

WATERMARK

COAL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

February 2013

M

Report on Matters of
National Environmental
Significance



WATERMARK COAL PROJECT

Report on Matters of National Environmental Significance

For:

Shenhua Watermark Coal Pty Limited

February 2013

Final



PO Box 2474, Carlingford Court 2118
www.cumberlandecology.com.au

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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.

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Executive Summary

S1 Introduction

Cumberland Ecology was commissioned by Hansen Bailey on behalf of Shenhua Watermark Coal Pty Ltd (Shenhua Watermark) to undertake an Ecological Impact Assessment (EIA) of the proposed Watermark Coal Project (the Project). The Project is a 30 year open cut coal mining operation and associated infrastructure. The EIA will form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities has determined that the Project is a “controlled action” under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This determination has been made because the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) considers that the Project will have a significant impact on Matters of National Environmental Significance (MNES), in particular an EPBC Act listed Critically Endangered Ecological Community (CEEC) White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) and EPBC Act listed migratory and threatened species. The Koala (*Phascolarctos cinereus*) was listed under the EPBC Act after the determination of the Project as a controlled action; however it has been considered within this document.

In accordance with the one-off accredited assessment process for the Project, the environmental assessment of the impacts of the controlled action must be assessed under the EP&A Act. The assessment should include enough information about the controlled action and its relevant impacts to allow the Commonwealth Minister for SEWPaC to make an informed decision whether or not to approve the controlled action under the EPBC Act.

Director-General’s Environmental Assessment Requirements (DGRs) were issued by the NSW Department of Planning and Infrastructure (DP&I) and SEWPaC for the Project. This report addresses the relevant biodiversity requirements relating to MNES outlined in the DGRs.

The purpose of this document is to provide the requisite information about the controlled action and its relevant impacts to allow the Commonwealth Minister for SEWPaC to make an informed decision whether or not to approve the controlled action under the EPBC Act.

S2 Methodology

S2.1 Surveys Within the Project Boundary

Previous flora and fauna studies have been undertaken by GHD in 2009 and were reviewed to gain an understanding of the character and key environmental attributes of the Project Boundary. Carbon Based Environmental Pty Ltd (CBE) conducts monthly environmental monitoring for Shenhua Watermark. Surface water quality data collected by CBE was used to complement the aquatic survey results, as was surface water flow data obtained from the NSW Office of Water. Rainfall records were obtained from the Australian Bureau of Meteorology. These results have been incorporated into the current survey results to provide a comprehensive assessment of the biodiversity recorded within the Project Boundary.

The environment within the Project Boundary was systematically surveyed between 2010 and 2012 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 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: vegetation mapping of all recognisable plant communities and 90 flora quadrats (20 x 50 m plots). Boundary walks, meander transects and opportunistic observations were also undertaken to maximise the detection of general, threatened and regionally significant flora species.

Field surveys for the Koala were undertaken throughout the Project Boundary, Breeza State Forest and Offset Area 6 (collectively referred to as the Survey Area). A survey of Koala activity was conducted using the Spot Assessment Technique (SAT) as described within Phillips and Callaghan (2011). Koala density surveys followed the area search method described by Phillips et al. (submitted). The results of the area searches were used to estimate the impacted population. A total of 168 sites were surveyed within the Survey Area using the SAT methodology and area search methodology. Whilst the data collected provides a good basis for calculating density and population estimates, additional surveys or further techniques could be considered to refine the estimates including strip or line transects, spotlighting searches, mark and recapture and radio-tracking.

Comprehensive terrestrial fauna surveys were conducted between 2010 and 2012 over several survey sessions to increase the seasonal range of sampling and to maximise detection. Surveys were undertaken within and surrounding the Project Boundary, including over 1,424 trap nights and over 260 person hours of fauna surveys. These surveys included: bat surveys (including echolocation recordings and harp trapping); reptile and amphibian surveys (including funnel trapping); active fauna searches (diurnal and nocturnal); bird surveys (diurnal and nocturnal); small mammal surveys (spotlighting, terrestrial and arboreal Elliott and cage trapping), fauna habitat assessment; and systematic hollow-bearing tree assessment.

Aquatic surveys were conducted using the Australian River Assessment System (AusRivAS) sampling procedures on a number of artificial water bodies within the Project Boundary. As a precautionary measure, in-situ water quality sampling was also undertaken at Lake Goran, and along the Mooki River, as these were considered significant habitats which are located in the vicinity of the Project.

Aquatic surveys involved undertaking habitat assessments, *in-situ* water quality measurements and macro-invertebrate samples to provide an indication of the current condition of the aquatic environments within and in the vicinity of the Project Boundary. The aquatic survey did not include vertebrate sampling (e.g. fish) as no major watercourses occur within the Project Boundary and the watercourses that do occur within the Project Boundary are ephemeral.

Macro-invertebrate data collected was analysed using AusRivAS and Stream Invertebrate Grade Number – Average Level (SIGNAL) Analysis. These are two macro-invertebrate scoring systems used to give an indication of the water quality at the sample collection sites.

S2.2 Surveys for Potential Offset Sites

Due to the potential impacts of the Project on the ecological values within the Project Boundary, it was apparent at the outset of the assessment that land to be used as compensatory offsets would be required to address the ecological impacts of the Project.

A high level desktop analysis of suitable areas in which to prioritise searches for candidate offset properties was completed for the Project. This analysis was guided by consideration of the local context of the Project and any potential offset areas. Six areas of land (excluding the proposed mine rehabilitation area) have been selected for inclusion within the offsets package for the Project. Of these areas of land, portions the Mt Watermark Offset Area and Offset Area 6 have been surveyed as part of the surveys undertaken within the Project Boundary. Additional surveys have been undertaken within Offset Area 6 and the Offsite Offset Areas (Clonmeen Offset Area and Aandra Offset Area). Surveys included vegetation mapping, quadrat sampling, diurnal bird surveys, Anabat detection and harp trapping.

