings for CEEC Box Gum Woodland and Derived Grasslands (Gibbons and Boak, 2000, NSW Scientific Committee, 2004k).

Photograph 3.2 **White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest**

iii. White Box - White Cypress Pine grassy woodland

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

This grassy woodland is much less extensive than the aforementioned box communities and is largely restricted to valley floors and floodplain flats, where soils are relatively more fertile. It is dominated by *Eucalyptus albens* and supported by a sub canopy of *Callitris glaucophylla* but is conspicuous in the absence of ironbarks. It is sparsely shrubby, containing localised patches of *Geijera parviflora*, *Notelaea microcarpa var. microcarpa* and *Acacia decora.*

In the Project Boundary, it comprises semi-mature woodlands as a result of past logging and contains few hollow-bearing or old growth trees (**Photograph 3.3**).

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

Photograph 3.3 White Box - White Cypress Pine grassy woodland

iv. Yellow Box - Blakely's Red Gum grassy woodland

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

The community occurs within the Project Boundary as small, narrow pocket remnants in association with ephemeral creek lines and alluvial soils on higher points on flood plains. It is dominated by *E. melliodora*, with occasional occurrences of *E. blakelyi*, *E. albens* and *Callitris glaucophylla*. It is characterised by a low density shrub storey that is dominated by *Geijera parviflora* (Wilga). Other occasional shrub species include *Notelaea microcarpa*, *Acacia decora* (Western Golden Wattle) and *Indigofera australis* (Australian Indigo) (**Photograph 3.4**).

Occurrences of this community are generally in moderate to good condition with a high proportion of native plant species and few weeds. However, it has been fragmented and occurs as patches or corridors. The canopy has been logged and many trees are young, although some numbers of trees with hollows still remain.

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

Photograph 3.4 Yellow Box - Blakely's Red Gum grassy woodland

3.2.2 Red Gum/Ironbark Forests

The Red Gum/Ironbark association is a group of communities recognised for the ubiquitous occurrence of *E. crebra* or *E. melanophloia* (Silver-leaved Ironbark). These Red Gum/Ironbark communities generally occupy the upper slope to ridgetop positions within the Project Boundary on fairly skeletal, bleached soils. In broad terms, the ironbark forests are located upslope of the box woodlands and share very similar understorey floristics, differing largely in the dominant canopy species and in the openness of the mid to small tree strata. *Callitris endlicheri* (Black Cypress Pine) is the common subdominant canopy species in these ironbark forests.

The presence of a mixture of red gum species, namely *E. dwyeri* (Dwyer's Red Gum) but also *E. dealbata* (Tumbledown Red Gum) tends to phase in and out of the ironbark forests but become locally dominant where very shallow soils on large rock sheets produce grassy woodlands or occasionally mallee woodland.

i. Narrow-leaved Ironbark - White Cypress Pine shrubby open forest

Status: Not listed

This is floristically similar to *White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest* and *White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest* (**Photograph 3.5**). It was recorded on upper slopes on skeletal soils over conglomerate. Generally, the subdominant species recorded was *Callitris endlicheri*; although *E. albens* was recorded in low densities in areas such as drainage heads with locally deeper soils it was observed to be largely absent.

At points of higher relief, the community becomes very shrubby (above 35% projective foliage cover) but can be quite open and grassy on gentler grades. Common shrub species include *Acacia cheelii, Melichrus urceolatus, Canthium odoratum, Dodonea viscosa and Bursaria spinosa*.

This community does not conform to the description of CEEC Box Gum Woodland and Derived Grasslands since *E. albens* occurs as a scattered component and not as a co-dominant species.

Photograph 3.5 **Narrow-leaved Ironbark - White Cypress Pine shrubby open forest**

ii. Dwyer's Red Gum - Ironbark woodland

Status: Not listed

This community appears to be an intermediate between *Narrow-leaved Ironbark - White Cypress Pine shrubby open forest* and areas of *Dwyer's Red Gum woodland* and is dominated by a mixture of *E. crebra*, *E. dwyeri* (Dwyer's Red Gum) and possibly occurrences of *E. dealbata* (Tumbledown Red Gum). The red gum species were recorded in variable densities in open woodland areas on fairly skeletal soils (**Photograph 3.6**).

The small tree stratum ranges from scattered individuals or localised groups of *Acacia cheelii*, *Brachychiton populneus* (Kurrajong) and regenerating canopy trees to dense stands of *Acacia cheelii* and *Dodenaea viscosa*. In some areas there was locally dense regeneration of *E. crebra* and scattered occurrences of *Alphitonia excelsa* (Red Ash), particularly on the volcanics along ridgetops in the south west within the Project Boundary.

Photograph 3.6 **Dwyer's Red Gum - Ironbark woodland**

iii. Dwyer's Red Gum woodland

Status: Not listed

A much localised occurrence of this grassy woodland was recorded on the upper slopes of within the Project Boundary. It was markedly distinguishable from *Dwyer's Red Gum - Ironbark woodland* by the dominance of *E. dwyeri* and the absence of any other canopy tree species. The ridgetop in this area, by nature of its gentle grade, forms a plateau on which shallow soils resulted in areas of exposed rock sheets.

iv. Silver-leaved Ironbark heathy woodland

Status: Not listed

Eucalyptus melanophloia (Silver-leaved Ironbark) woodland and open forest occurs on the steeper slopes in the eastern and northern half of the Project Boundary (**Photograph 3.7**). The understorey is contiguous with adjacent areas of *White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest* and *Narrow-leaved Ironbark - White Cypress Pine shrubby open forest*. The vegetation mapping (**Figure 3.1**) shows small remnant pockets of this community surrounded by larger areas of *E. crebra - Callitris glaucophylla* woodland and open forest and suggests that the occurrence of these two ironbark species may be mixed in many areas.

This community does not correspond to the description of Box Gum Woodland as *E. albens* does not occur as a co-dominant species. Occurrences of this community are generally in good condition with a high proportion of native plant species and few weeds. Many trees within the canopy were found to be young, although substantial numbers of trees with hollows still remain.

Photograph 3.7 Silver-leaved Ironbark heathy woodland

3.2.3 Belah Associations

i. Belah woodland

Status: Not listed

This woodland type occurs on heavier soils that are suitable for cropping and has been heavily cleared in the past. It is poorly represented in conservation reserves and of conservation significance. A patch of this community occurs on fine-textured black soil associated with basalt or quaternary alluvium geology. It is restricted to the flats and low slope areas on the western side of the Project Boundary at the fringes of existing cropping fields. As the slope increases, this community grades into *White Box - Wilga - Belah woodland*.

The main canopy species is *Casuarina cristata* (Belah). There is up to 25% cover of shrubs including *Geijera parviflora* but the distribution of shrubs is patchy (**Photograph 3.8**). The diversity of this community is generally low, with a sparse understorey of weeds and natives like *Sclerolaena birchii* (Galvanised Burr), *Einadia hastata* (Berry Saltbush), *Chondrilla juncea* (Skeleton Weed) and *Sonchus oleraceus* (Common Sowthistle). Only one grass species was recorded, *Lachnagrostis filiformis*.

Occurrences of this community are generally in poor condition with a high proportion of weeds in the ground stratum. The community has been heavily cleared for agriculture and the patches that remain are impacted by weeds, erosion and fragmentation. The canopy was found to contain many young trees, although a substantial number of trees with hollows still remain. It would have once contained a diversity of shrub and small tree species.

Photograph 3.8 Belah woodland

ii. Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland

Status: Not listed

This is a variable community that occurs as tall woodland to open forests and is co-dominated by *E.populnea* (Poplar Box) and *E. pilligaensis* (Narrow-leaved Grey Box) (**Photograph 3.9**). It is associated with alluvial flats and generally occupies similar areas as *Yellow Box - Blakely's Red Gum grassy woodland* and *White Box - White Cypress Pine grassy woodland*. It occurs within the Project Boundary and surrounds in low-lying areas, such as south of Back Creek and along the southern and south western margins of Leard State Forest (**Figure 3.1**).

On better drained red-brown soils, *Callitris glaucophylla* is usually present as a subdominant tree species along with *Geijera parviflora*. On heavy dark soils, the community exhibits a distinctive assemblage of supporting shrub and small tree species, including *Casuarina cristata*, *Allocasuarina luehmanii* (Bulloak), *Capparis mitchellii* (Native Orange), *Eremophila*

mitchelli (Budda), *Alectryon oleifolius* (Western Rosewood) and *Ventilago viminalis* (Supple Jack), which are characteristic species found on the basaltic or rich alluvial cracking clays. Occurrences of this community are generally in good condition with a high proportion of native plant species and few weeds. Many trees within the canopy were found to be young, although substantial numbers of trees with hollows still remain.

Photograph 3.9 **Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland**

iii. White Box - Wilga - Belah woodland

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

This community is found on heavy black soils on the plains and is floristically very similar to *Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland* where the latter occurs on heavy basalt soils. *Eucalyptus albens* replaces *E. populnea* and *E. pilligaensis* the canopy but is otherwise supported by the same suite of shrub and small tree species, including *Casuarina cristata*, *Geijera parviflora*, *Eremophila mitchelli*, *Alectryon oleifolius* and *Ventilago viminalis* (Supple Jack). As with other communities that occur on fertile heavy soils, this community has been extensively cleared for cultivation in the past and current occurrences consist of young trees, largely without tree hollows.

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

3.2.4 Riparian Forests

i. Melaleuca riparian forest

Status: Not listed

The riparian areas of Back Creek and its tributaries in the northern section of the Project Boundary are dominated by *Melaleuca bracteata* over a grassy understorey that is contiguous with the surrounding vegetation communities. This riparian (stream bank) vegetation occurs where the *Melaleuca* can be sustained by extra water from ephemeral flows within these creeks. The community does not appear to be sustained by groundwater and much of the understorey and ground stratum is similar to the surrounding communities that occur on the lower slopes of nearby hillsides. Field observations made by Cumberland Ecology suggest that it is probable that the dominant shrub *Melaleuca bracteata* draws water from perched water tables amid the alluvium of the dry creek systems. The root systems appear to be relatively shallow and concentrated in the top 1-2 m of soil/alluvium. For this reason it is not considered to be a groundwater dependent ecosystem that is dependent upon the groundwater system, which is located at a depth greater than 2 metres (see further discussion of potential impacts to this community in **Section 4.5.7** that deals with potential impacts to Groundwater Dependent Ecosystems).

Shrub species present include *Geijera parviflora*, *Notelaea microcarpa* and *Pimelea linifolia*, whilst common groundcover species include *Daucus glochidiatus* (Native Carrot), *Calotis lappulacea* (Yellow Burr-daisy), *Vittadinia sulcata*, *Xerochrysum viscosum* (Sticky Everlasting), *Wahlenbergia communis*, *Dichondra repens* (Kidney Weed) and *Geranium solanderi* (Native Geranium). Common grasses recorded were *Austrodanthonia racemosa* (Wallaby Grass), *Austrostipa scabra* (Speargrass), *Austrostipa verticillata* (Slender Bamboo Grass), *Cymbopogon refractus* (Barbed Wire Grass), *Bothriochloa macra* (Red-leg Grass), *Chloris truncata* (Windmill Grass), *Microlaena stipoides* (Weeping Meadow Grass) and *Poa sieberiana*.

ii. River Red Gum riparian woodlands and forests

Status: Not listed

Eucalyptus camaldulensis (River Red Gum) forms a riverine woodland on floodplains and around billabongs in association with the Namoi River. This community usually suffers from degradation due to trampling and erosion of the creek banks by livestock and hence, the understorey is largely comprised of a mixture of native and exotic sedges and rushes, pasture weeds and other exotics imported either by livestock or on the water. Very few shrubs are present in this community.

iii. White Box - Blakely's Red Gum - Melaleuca riparian forest

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

This community is very similar to *Melaleuca riparian forest* but contains *Eucalyptus albens* and occasional occurrences of *E. blakelyi* and *Callitris glaucophylla*. It is not present within Leard State Forest but was recorded as degraded woodland along a small tributary of Maules Creek to the west of the Leard State Forest. A shrub layer is absent, with a sparse small tree stratum of *Geijera parviflora.* The groundcover is predominantly grassy but is largely influenced by surrounding agricultural activities. In the Project Boundary, the groundcover was mostly native but was species-poor due to a history of cultivation on the property.

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

3.2.5 Native Grasslands

i. Plains Grassland

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

Plains Grassland is a natural grassland community that occurs on deep alluvial cracking clay-loam soils derived from basalts. The extensive black soil plains, undulating volcanic hills and alluvial floodplains of the Namoi Valley once supported large tracts of closed grasslands dominated by *Austrostipa aristiglumis* (Plains Grass) together with an array of sub-dominant grasses (*Panicum* spp., *Austrodanthonia* spp., *Dichanthium* spp., *Bothriochloa* spp. and *Chloris* spp.). As these areas are highly fertile, much of these lands have been cleared for cultivation, grazing and other agricultural activities.

An area of Plains Grassland is located next to the proposed rail transport corridor (Parsons Brinckerhoff Australia Pty Ltd, 2010) to the south west of the Project Boundary. It is currently grazed but is in moderate condition.

The community is consistent with the EEC *Native vegetation on cracking clay soils of the Liverpool Plains*, which is listed under the TSC Act. It is also consistent with the EPBC Act equivalent, *CEEC Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland.*

ii. Derived Native Grasslands

Status: Critically Endangered Ecological Community (EPBC Act)

Endangered Ecological Community (TSC Act)

Much of the native grasslands around Leard State Forest have historically been derived from the clearing of trees and shrubs to create pasture for livestock. Derived grassland (also known as secondary grassland or understorey) can remain relatively intact, but by nature, the floristic composition of these grasslands will vary according to the forest or woodland community from which it originated. The slope, aspect, soil, underlying geology and land use also heavily influences the floristic composition.

Native grasslands within the Project Boundary that were derived from the clearing of grassy communities dominated by White Box, Yellow Box, or Blakely's Red Gum were mapped and referred to as Derived Native Grasslands (**Figure 3.1**). To be identified as Derived Native Grasslands, at least 12 native forbs with one being a recognised "important" species must be present within a 0.1 ha plot (see explanation in **Appendix A**). Most occurrences of Derived Native Grassland were restricted to the fringes of extant woodland and forest vegetation; the diversity of the grassland decreased quite quickly with distance from the forest and woodland margins.

This community is consistent with the CEEC Box Gum Woodland and Derived Grasslands, which is listed under the EPBC Act and TSC Act.

iii. Low Diversity Derived Native Grasslands

Status: Not listed

Much of the native grassland within the Project Boundary is generally degraded to varying degrees across its extent by past clearing, grazing practices and exploration and mining activities. Therefore, most areas of native grasslands contain a very low diversity of native species. These are referred to as *Low Diversity Derived Native Grasslands.*

Of these grasslands, those areas that have been derived from grassy communities dominated by White Box, Yellow Box, or Blakely's Red Gum do not conform to the CEEC Box Gum Woodland and Derived Grasslands listed under the EPBC Act and TSC Act. This is because the diversity of the groundcover herb assemblage is too low to meet the condition criteria under legislated definitions of the community.

Notwithstanding this, there is an inherent value in derived native grasslands, particularly where rehabilitation objectives require the re-establishment of an ecological community. This is because it is generally recognised that re-establishing understorey is very difficult. To this end, this vegetation unit has been mapped and differentiated according to the original community from which it was derived (**Figure 3.1**).

3.2.6 Cultivations and Exotic Grasslands

The remaining vegetation within the Project Boundary comprises cultivated fields and areas of much degraded grassland dominated by exotic grass and forb species.

3.3 Flora

The Project Boundary supports vegetation containing a very high diversity of native species. Several hundred flora species have now been recorded within Leard State Forest and the surrounding landscape, many of which have been recorded consistently over a number of ecological studies (**Appendix B**).

The dominant plant families encountered in the forest have been consistently represented by the Myrtaceae, Fabaceae, Asteraceae and Poaceae families. The most common genera encountered are *Eucalyptus* and *Acacia*. Poaceae is the family represented by the highest diversity of species, although it is not strongly represented by any one genus.

The floral assemblage is typical of dry sclerophyll vegetation. The ironbarks, White Box and cypress pine species occur most frequently as is demonstrated by the vegetation mapping of the Project Boundary (**Figure 3.1**). Small trees and shrubs are more patchily distributed but are generally consistent across different areas within the Project Boundary where a shrub stratum exists. The groundcover is species diverse and variable but mainly comprises tussock grasses in low frequency as well as a diversity of herbaceous species including *Chrysocephalum* spp., *Calotis* spp. and *Brachycome* spp.

3.3.1 Threatened Flora Species

No threatened flora species were detected within the Project Boundary during survey for this ecological assessment. Furthermore, very few threatened species have been recorded in the history of survey of Leard State Forest and its surrounds (see **Table 3.7** at the end of the Chapter). Retrospective study of the flora species recorded throughout the Leard State Forest since the early 1980s have not identified any species that have been listed since the completion of these studies.

Notwithstanding this, a suite of threatened plant species are known to occur in the locality of Leard State Forest and/or in the Narrabri LGA. The land within the Project Boundary contains suitable habitat for a number of these species (**Table 3.2**), which include the following TSC Act and EPBC Act listed species: *Bertya opponens*, *Swainsona recta*, *Pultenaea setulosa*, *Dichanthium setosum* and *Digitaria porrecta* (for a full assessment of the likely of occurrence of threatened species known from the locality, see **Appendix D**). Based on current cumulative data dating back to the early 1980s, there are no known individuals or sizable populations of these species within the Project Boundary despite the availability of suitable habitat. Nevertheless, these species have been assessed against the potential Project impacts in **Chapter 4**.

Table 3.2 Threatened Plant Species That Have Suitable Habitat in the Project Boundary

Family	Scientific Name	Common Name	TSC Act	EPBC Act
Brassicaceae	*Lepidium aschersonii*	Spiny Pepper-cress	V	V
Euphorbiaceae	*Bertya opponens*	Coolabah Bertya	V	V
Fabaceae-Faboideae	*Swainsona recta*	Mountain Swainson-pea		
Fabaceae-Faboideae	*Pultenaea setulosa*		-	V
Poaceae	*Dichanthium setosum*		V	V
Poaceae	*Digitaria porrecta*	Finger Panic Grass	E	E
Rhamnaceae	*Pomaderris queenslandica*	Scant Pomaderris	E	-

Of the species listed in **Table 3.2** above, the following species have been detected in the vicinity of the Project Boundary, either in Leard State Forest or in Leard State Conservation Area. As such, they are considered highly likely to occur and are discussed below:

- *Pomaderris queenslandica* (Scant Pomaderris), a Vulnerable plant under the TSC Act, was located in the Leard State Forest in the wider study area (Parsons Brinckerhoff Australia Pty Ltd, 2010). Potential habitat for this species occurs within the Project Boundary in pockets of sheltered shrubby woodland and along creeks, but has not been located during targeted surveys within the Project Boundary. Very little is known about this species; however, the *Pomaderris* group tend to occur in low numbers in localised distributions, making populations highly susceptible to natural stochastic events and clearing.

- *Pultenaea setulosa* is a pea shrub that is listed under the Vulnerable listing (EPBC Act). This species was once considered to be restricted but is now recognised to be more widespread than previously believed (de Kok and West, 2002). This species is known in NSW from the Nandewar Range and its distribution is not known to overlap with any threatened ecological community (Threatened Species Scientific Committee, 2008b). In NSW, this species grows in sclerophyll forests on volcanic substrates (Threatened Species Scientific Committee, 2008b). The species was recorded to the south of the Project Boundary on shallow soils in shrubby woodland along drainages but also on more fertile soils in grassy woodland, and hence may tolerate a range of woodland habitats (Parsons Brinckerhoff Australia Pty Ltd, 2010).

- *Lepidium aschersonii* (Spiny Peppercress), a Vulnerable plant under both the TSC Act and EPBC Act, is known to occur in Leard State Conservation Area (OEH (NSW), 2011). The Leard State Conservation Area is proximate to but separated from the Leard State Forest (see Figure 1.2 for location of the Conservation Area). The species occurs on cracking clays in the Brigalow, in periodically wet areas like

Gilgai depressions and lake margins (Peake, 2006, NSW Scientific Committee, 2009a, Carter, 2010). Potential habitat for this species occurs within the western edge of the Project Boundary and, as it is a small plant, it could potentially occur, though it has not been located during targeted surveys within the Project Boundary.

3.3.2 Regionally Significant Species

A list of the regionally significant species relevant to the Nandewar Subregion is provided in **Table 3.3** (Briggs and Leigh, 1995). The list also includes species that are protected under the NP&W Act. Of these, two species were recorded in the Project Boundary: *Acacia decora* and *Cymbidium canaliculatum*. Whilst there is no legal requirement to take measures to protect them under the EPBC Act and TSC Act, their significance is noted in this ecological assessment.

Table 3.3 Regionally Significant Flora Species Known from the Locality

Family	Scientific Name	Common Name	ROTAP*	NP&W Act
Cyperaceae	*Eleocharis blakeana*	n/a	3RC	
Dilleniaceae	*Hibbertia kaputarensis*	Kaputar Guinea Flower	2RC-	-
Fabaceae - Faboideae	*Isotropis foliosa*	n/a	3KC-	
Fabaceae - Mimosoideae	*Acacia decora*	Western Silver Wattle	-	P13
Haloragaceae	*Gonocarpus longifolius*	n/a	3RC-	-
Lamiaceae	*Prostanthera cruciflora*	Mint Bush	2RC-t	-
Myrtaceae	*Eucalyptus elliptica*	Bendemeer White Gum	3KC-	-
Myrtaceae	*Eucalyptus nandewarica*	Mallee Red Gum	3Rca	-
Orchidaceae	*Cymbidium canaliculatum*	Tiger Orchid	-	P13
Phyllanthaceae	*Sauropus ramosissimus*	n/a	3KC-	-
Proteaceae	*Persoonia terminalis subsp. recurva*	n/a	3R	
Rhamnaceae	*Discaria pubescens*	Hairy Anchor Plant	3Rca	-
Rutaceae	*Phebalium viridiflorum*	Green Phebalium	3Rca	-
Rutaceae	*Zieria odorifera*	n/a	3RCi	
Sapindaceae	*Dodonaea rhombifolia*	Broad-leaf Hop-bush	3RCa	-
Zamiaceae	*Macrozamia stenomera*	Burrawang	2RC-	P13

ROTAP = rare or threatened Australian Plants, listed according to a system that predates the EPBC Act and TSC Act. Such plants are not legally threatened but the old list contains some species of regional interest and so they are covered in this report.

ROTAP codes:

***2** = Species with a very restricted distribution in Australia and a maximum geographic range of < 100km.*

***3** = Species range > 100 km but in small populations restricted to highly specific and localised habitats.*

***K** = Poorly Known. Suspected to belong to R or V, however field distribution information inadequate*

***R** = Rare. May be represented by large population in restricted area, or smaller populations in larger range.*

***V** = Vulnerable. Species at risk of disappearing from the wild over longer period through continued depletion.*

***C** = Symbol used to indicate species is known to be represented in a National Park or reserve*

***a** = Species considered adequately reserved with total population of more than 1000 plants.*

***i** = Species considered inadequately reserved with total population of less than 1000 plants.*

***t** = Indicates total known population of species occurs within conservation area.*

***-** = Population size is unknown*

3.4 Terrestrial Fauna

3.4.1 Fauna Habitat

Vegetation within the Project Boundary provides potential habitat for a range of native vertebrate fauna species, including amphibians, reptiles, birds, bats and arboreal and terrestrial mammals. Assessment of aerial and satellite imagery, combined with ground-truthing during the survey, indicates that the vegetation within the Project Boundary only provides a "stepping stone" corridor for a range of highly mobile species, particularly birds and bats. Historical disturbance and surrounding agricultural development have resulted in the relative isolation of the Leard State Forest from other similar forest or woodland habitats. Riparian vegetation along Back Creek may provide some additional corridor values, particularly for Koalas and other arboreal mammals.

Key habitat features recorded during the current study included:

- Wetland and riparian environments suitable for fauna species dependant on these habitats such as wetland birds, some frogs and reptiles;
- Ground cover, leaf litter, fallen timber and rocky outcrops suitable as shelter for small terrestrial fauna species;
- Understorey vegetation, which provides shelter for small mammals and woodland birds;
- Tree hollows suitable as shelter and breeding habitat for a range of hollow-dependant fauna;
- Blossom-producing trees suitable as forage for a range of nectarivores;
- Secondary Koala feed tree species; and

- Caves, culverts and other suitable shelter or breeding habitat for a range of cave-dependant fauna.

i. Wetland and Riparian Environments

Naturally occurring wetlands and permanent streams are largely absent within the Project Boundary. The construction of a dam has created a permanent water source, particularly valuable as a source of drinking water for birds and mammals. The water dam does not support significant amounts of aquatic or riparian vegetation and is therefore unlikely to provide suitable habitat for most wetland-dependant species. The water dam does however provide suitable habitat for amphibian species. The water contained within the dam provides a drinking source for terrestrial and flying mammals, birds and reptiles.

The Project Boundary is located within the Namoi Catchment and the Namoi River is a major aquatic habitat within the locality. It is a lowland river, typical of those of the Murray-Darling Basin and is one of the primary rivers of the Murray Darling system. It is characterised by having a meandering channel and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplain areas.

The complex Namoi River morphology supports many aquatic and semi-aquatic habitats that play an important role in the life cycles of plants, terrestrial vertebrates (particularly waterbirds, bats, reptiles and amphibians), fish and aquatic invertebrates.

The Namoi River is included within a recently listed endangered ecological community (EEC) known as “Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River”. The listing specifically mentions the Namoi River from the junction of the Manilla River at Manilla.

The Project will occur predominantly in areas located away from the Namoi River and its floodplain, so will have limited potential to impact the EEC. However, the Project holds the relevant licences under the *Water Management Act 2000* to construct a pump station and to extract water from the Namoi River. The location of the pump and pipeline on the Namoi River floodplain and the impacts of water extraction are discussed within **Section 4.5**.

ii. Bush Rock, Stags and Fallen Logs

Significant amounts of bush rock are located in the Project Boundary, and similar distribution continued throughout the locality. Scattered rock outcrops also occur in the wider area, although no significant outcrops were located in the Project Boundary. Fallen timber and woody debris were moderately abundant in the Leard State Forest. This is typical of box eucalypts that readily drop their limbs. Further historical thinning activities by Forestry provide additional timber. Fallen timber is an important feature for many woodland birds, particularly Brown Treecreeper (*Climacteris picumnus*) and Specked Warbler (*Pyrrholaemus saggitatus*). Fallen logs, leaf litter and ground vegetation provide habitat features that would provide shelter for many of the small to medium sized terrestrial fauna species known from the locality.

iii. Understorey Vegetation

Many native woodland bird species are strongly associated with shrub and tall tussock grass understorey. Understorey vegetation (and thus woodland structural complexity) provides nesting sites, refuge from predators and food (McIntyre et al., 2002). The vegetation in the Project Boundary features a diverse and complex understorey structure, containing native groundcover tussock grasses like Kangaroo Grass (*Themeda australis*) and spear grasses (*Austrostipa* spp.) and localised areas of shrubby understorey largely represented by hop bushes (*Dodonaea* spp.), daisy-bushes (*Olearia* spp.) and cassinias (*Cassinia* spp.). The overstorey structure is also complex as the canopy is supported by small trees and mixed aged stands of regenerated trees.

iv. Tree Hollows

Tree hollows are an essential resource for a number of fauna species that rely on them for refuge and nesting (Newton, 1994, Gibbons and Lindenmayer, 2002, Heinsohn et al., 2003, Cockle et al., 2008). Tree hollows of various size classes were counted at each of the 81 sites used for conducting the koala survey. The plots were 1000 square metres in size (one tenth of a hectare) and provided detailed and reliable data on the abundance of hollows per tree species and per size class of hollow, as well as the average total hollows per ha. The data is summarised in **Table 3.4** below based upon average values from the 81 plots, multiplied by 10 to give values per ha.

Over 100 hollows per ha were found to occur within the Project Boundary. White Box woodland communities in the Project Boundary provide an abundance and diversity of tree hollows for fauna species that are dependant on this resource as shelter and breeding habitat. In comparison, the Ironbark and Cypress dominated communities within the Project Boundary support relatively few hollow-bearing trees. Throughout all communities where it occurs, White Box provides the majority of tree hollows available for wildlife, although it is uncertain how suitable these hollows are for specific fauna species. Since different species require different hollow characteristics for nesting or roosting (Lindenmayer et al., 1990, Gibbons et al., 2002) more extensive study beyond the scoped report would be required to estimate the actual functionality of all the hollows present for different species.

Tree hollows were largely small in size and this almost certainly reflects the history of timber harvesting that has occurred in the past.

Table 3.4 Entrance Size and Abundance of Tree Hollows Within the Project Boundary, Averaged From 81 Sample Plots

Hollow Size Class	Tree Species	Total number of hollows within 81 Plots	Average number of hollows per hectare
<5cm	*E. albens*	302	37.28
	E. crebra	64	7.90
	Stag	86	10.62

Table 3.4 Entrance Size and Abundance of Tree Hollows Within the Project Boundary, Averaged From 81 Sample Plots

Hollow Size Class	Tree Species	Total number of hollows within 81 Plots	Average number of hollows per hectare
	Casuarina cunninghamiana	26	3.21
	E. dwyeri	1	0.12
	E. melanophloia	11	1.36
5-10cm	*E. albens*	190	23.46
	E. crebra	42	5.19
	Stag	57	7.04
	Casuarina cunninghamiana	9	1.11
	E. melanophloia	4	0.49
11-15cm	*E. albens*	73	9.01
	E. crebra	16	1.98
	Stag	16	1.98
	Casuarina cunninghamiana	2	0.25
16-20cm	*E. albens*	18	2.22
	E. crebra	5	0.62
	Stag	4	0.49
	Casuarina cunninghamiana	1	0.12
21-25cm	*E. albens*	1	0.12
	E. crebra	1	0.12
	Stag	1	0.12
26-30cm	*E. albens*	3	0.37
Total Hollows:		**933**	**115**

v. Blossum-producing Trees

Table 3.5 below indicates that summer, autumn, winter and spring flowering trees can be found in all forest and woodland communities within the Project Boundary. This demonstrates that the native vegetation within the Project Boundary can supply flowering resources most of the year but that *Eucalyptus albens* is an important species during early Autumn when other species are unlikely to be flowering.

Table 3.5 Flowering Periods for Dominant Tree Species

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eucalyptus crebra	x				x	x	x	x	x	x	x	x
Eucalyptus blakelyi								x	x	x	x	x
Eucalyptus siderophloia					x	x	x	x	x	x		
Eucalyptus dwyeri							x	x	x	x	x	
Eucalyptus camaldulensis	x	x					x	x	x	x	x	x
Eucalyptus albens			x	x	x	x						
Eucalyptus melliodora	x	x							x	x	x	x

(Source: Boland et al., 1984, Brooker and Kleinig, 1990)

vi. Koala Habitat Assessment

Habitat assessment during the current study indicated that the Project Boundary does not support the primary food tree species for the Koala (*Phascolarctos cinereus*). The site does however support a number of secondary food trees for koalas, in particular *E. albens* (White Box), *E. populnea* (Poplar Box), *E. melliodora* (Yellow Box), *E. pilligaensis* (Narrow-leaved Grey Box), *E. blakelyi* (Blakely's Red Gum) and *E. dwyeri* (Dwyers Red Gum).

vii. Caves, culverts and other suitable shelter or breeding habitat for a range of cave-dependant fauna.

Habitat assessment during the survey indicated that the Project Boundary supports very few areas of habitat suitable for cave-dependant fauna, particularly various microchiropteran bats. The abundance of tree hollows within the Project Boundary does however provide suitable habitat for microbats.

3.4.2 Fauna Species

i. Birds

Previous and current surveys indicate that the forest/woodland communities of the Project Boundary support a high diversity of avifauna. The data from these surveys demonstrate that the fauna assemblage has been consistently dominated by avifauna over time (**Appendix C**); this is unsurprising given the extent of suitable and relatively intact habitat combined with the mobility of this fauna group.

The group itself is apparently dominated by woodland and parrot species; this could be an artefact of the relatively sedentary nature of small woodland species and the high detability of the parrot family. Notwithstanding this, the history of harvesting, regrowth and maintenance of the canopy and shrub strata by forestry within Leard State Forest (and consequently, the Project Boundary) maintains a high level of understorey complexity

suitable for many woodland bird species, including that observed within the Project Boundary in this present study.

The Project Boundary supports a suite of threatened bird species, including migratory species and more sedentary woodland species. These are discussed in further detail within **Section 3.4.3** below.

ii. Amphibians

A total of eight frog species were detected in the Project Boundary (**Appendix C**). No threatened frog species were recorded during the survey period. Based upon database information and the types of habitats available, no threatened species are considered likely to occur in the Project Boundary. The Project Boundary provides few permanent water sources for amphibians; however the network of intermittent drainage lines and temporary pools would provide suitable forage and breeding habitat for a number of amphibian species during heavy rainfall periods.

iii. Reptiles

During the current surveys a range of common reptile species were recorded from within the Project Boundary (**Appendix C**). It is likely that a number of additional common species are also likely to occur here, as the vegetation within the Project Boundary provides suitable forest and woodland habitat for reptiles known to occupy these habitats. A total of 25 reptile species were recorded in the Project Boundary, including snakes, geckos and skinks but were not recorded in high abundances. No threatened reptile species were recorded during the survey period.

iv. Mammals

Although the Project Boundary provides extensive forage, breeding and shelter habitat for a range of terrestrial and arboreal mammals, survey results indicate a relatively low abundance and diversity of this fauna group (**Appendix C**). This may be the result of historical disturbance and relative isolation from more extensive forest/woodland areas. Twenty-two mammal species were detected in the Project Boundary, which included 11 terrestrial species, two arboreal species and nine bat species.

The earlier fauna surveys by Croft and Associates (James B. Croft & Associates, 1979) detected only 16 species in total but several larger species detected in the earlier surveys were not detected in the current surveys including the Koala, which is a Vulnerable species under State legislation (see **Section v** below). Dames and Moore (1983a, 1984) detected a total of 12 mammal species during surveys.

The majority of mammals were large macropods, bats or exotic animals (foxes, cats, hares, rabbits and pigs). There are very few ground dwelling native animals known to occur and few arboreal mammals. The open nature of the understorey and the prevalence of exotic predators such as foxes, cats and pigs may have impacted the ground dwelling mammal fauna.

Bats are highly mobile and the Project Boundary provides suitable habitat for a diverse range of bat species, including a number of threatened species. These are discussed in **Section 3.4.3**.

v. Koala

Koalas occur in the Narrabri Local Government Area (Narrabri LGA) and are known to occur in the Project Boundary (James B. Croft & Associates, 1979) and the locality. The dominant trees across a high proportion of the woodland and open forest include species that are regarded as important secondary browse species for this animal, including *Eucalyptus albens* (White Box), *E. populnea* (Poplar Box), *E. melliodora* (Yellow Box), *E. pilligaensis* (Narrow-leaved Grey Box), *E. blakelyi* (Blakely's Red Gum) and *E. dwyeri* (Dwyer's Red Gum).

The NPWS Wildlife Atlas holds 344 records of koalas within the Narrabri LGA.

To adequately survey this species, the Spot Assessment Technique (SAT) was used as discussed in **Section 2.3.3ix**. Eighty one sites were assessed across the Project Boundary and no koalas were found and no signs of koala activity were found on any of the grid areas. As this species is known to occur occasionally in the Project Boundary, the results indicate that koala density is extremely low and that the occurrences of koalas most likely represent occasional transient individuals.

Within NSW legislation has been prepared to assist in the conservation of the Koala. State Environmental Planning Policy (SEPP) 44 – Koala Habitat Protection (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas (Department of Planning, 1995). Schedule 1 lists the LGAs which area covered by SEPP 44 and Schedule 2 lists the feed tree species for the Koala. The Project Boundary falls within a listed LGA (Narrabri). Two of the ten feed species listed in SEPP 44 are located within the Project Boundary.

An approved Recovery Plan for the Koala was prepared by the Department of Environment, Climate Change and Water (DECCW) (DECC (NSW), 2008b). Within this plan, management areas have been delineated across NSW. The Project Boundary falls within Koala Management Area 6: Western Slopes and Plains. The Recovery Plan lists primary, secondary and supplementary koala food tree species within each management area. The Project Boundary contains 6 of the secondary food tree species listed within Management Area 6 (*Eucalyptus albens* (White Box), *E. populnea* (Poplar Box), *E. melliodora* (Yellow Box), *E. pilligaensis* (Narrow-leaved Grey Box), *E. blakelyi* (Blakely's Red Gum) and *E. dwyeri* (Dwyers Red Gum).

The primary food tree species in this area is *Eucalyptus camaldulensis* (River Red Gum), which occurs along the Namoi River to the west of the Project Boundary, Maules Creek to the north of the Project Boundary, and along the rivers and river valleys in the locality.

The Recovery Plan also provides two systems to categorise koala habitat which are both based upon the abundance of primary and secondary food tree species. Within the first category system (Option 1), the Project Boundary is considered as secondary habitat (Class

B) as the primary food tree species is absent. According to this category, the Project Boundary is capable of supporting a viable, low density population of koalas.

Within the secondary category system (Option 2), the Project Boundary is considered as Secondary Habitat (Class A) as at least 50% of forested or woodland areas are comprised of secondary food tree species. According to this classification, the Project Boundary is considered capable of supporting a viable high-medium density koala population.

vi. Feral Fauna

Leard State Forest supports a significant feral fauna population, notably European Red Fox (*Vulpes vulpes*) and Feral Pig (*Sus scrofa*). All of the camera bait stations that were established during survey recorded European Red Fox and Feral Pig. Fox offspring were also recorded and a mob of at least 25 pigs were sighted within the Project Boundary during survey. Pigs are abundant such that regular harvesting of the Feral Pig takes place within the Leard State Forest (pers.comm. Chris Lauritzen, 2008).

Feral foxes are likely to be a key factor in the low numbers and diversity of ground-dwelling fauna the State Forest as they have long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC, 2010b). Feral pigs are also known to prey on frogs, reptiles, birds and small mammals (DEC (NSW), 2005x) as well as degrade habitat by:

- Feeding selectively on plant communities;
- Creating drainage channels in swamps;
- Eroding soil and fouling watering points with their wallowing; and
- Spreading weeds and possibly disease, such as foot and mouth disease.

3.4.3 Threatened Fauna Species

i. Detected Species

The present study detected the presence of a number of threatened species within or in close proximity of the Project Boundary, which included 16 bird species and two mammal species (**Table 3.7**). A summary of all the species recorded in this study is shown in **Figure 3.3** at the end of the Chapter. There has been an additional five bird species and five mammal species detected in Leard State Forest and surrounds since the early 1980s by other studies. A list of the threatened species that have been recorded by the current ecological assessment and by past ecological studies of the locality is provided in **Table 3.7** at the end of the Chapter.

Table 3.7 demonstrates that the threatened species known from Leard State Forest and the immediate surrounds is dominated by avifauna, reflecting the general trend in species assemblage (as discussed in **Section 3.4.2i** above). No other fauna groups are represented

in the threatened species that have been recorded in the Project Boundary, with exception of microchiropteran bats and the Koala.

Leard State Forest is a disjunct patch of forest surrounded by heavily cleared agricultural land and has probably existed in this state of isolation for many decades. It is therefore possible that this habitat has lower capabilities to support less mobile and rare species because of the few opportunities for movement between significant patches of vegetation in the locality. The consistently low species diversity and low abundance of sedentary or rare faunal species may be a reflection of this.

Of the species that have been recorded in the Project Boundary and immediate surrounds, the following species have been consistently recorded since the 1980s. They are notable for comprising predominantly woodland bird species:

- Speckled Warbler (*Chthonicola sagittata*);
- White-browed Woodswallow (*Artamus superciliosus*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);
- Diamond Firetail (*Stagonopleura guttata*);
- Rainbow Bee-eater (*Merops ornatus*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*); and
- Turquoise Parrot (*Neophema pulchella*).

ii. Potential Species

Threatened species that have not been detected but have suitable habitat within the Project Boundary or in the immediate locality are listed in **Table 3.6** below (for a full assessment of the likely of occurrence of threatened species known from the locality, see **Appendix E**). Based on current cumulative data dating back to the early 1980s, there are no known individuals or sizable populations of these species within the Project Boundary despite the availability of suitable habitat. They are therefore regarded as being unlikely to occur in the Project Boundary.

Whilst most of the threatened species recorded in the Project Boundary are represented by woodland bird species, most of the species that have not been recorded but have suitable habitat within the Project Boundary are migratory or semi-nomadic bird species such as the White-bellied Sea-eagle, Regent Honeyeater and Swift Parrot. Very few potentially occurring threatened species are represented by ground mammals, reptiles or amphibians.

Table 3.6 Threatened Species with Potential to Occur in the Project Boundary or are Relevant to the Project

Family	Scientific Name	Common Name	TSC Act	EPBC Act
Amphibians				
Myobatrichidae	*Crinia sloanei*	Sloane's Froglet	V	-
Fish				
Percichthyidae	*Maccullochella peelii peelii*	Murray Cod	-	V
Plotosidae	*Tandanus tandanus*	Eel-tailed Catfish	E2	-
Terapontidae	*Bidyanus bidyanus*	Silver Perch	V	-
Avifauna				
Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	-	M
	Hamirostra melanosternon	Black-breasted Buzzard	V	-
Ardeidae	*Ardea alba*	Great Egret	-	M
	Ardea ibis	Cattle Egret	-	M
Cacatuidae	*Calyptorhynchus banksii*	Red-tailed Black-Cockatoo	V	
Meliphagidae	*Xanthomyza phrygia*	Regent Honeyeater	E1	E,M
Meropidae	*Merops ornatus*	Rainbow Bee-eater	-	M
Petroicidae	*Petroica phoenicea*	Flame Robin	V	-
Psittacidae	*Lathamus discolor*	Swift Parrot	E1	E
Mammals				
Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V	E
Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V	-
Vespertilionidae	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V
Reptiles				
Gekkonidae	*Underwoodisaurus sphyrurus*	Border Thicktailed Gecko	V	V
Scincidae	*Anomalopus mackayi*	Five-clawed Worm-skink	E1	V

Regent Honeyeaters mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations (DEWHA, 2009a). The Regent Honeyeater is a generalist forager and key eucalypt feed trees for their species include *Eucalyptus sideroxylon* (Mugga Ironbark), *E. melliodora* (Yellow Box), *E. blakelyi* (Blakely's Red Gum), *E. albens* (White Box) and *E. robusta* (Swamp Mahogany) (DEC (NSW), 2005a1). Nests are usually built in rough-barked trees, mostly eucalypts such as ironbarks, stringybarks or River Sheoak, or sometimes in smooth or box-barked species (e.g. Blakely's Red Gum, White Box, Yellow Box) if rough-barked trees are not available (DEWHA, 2009a).

The Swift Parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, New South Wales and southern Queensland (DSEWPC, 2011). The species is known to forage in box-gum woodlands dominated by *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum), all of which have been recorded within the Project Boundary.

These migratory birds are difficult to detect outside of reliable breeding or foraging sites. Individual Swift Parrots tend to move across the landscape unpredictably but are highly detectable when present (D. Stojanovic, ANU, pers. comm., 2011). However, all of these species are known to forage within the CEEC Box Gum Woodland and have historically been known from the region, and are thus highly likely to occur in the Project Boundary from time to time. They are therefore discussed within this report as relevant species for assessment.

iii. Discussion of Key Relevant Threatened Species Groups

The following sections discuss the threatened species recorded in the Project Boundary and the above relevant species in respect to their preferred foraging and breeding habitat.

a. Blossum-dependent Birds

A suite of blossom-dependent migratory or nomadic birds occur in the treed habitats of the Project Boundary:

- Painted Honeyeater (*Grantiella picta*) (Vulnerable under the TSC Act); and
- Little Lorikeet (*Glossopsitta pusilla*) (Vulnerable under the TSC Act).

As discussed above, whilst the following species have not been detected in the Project Boundary, they have a high potential to forage within the Project Boundary and are therefore noted:

- Swift Parrot; and
- Regent Honeyeater.

b. Woodland Birds

A suite of woodland bird species listed as Vulnerable under the TSC Act has been recorded from within the Project Boundary during surveys undertaken between 1979 and the present. These are:

- Speckled Warbler (*Chthonicola sagittata*);
- White-browed Woodswallow (*Artamus superciliosus*);
- Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*);

- Diamond Firetail (*Stagonopleura guttata*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*); and
- Turquoise Parrot (*Neophema pulchella*).

The Grey-crowned Babbler and Speckled Warbler are locally abundant within the locality. Evidence of this statement is supported by the results of the recent surveys where both of these species were recorded within all parts of the Project Boundary. The Grey-crowned Babbler seems particularly well established and is regularly sighted in semi-urban environments such as rural gardens and hotel car parks.

All of the bird species listed above are dependant, to some extent, on woodland communities although some will also occur in forest communities (Varied Sittella and Scarlet Robin) or the ecotonal zone between woodland and derived native grassland (Diamond Firetail and Hooded Robin).

c. Raptors

Threatened raptors have been recorded from within, or adjacent to, the Project Boundary during surveys undertaken between 1979 and the present. Several additional raptor species were recently determined as Vulnerable under the TSC Act which have been recorded within the locality. These species are:

- Spotted Harrier (*Circus assimilis*);
- Square-tailed Kite (*Lophoictinia isura*);
- Little Eagle (*Hieraaetus morphnoides*);
- Barking Owl (*Ninox connivens*); and
- Masked Owl (*Tyto novaehollandiae*).

These raptor species occur in and around the Project Boundary. Being higher order predators, they occur in low numbers but are likely to have foraging and potentially breeding habitat within the forest and woodland within the Project Boundary.

d. Migratory Birds

A number of birds listed as migratory under the EPBC Act have potential to occur within the locality. These include:

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

- Fork-tailed Swift (*Apus pacificus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Satin Flycatcher (*Myiagra cyanoleuca*);
- Regent Honeyeater; and
- Swift Parrot.

The White-throated Needle-tail is a summer migrant that forages over the canopy of forest and woodland communities for small flying insects. This is a wide-ranging species and it is unlikely that the Project will result in the removal of any significant foraging habitat for the White-throated Needle-tail as adjacent protected areas provide a more extensive habitat.

The Satin Flycatcher is also a warm season migrant that forages and nests within forest and woodland. The Fork-tailed Swift and Rainbow Bee-eater were recorded during recent surveys. The Rainbow Bee-eater has been recorded within the Project Boundary during most of the previous surveys (see **Appendix C**). This common species migrates to the region in summer to breed in burrows constructed in sand or earth river banks. The Rainbow Bee-eater forages in open woodland and grassland habitats. These bird species utlise forest and woodland habitats and will lose foraging and/or nesting habitat as a result of the Project.

Regent Honeyeater and Swift Parrot are winter migrants that can potentially utlise the forest and woodland winter flowering trees of the study area. Neither species has been detected in the Project Boundary, but both are considered to have potential to occur. The Project will remove potential winter foraging habitat for both of these winter migrant species.

e. Microbats

Eight bat species were positively identified during the Spring 2008 survey with one other bat identified to genus. Two of the eight species are regarded as threatened, with *Saccolaimus flaviventris* (Yellow-bellied Sheathtail Bat) listed as Vulnerable under the TSC Act and *Nyctophilus timoriensis* (Greater Long-eared Bat) listed as Vulnerable under both the TSC Act and EPBC Act.

Several listed threatened species of microbats have been recorded within the Project Boundary. The threatened microbat species recorded within the Project Boundary are:

- Greater Long-eared Bat (*Nyctophilus timoriensis*) (Vulnerable under the EPBC and TSC Acts);
- Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) (Vulnerable under the TSC Act);
- Little Pied Bat (*Chalinolobus picatus*) (Vulnerable under the TSC Act);

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (Vulnerable under the TSC Act);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) (Vulnerable under the TSC Act); and
- Eastern Cave Bat (*Vespadelus troughtoni*) (Vulnerable under the TSC Act)

The Greater Long-eared Bat, Yellow-bellied Sheathtail Bat and Eastern False Pipistrelle are tree roosting bats and all forage in or around the canopies of forest and woodland trees. All of these bats will have habitat removed as part of the Project.

The Little Pied Bat roosts in trees, caves, mines and a varietyof other locations. It forages in forest and woodland and would be impacted by the clearance of forest and woodland witin the Project Boundary.

The Eastern Bentwing-bats and the Eastern Cave Bat are predominantly cave-roosting species, although bentwing-bat species have also been known to roost in mine shafts, culverts, roof cavities and other artificial structures. As both the Eastern Cave Bat and Eastern Bentwing-bats are predominantly cave-dependant species it is unlikely that the area within the Project Boundary would provide suitable roosting habitat for these species. It is likely that they only frequent the area while foraging at night, and would return to roost sites outside of the Project Boundary each morning.

Table 3.7 Threatened and Migratory Species Recorded in Leard State Forest and Surrounds

Family	Scientific Name	Common Name	Status		Study Detected					
			TSC	EPBC	C&A	D&M	PB	ELA	CE	OEH
Aves										
Acanthizidae	*Pyrrholaemus saggitatus*	Speckled Warbler	V		X	X	X	X	X	X
Accipitridae	*Circus assimilis*	Spotted Harrier	V				X		X	
	Hieraaetus morphnoides	Little Eagle	V		X		X			
	Lophoictinia isura	Square-tailed Kite	V						X	
Apodidae	*Apus pacificus*	Fork-tailed Swift		M	X				X	
	Hirundapus caudacutus	White-throated Needletail		M	X		X			
Artamidae	*Artamus superciliosus*	White-browed Woodswallow	V		X		X		X	
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E				X			
Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper	V		X	X	X	X	X	X
Estrildidae	*Stagonopleura guttata*	Diamond Firetail	V		X	X	X		X	
Meliphagidae	*Grantiella picta*	Painted Honeyeater	V						X	
	Melithreptus gularis gularis	Black-chinned Honeyeater	V				X			
Meropidae	*Merops ornatus*	Rainbow Bee-eater		M	X	X	X		X	
Monarchidae	*Myiagra cyanoleuca*	Satin Flycatcher		M			X			
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V		X	X	X		X	
Petroicidae	*Melanodryas cucullata*	Hooded Robin	V		X		X		X	
Pomatostomidae	*Pomatostomus temporalis*	Grey-crowned Babbler	V		X	X	X		X	
Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V		X		X		X	X

Table 3.7 Threatened and Migratory Species Recorded in Leard State Forest and Surrounds

Family	Scientific Name	Common Name	Status		Study Detected					
			TSC	EPBC	C&A	D&M	PB	ELA	CE	OEH
	Neophema pulchella	Turquoise Parrot	V		X	X	X	X	X	X
Strigidae	*Ninox connivens*	Barking Owl	V		X		X		X	
Tytonidae	*Tyto novaehollandiae*	Masked Owl	V				X		X	
Mammalia										
Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail Bat	V				X		X	X
Phascolarctidae	*Phascolarctos cinereus*	Koala	V		X		X			
Vespertilionidae	*Chalinolobus picatus*	Little Pied Bat	V				X			
	Falsistrellus tasmaniensis	Eastern False Pipistrelle	V				X			
	Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V				X			
	Nyctophilus timoriensis	Greater Long-eared Bat	V	V	X				X	X
	Vespadelus troughtoni	Eastern Cave Bat	V				X			
Plants										
Brassicaceae	*Lepidium aschersonii*	Spiny Pepper-cress	V	V						X
Fabaceae (Faboideae)	*Pultenaea setulosa*			V			X			
Rhamnaceae	*Pomaderris queenslandica*	Scant Pomaderris	E				X			

Notes: C&A: Croft and Associates (1979); D&M: Dames and Moore (1983-1984); CE: Cumberland Ecology (2010) - surveys conducted in 2008 and 2010; PB: Parsons Brinckerhoff (2010); ELA: Eco Logical (2009); OEH (2011) - surveys conducted in 2007 and 2001 for the Leard State Conservation Area. For ELA - results are not the full species list; fauna results are from an opportunistic fauna species list from 2 days of sampling in 2009

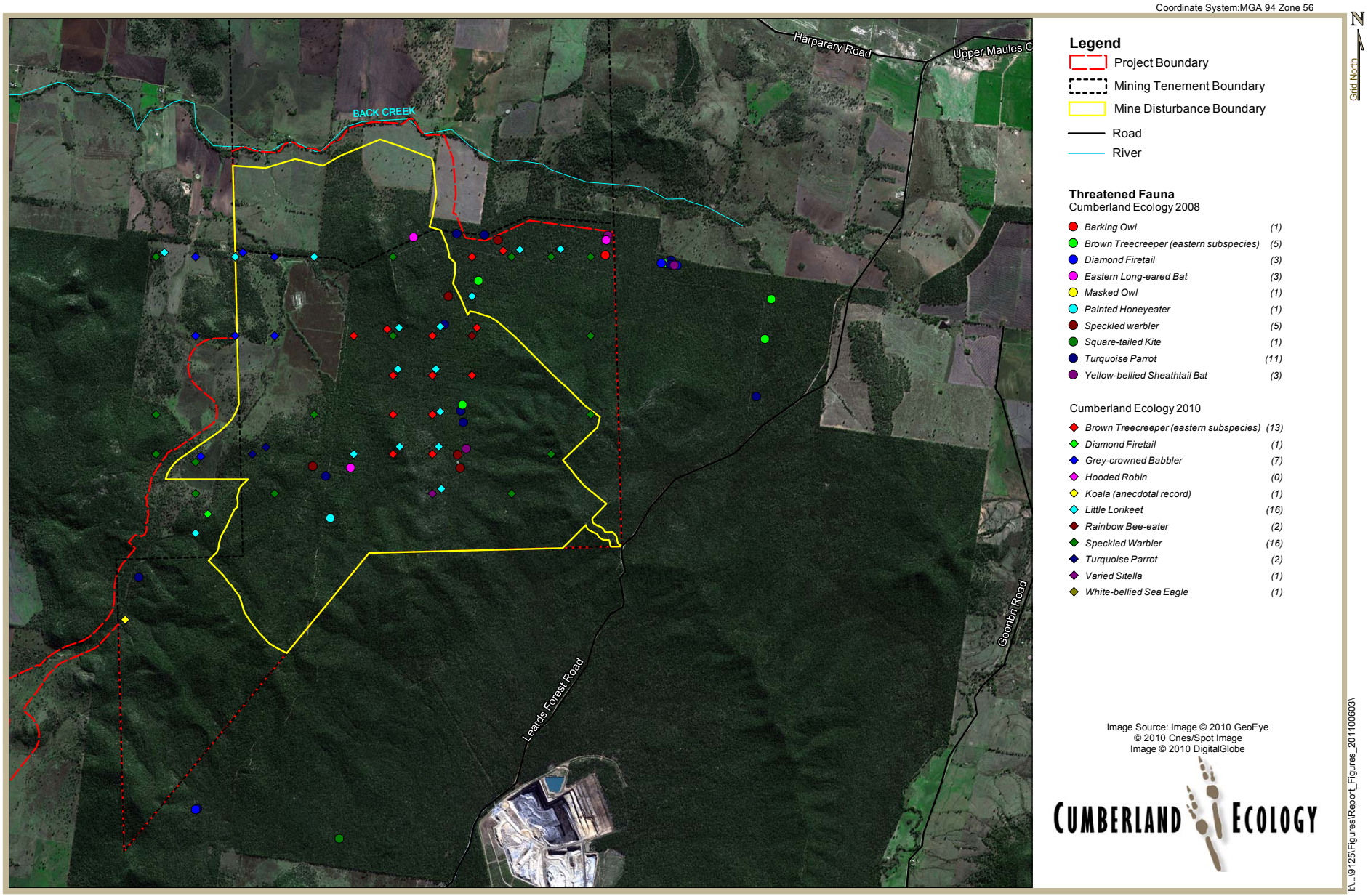

Figure 3.3 THREATENED FAUNA SPECIES RECORDED WITHIN THE PROJECT BOUNDARY (CUMBERLAND ECOLOGY 2008, 2010)

Chapter 4

Impact Assessment

This Chapter considers the ecological impacts of the Project on the biodiversity values of the Project Boundary. The draft Part 3A guidelines (DEC and DPI, 2005) identify the following key thresholds for consideration when assessing the impacts of development proposals:

- *Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values;*
- *Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;*
- *Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and*
- *Whether or not the proposal will adversely affect critical habitat.*

The ecological impacts of the Project are largely related to direct habitat loss and future degradation of the remaining habitat. Habitat loss will be primarily represented by the removal of native and semi-natural vegetation but impacts to other forms of habitat are considered in this Chapter. For instance, the consideration of impacts to habitat will also include potential future impacts on the Namoi River during the development and operation of the Project.

The nature of the impacts on habitat for threatened species is highly likely to be similar for both threatened flora and fauna assemblages relevant to the Project. This is because a large area of forest and woodland will be removed that provide significant habitat for both native flora and fauna species. Although the original character of the vegetation within the Project Boundary has been greatly altered, most areas of forest and woodland are still largely intact and have been shown to support a high diversity of native flora and fauna, as well as threatened ecological communities. Secondary impacts due to indirect effects of vegetation and habitat disturbance are also relevant to the Project and are discussed in greater detail within this Chapter.

Additionally, discussions are provided about how the impacts from the Project will add to the cumulative impacts to flora and fauna within the locality, the duration and timing of impacts, and the permanence and reversibility of impacts.

4.1 Loss of Vegetation and Habitat

The largest direct impact of the Project is the removal of habitat for flora, fauna and ecological communities. Although there are different types of flora and fauna habitat within the Project Boundary such as natural and semi-natural vegetation, rock outcrops and minor areas of ephemeral streams or gullies, the most extensive habitat is represented by vegetation.

A total of approximately 1664.8 ha of forest and woodland habitat will be removed by the Project, comprising a suite of communities as shown in **Table 4.1** and **Figure 4.1** below. The vegetation communities that would be most significantly impacted by the Project include Red Gum/Ironbark Forests; White Box, Yellow Box, Blakely's Red Gum Woodlands; and various types of grasslands (**Table 4.1**). The majority of the vegetation to be cleared will be from within the relatively intact areas of forest and woodland within the north western portion of Leard State Forest. However other patches of vegetation to be cleared occur along Back Creek and in patches along the rail corridor.

In addition to the direct removal of these native vegetation communities, the Project will also indirectly impact vegetation that will remain by additional fragmentation and isolation (see **Section 4.3** below). Remnant vegetation is already fragmented within the Project Boundary; however the proposed development has potential to increase the level of fragmentation and isolation of forested areas. An offset strategy has been developed to address and counter such predicted impacts. These are discussed in **Chapter 5**.

4.1.1 Threatened Ecological Communities

i. Box Gum Woodland and Derived Grasslands

Under the mine plan proposed for the Project, a total of 458 ha of woodland and 86 ha of derived native grasslands conforming to Box Gum Woodland and Derived Grasslands will be removed (**Table 4.2**). There is an additional 210 ha of low diversity native grassland derived from the clearing of White Box trees (i.e. Derived Native Grassland: Low diversity – White Box Woodland; see **Table 4.2**) that will be cleared as a result of the Project. This area of grassland was identified to be species-poor and as such does not meet the condition criteria in the EPBC Conservation Listing for Box Gum Woodland to be listed (DEH, 2006).

Low diversity grasslands notwithstanding, the removal of significant areas of Box Gum Woodland and Derived Grasslands amounting to 458 woodland and 86 ha of derived native grassland will constitute a potentially significant loss of the community from the locality. This impact is compounded by the fact that additional removal of Box Gum Woodland and Derived Grasslands within the locality of the Project is highly likely, with various other mine extension proposals recently submitted for development approval (see Section 4.8 ELA, 2010, Parsons Brinckerhoff Australia Pty Ltd, 2010).

Box Gum Woodland and Derived Grasslands has suffered a large decline in the past and remaining remnants (an estimated 405000 hectares, NSW DECCW, 2010) are recognised to be under continued threat from further land clearing due to ongoing land use for agriculture, horticulture, urban expansion and public infrastructure (NSW DECCW, 2010). Furthermore,

as remnant patches become more fragmented and isolated, they become even less resilient to damaging forces and will require active management to counter the effects of continued degradation. Since the CEEC remains poorly represented in the national conservation reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants are critical to the recovery of the CEEC and thus the the Key Threatening Processes "*Clearing of native vegetation*" (TSC Act) and "*Land Clearance*" (EPBC Act) have been named as the most prevalent threats to this community (NSW DECCW, 2010).

As a consequence of the decline of this community, many flora and fauna species occurring within this community are now listed as threatened under State and/or Commonwealth legislation. A list of the threatened species that may occur in Box Gum Woodland and Derived Grasslands is provided in **Appendix H**. Recovery of the ecological community can be expected to directly benefit the recovery of these species (NSW DECCW, 2010).

The estimated total of 544 ha of Box Gum Woodland and Derived Grasslands to be cleared is a generous estimate of impact based upon measurement of the concept plan that entails buffers around some proposed infrastructure. The proponent has committed to aim to avoid impacts on Box Gum Woodland during the final design where ever possible. The actual direct impact on Box Gum Woodland is therefore expected to be lower than this figure.

ii. Plains Grassland

The 0.99 ha of Plains Grassland identified within the Project rail corridor is part of a larger area of Plains Grassland that was mapped by Parsons Brinckerhoff Australia Pty Ltd (2010). This area of Plains Grassland will not be removed by the Project and thus the direct impact to this community is expected to be minimal.

Table 4.1 Summary of Direct Vegetation Loss Within the Project Boundary

Associations	Vegetation Communities	Area within Project Boundary (ha)	Area to be cleared (ha)	Proportion to be cleared (%)
Red Gum/Ironbark forests	Dwyer's Red Gum woodland	3.59	0.05	1.39%
	Dwyer's Red Gum - Ironbark woodland	159.75	123.56	77.34%
	Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	1008.14	594.83	59.00%
	Silver-leaved Ironbark heathy woodland	394.52	334.52	84.79%
RF elements	Cliff and scree Thickets (Rainforest Species)	0.13	0	0.00%
Riparian forests	Melaleuca riparian forest	11.44	0	0.00%
	River Red Gum riparian woodlands and forests	11.96	1.57	13.13%
	White Box - Blakely's Red Gum - Melaleuca riparian forest	17.20	10.12	58.84%
White Box, Yellow Box, Blakely's Red Gum woodlands	White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest	766.82	406.97	53.07%
	White Box - Narrow-leaved Ironbark - White Cypress Pine shrubby open forest	261.44	136.43	52.19%
	White Box - White Cypress Pine grassy woodland	1.30	0.80	61.54%
	Yellow Box - Blakely's Red Gum grassy woodland	25.92	8.64	33.33%
Belah associations	Belah woodland	4.21	4.21	100.00%
	Pilliga Box - Poplar Box - White Cypress Pine grassy open woodland	27.22	11.69	42.95%
	White Box - Wilga - Belah woodland	34.11	31.46	92.23%
Total forest and woodland		**2727.75**	**1664.85**	**61.03%**
Grasslands	Plains Grassland	0.99	0	0.00%

Table 4.1 Summary of Direct Vegetation Loss Within the Project Boundary

Associations	Vegetation Communities	Area within Project Boundary (ha)	Area to be cleared (ha)	Proportion to be cleared (%)
	Derived Native Grassland	98.99	86.48	87.36%
	Derived Native Grassland (Low Diversity - Ironbark Woodland)	11.74	3.74	31.86%
	Derived Native Grassland (Low Diversity - White Box Woodland)	365.40	210.89	57.71%
	Derived Native Grassland (Low Diversity - with scattered Poplar Box trees)	167.85	112.67	67.15%
Sub Total native grasslands		**644.97**	**413.78**	**64.16%**
Cultivated/Exotic areas	Wheat Field (with scattered Ironbark trees)	14.22	1.52	10.69%
	Wheat Field (with scattered Poplar Box trees)	32.13	16.50	51.35%
	Wheat Field (with scattered White Box trees)	6.54	2.45	37.56%
	Crop land on basalt soil (with scattered White Box)	61.61	53.83	87.38%
	Exotic grassland	63.57	24.51	38.56%
Subtotal Cultivated Areas		**178.07**	**98.81**	**55.50%**
TOTAL AREA/PROPORTION		**3550.79**	**2177.44**	**75.07%**

Table 4.2 Summary of Direct Loss of Critically Endangered Box Gum Woodland and Derived Grasslands Within the Project Boundary

Associations	Vegetation Communities	Area within Project Boundary (ha)	Area to be cleared (ha)	Proportion to be cleared (%)
Riparian forests	White Box - Blakely's Red Gum - Melaleuca riparian forest	17.20	10.12	58.84%
White Box, Yellow Box, Blakely's Red Gum woodlands	White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest	766.82	406.97	53.07%
	White Box - White Cypress Pine grassy woodland	1.30	0.80	61.78%
	Yellow Box - Blakely's Red Gum grassy woodland	25.92	8.64	33.34%
Belah associations	White Box - Wilga - Belah woodland	34.11	31.46	92.23%
Total forest and woodland		**845.35**	**457.99**	**54.18%**
Grasslands	Plains Grassland	0.99	0.00	0.00%
	Derived Native Grassland	98.99	86.48	87.36%
Total native grasslands		**99.98**	**86.48**	**86.49%**
TOTAL AREA		**945.33**	**544.47**	**57.60%**

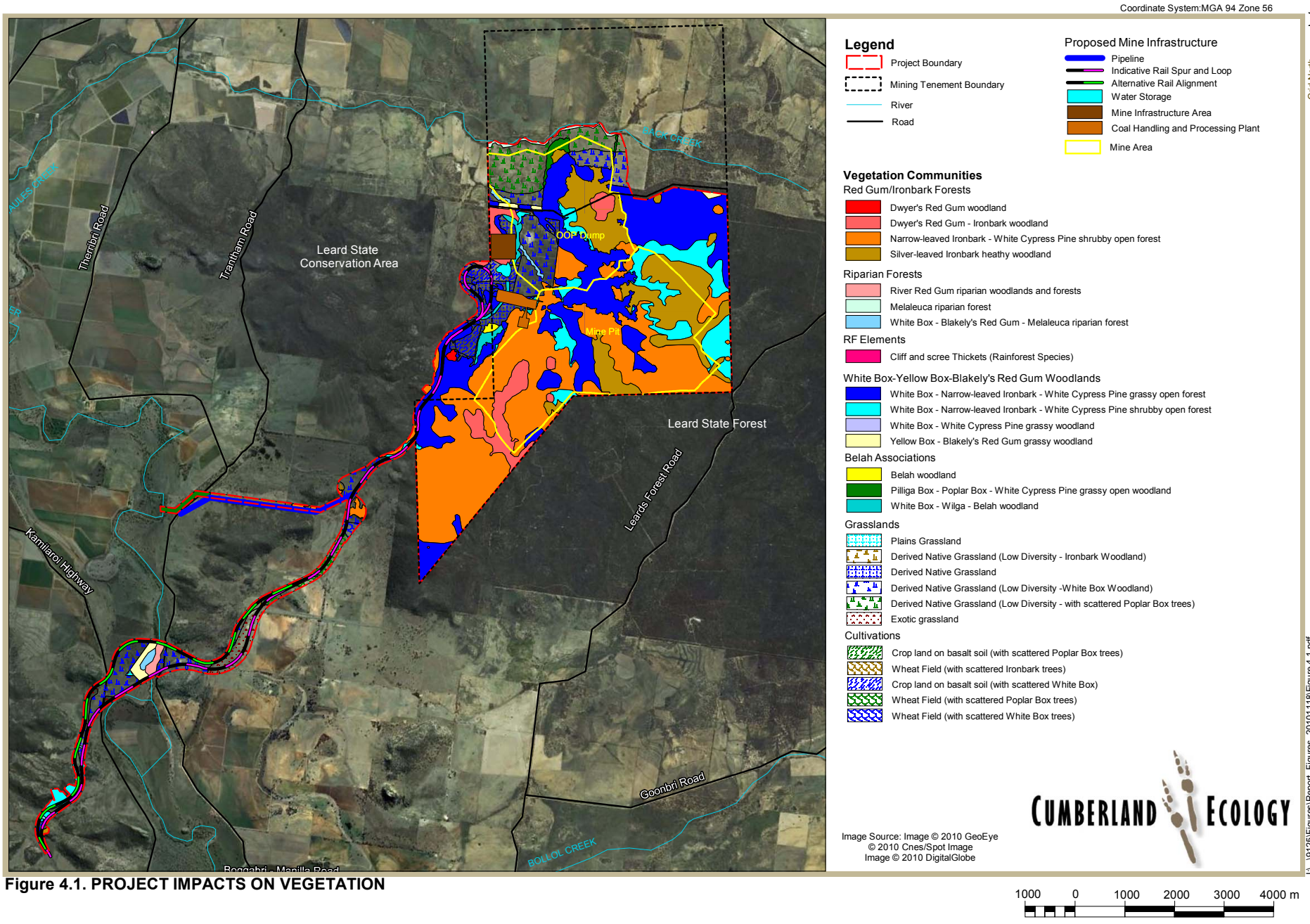

Figure 4.1. PROJECT IMPACTS ON VEGETATION

4.2 Loss of Important Habitat Features

The open forest, woodland and derived grassland communities of the Project Boundary provide habitat for a range of fauna; including some species that are listed as threatened or migratory under the EPBC Act and/or the TSC Act. Within these vegetation communities, a range of habitat features provide foraging, shelter and breeding opportunities for fauna. The quality of habitat is dependent upon location and is very dependent upon past land use. Regrowth areas generally lack many habitat features but areas of good quality habitat were identified at several locations. Important fauna habitat features that will be removed by the Project are:

- Dense understorey vegetation – shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- Fallen logs, debris and leaf litter – shelter habitat for amphibians, reptiles and terrestrial mammals;
- Rocky outcrops – shelter and breeding habitat for amphibians, reptiles and terrestrial mammals;
- Hollow-bearing living trees and stags – providing shelter and breeding habitat for a range of reptiles, birds, arboreal mammals and microbats;
- Nectar-producing trees and shrubs – foraging habitat for insects, blossom-dependant birds, arboreal mammals and megachiropteran bats (flying-foxes);
- Feed trees, shrubs and grasses for a range of species – food for small birds, cockatoos and herbivorous mammals;
- Ecotonal (edge) communities – foraging habitat for many species, particularly birds;
- Ephemeral drainage lines - foraging, shelter and breeding habitat for amphibians, aquatic reptiles, wetland birds and aquatic mammals; and
- Constructed farm dams with aquatic vegetation - foraging and breeding habitat for amphibians, aquatic reptiles and wetland birds.

The impact of mining on fauna habitat results in the clearance of vegetation and removal of fauna habitat features. This process results in numerous actions considered to be Key Threatening Processes by OEH such as the Clearing of Native Vegetation (NSW Scientific Committee, 2004c), Loss of Hollow-bearing Trees (NSW Scientific Committee, 2006a), Removal of Dead Wood and Dead Trees (NSW Scientific Committee, 2004i) Bushrock Removal (NSW Scientific Committee, 2004b) and the Alteration to the Natural Flow Regimes of Rivers, Streams, Floodplains and Wetlands (NSW Scientific Committee, 2004a).

4.2.1 Loss of Tree Hollows

Tree hollows are an essential resource for a number of fauna species that rely on them for refuge and nesting (Cockle et al., 2010, Newton, 1994, Heinsohn et al., 2003, Gibbons and Lindenmayer, 2002). Tree hollows have been shown to be a key limiting resource for hollow-dependent fauna (Lindenmayer et al., 1990, Newton, 1994, Heinsohn et al., 2003, Gibbons and Lindenmayer, 2002, Brawn and Balda, 1988, Cameron, 2006, Gibbons et al., 2002), especially when we consider that the processes of natural decay and primary excavation that produce hollows are time-consuming and energy costly (Aitken and Martin, 2007, Aitken and Martin, 2008, Marsden and Pilgrim, 2003, Murphy and Legge, 2007). Furthermore, many hollow-dependent species such as the Swift Parrot (*Lathamus discolor*) are hollow specialists (as opposed to hollow generalists) and will only occupy hollows with specific hollow characteristics (Gibbons et al., 2002); this means that many of the available number of hollows in an area of habitat is unlikely to be usable or 'functional', which increases the demand on the remaining suitable hollows.

In spite of the history of logging and gathering of timber for firewood within Leard State Forest, many trees remaining within the forest have hollows; particularly within the Box Gum Woodland and Riparian vegetation communities (see **Section 3.4.1iv**). Of these, it is possible that only a small proportion of available hollows are likely to be functional (Cockle et al., 2008) and so the importance of this limited resource in the Project Boundary is likely to be quite high.

Much of this resource will be lost in the short term and medium term from within the footprint of the Project Boundary. Furthermore, fragmentation and edge effects will have consequences for the integrity of the remaining hollow-bearing forest (e.g. susceptibility to windblow). The loss of tree hollows will have important implications for threatened species such as bats, owls and some diurnal birds, as discussed below.

The recommended mitigation and offset measures to minimise adverse impacts resulting from the mining process are described in detail in **Chapter 5**.

4.3 Impacts on Remaining Vegetation / Habitat

The direct impacts of the Project on flora, fauna and vegetation communities are mostly related to the removal of native vegetation which provides direct habitat for a wide diversity of species (see preceding sections). However, the Project will also have indirect impacts on the ecological values of the Project Boundary, including fragmentation, noise, dust, and erosion. These indirect impacts of the Project are considered in more detail below.

4.3.1 Habitat Fragmentation

One of the major impacts of the Project on flora and fauna will be habitat fragmentation. Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non forest land (Lindenmayer, 2006, Primack, 1993, Fahrig, 2003). The resultant divided habitat is often artificial and

inhospitable to the species remaining within the fragments (Bennett A.F, 1990, Reid, 1999).

Habitat fragmentation can:

- Reduce the total area of available habitat;
- Increase the relative length of edge to interior habitat;
- Decrease the amount of interior habitat;
- Isolation one habitat fragment from other areas of habitat; and
- Decrease the average size of each patch of habitat.

Habitat fragmentation affects biodiversity by reducing the amount of available habitat for some species as it involves some habitat loss. Plants and other sessile organisms are usually directly destroyed, while mobile animals (especially birds and mammals) retreat into sufficiently large remnant patches of habitat (Lindenmayer, 2006). The displacement of mobile fauna can be serious in the case where there are limited areas of sufficiently large habitat within dispersal distance to retreat to.

Indirectly, fragmentation can put stress on the native flora and fauna by increasing intraspecific and interspecific competition for space and resources in areas of remaining habitat.

Genetic isolation is another potential impact of habitat fragmentation (Primack, 1993). Genetic isolation occurs where individuals from a population within one fragment are unable to interbreed with individuals from populations in adjoining fragments. Genetic isolation can lead to inbreeding and genetic drift problems for populations isolated within a fragment.

Barrier effects, which occur where particular species are either unable, or are unwilling, to move between suitable areas of fragmented habitat, can be caused by fragmentation. For some species, this could result in either a complete halt to movement or a reduced level of movement between fragments. Species that are most vulnerable to barrier effects include rare species (even a small reduction in movements can reduce genetic continuity within the population, hence reducing the effective population size), smaller ground-dwelling species and species with low mobility. Species that are least vulnerable to barrier effects tend to be those that are highly mobile (e.g. birds and bats), although even these species can vary in their response to barriers (Bennett A.F, 1990).

Fragmentation of forests and woodlands increases the ratio of “edge” habitat to “interior” habitat. Consequently, species that require large areas of interior habitat may not persist in small fragments due to the large edge effects (see below). Species that can move between fragments may use more than one fragment, although species that cannot move between fragments are restricted to a single area (Andrews, 1990). Area is typically primary determinant of the number of species in a fragment, and small fragments of

habitat can only support small populations or sub-populations of plants and animals. For this reason several small, isolated forest patches will be able to maintain fewer species than a single intact forest of the same total area. Forest fragments are also especially vulnerable to fire, the invasion of weedy species, and other processes of habitat erosion associated with the increase in area of edge habitat relative to the area of interior habitat (see **Section 4.3** below).

The Project will increase fragmentation through the clearing of areas of forest and woodland, particularly within the mine disturbance area. The threatened species found in the Project Boundary are mainly highly mobile birds and bats and these have potential to move across disturbed areas. Notwithstanding this, it is thought that many threatened birds in agricultural landscapes of NSW are declining due to clearing for agriculture (Reid, 1999). It is also likely that fragmentation has impacted some threatened bat species too, although there is less information available about bats. Progressive rehabilitation of mined areas back to forest and woodland will help to address the impacts of fragmentation on native fauna, as discussed in the next Chapter.

4.3.2 Edge Effects

A consequence of habitat fragmentation is that it produces “edge effects”. Edge effects are impacts that occur at the interface between natural habitats, especially forests and disturbed or developed land (Yahner, 1988). When an edge is created between forest and a cleared area, changes to ecological processes within the vegetation can extend between 10 m and 100 m from the edge (Yahner, 1988). These include microclimatic changes in light, temperature, humidity and wind, which can favour a suite of different species and therefore cause significant changes to the ecology of the patch (Lindenmayer, 2006). These changes include; invasion by weeds, increase in feral animals, reduction in tree health, and barriers to dispersal or distribution (Yahner, 1988). Edge effects are typically more pronounced in small habitat fragments and they may extend throughout small patches, rendering them unsuitable for some species. In particular, small patches of forest and woodland habitat may be unfavourable for species which require interior habitat.

The Project will result in edge effects where forest and woodland is cleared to make way for infrastructure or mining. Due to edge effects, the footprint of the mine will extend beyond the areas that are being cleared and into areas of forest that are being retained. The edge created between farmland and mining development is not considered likely to negatively affect the ecology of the Project Boundary, it is mainly where edges are created between the Project and areas of forest that impacts will occur.

Progressive rehabilitation of mined areas back to forest and woodland will help to repair edge effects on native fauna, as discussed in the next Chapter.

4.3.3 Noise

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts that include habitat loss through avoidance,

reduced reproductive success and a retreat away from favourable habitats (AMEC Americas Limited, 2005).

Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise created by the mine, has the potential to disrupt the species relying on these calls with deleterious results including reduced reproductive success and mortality (AMEC Americas Limited, 2005).

The Project can generate significant noise during construction of infrastructure and through routine mining operations. Examples of noise can come from large volumes of traffic, particularly large mining trucks, excavation machinery, noise from explosions used during the mining phase, and the noise from generators and machinery used in the daily operation of the mine. Many fauna species are sensitive to elevated levels of noise in their environment and this has the potential to impact negatively on these species (AMEC Americas Limited, 2005).

The noise created by the construction and operation of the mine is likely to affect native species and affect the value of the habitats that remain. Some species are likely to move in response to noise, and therefore the habitat value of the forests remaining around the mining and infrastructure areas may decrease. This has the effect of increasing the amount of habitat for native species that will be removed as a result of the Project. However, it is likely that most animal species will habituate to the periodic noise disturbance (AMEC Americas Limited, 2005), and the construction and operational phases of the Project is likely to only cause temporary disturbance to fauna. Furthermore, the impacts from noise emissions are likely to be localised close to the operational pit (up to 100m) and are not likely to have a significant, long-term, impact on wildlife populations.

Noise will diminish within areas that are progressively rehabilitated and, in the long term, noise levels will return to normal following rehabilitation of the total mined area and cessation of mining.

4.3.4 Light

The Project has the potential to increase the level of artificial light in the natural environment. Increased light levels may adversely impact wildlife by direct glare, chronic or periodic increased illumination and temporary unexpected fluctuations in light levels (Saleh, 2007, Longcore, 2010).

Research into impacts from altered lighting indicates that it can trigger behavioural and physiological responses that include but are not limited to:

- Changes in foraging behaviour, such as when diurnal species begin foraging into the during night-time;
- A disruption of seasonal day length cues which trigger critical behaviours (Saleh, 2007, Longcore, 2010, Longcore and Rich, 2004);