S3 Results

The vegetation within the Project Boundary is dominated by grasslands, with smaller areas of grassy and shrubby woodland communities that are widespread in the wider landscape of the Namoi Valley.

The vegetation within the Project Boundary consists predominantly of cleared grasslands that are used for cattle grazing or crop production. These grasslands vary in their degree of modification from severely modified croplands, where the land has been cultivated and exotic crop species planted, to pasture improved land where fertilizer has been applied and exotic pasture species have been sown, to predominantly native grasslands that are grazed by cattle. Treed vegetation exist as fragmented narrow tracts of woodland along boundary fences and road verges, remnant patches of open forest or woodland on mountains and steeper slopes precluded from clearing, scattered paddocks trees forming open woodlands and isolated patches of remnant or regrowth open forest or woodland.

A suite of native ecological communities were mapped within the Project Boundary. Four vegetation communities have been identified as conforming to White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grassland, a Critically Endangered Ecological Community (CEEC) under the EPBC Act. Another four communities identified within the Project Boundary conform to EECs listed under the EPBC Act; Inland Grey Box Woodland, Weeping Myall Woodland, Semi-evergreen Vine Thickets and Brigalow.

The area within the Project Boundary supports vegetation containing a high diversity of native species, of which the majority are native. One threatened flora species, *Bothriochloa biloba* (Lobed Blue Grass) (Vulnerable under the EPBC Act) has been recorded within the Project Boundary during surveys conducted by Cumberland Ecology. No other threatened flora species listed under either the EPBC Act have been recorded within the Project Boundary during surveys conducted by GHD (2009) or surveys conducted by Cumberland Ecology. Four threatened plants have been recorded from the Gunnedah Local Government Area (LGA) and are considered to have potential to occur within the Project Boundary. These are *Dichanthium setosum*, *Digitaria porrecta*, *Cadellia pentastylis* and *Swainsona murrayana*. Of these species, the Atlas of NSW Wildlife only holds records of *Dichanthium setosum* within the Project Boundary. Despite targeted searches for the species in suitable habitat and areas surrounding, it has not been recorded by Cumberland Ecology.

The faunal assemblage within the Project Boundary is dominated by mobile fauna including a suite of bird species, and some microbats. Small ground dwelling native fauna (mammals, reptiles and amphibians) are not well represented within the Project Boundary, however large numbers of feral animals were recorded, particularly the European Red Fox and feral pigs.

One fauna species listed as Vulnerable under the EPBC Act (the Koala) was recorded within the Project Boundary as well as one Migratory EPBC Act species, the White-bellied Sea Eagle (*Haliaeetus leucogaster*). Although not recorded during field surveys, other threatened or migratory species listed under the EPBC Act are considered to have potential to occur due to the presence of suitable habitat. The Koala was frequently recorded within the Project Boundary during surveys. The Koala is listed as Vulnerable under the EPBC Act. Results of the SAT surveys indicated that Koala activity is variable within the Project Boundary.

Results from the aquatic surveys indicate that all sites surveyed are highly disturbed as a result of human activities and ecological function is significantly to severely impaired. AusRivAS and SIGNAL assessments indicate water quality and habitat quality is low and that the water bodies do not support abundant or diverse community assemblages.

S4 Impacts

The Project Disturbance Area will be approximately 4,084 ha within the Project Boundary. This area consists of 864 ha of native woodland, 73 ha of derived native grassland, 3,084 ha of low diversity grassland, plantings and exotic pasture, and the remaining 63 ha includes non-vegetated areas such as dams and roads. **Table S.1.1** provides a breakdown of the areas of each vegetation community to be impacted by the Project.

Table S.1.1 Summary of Vegetation Clearance within the Project Boundary				
Vegetation Community	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
Box Gum Woodland	CEEC	1,192	665	56
Derived Native Grassland	CEEC	73	73	100
<i>Subtotal Box Gum Woodland and Derived Native Grassland (CEEC)</i>		1,265	738	58
Inland Grey Box Grassy Woodland	EEC	55	30	55
Weeping Myall Woodland	EEC	22	3	14
Semi-evergreen Vine Thicket	EEC	n/a*	0	0
Brigalow	EEC	9	0	0
<i>Subtotal Other C/EEC</i>		86	33	38
Fuzzy Box Woodland		36	18	50
Poplar Box Woodland		223	45	20
Belah Woodland		7	1	14
Whitewood Woodland		76	13	17
Tumbledown Red Gum Grassy Open Woodland		50	16	32
White Box Shrubby Woodland		234	24	10
Regenerating White Box Shrubby Woodland		72	43	60
Blakely's Red Gum Shrubby Woodland		6	6	100
Blakely's Red Gum Motherumbah Shrubby Woodland		15	0	0
<i>Subtotal Other Woodland</i>		719	166	23
Low Diversity Grassland, Planted & Exotic Pasture		7,290	3,084	42
Cleared Areas (roads, dams, buildings, etc.)		141	63	45
<i>Subtotal Other</i>		7,431	3,147	42
TOTAL EPBC ACT C/EEC		1,351	771	57
GRAND TOTAL		9,501	4,084	43

*Area of occurrence is <0.1ha and has therefore not been mapped

The following is a summary of the impact of the Project on threatened biodiversity within the Project Boundary:

- Removal of approximately 771 ha of vegetation communities listed under the EPBC Act;
- Removal of approximately 864 ha of woodland (this includes 847 ha of preferred Koala habitat), providing known and potential habitat for the Koala and other threatened flora and fauna species; and
- Removal of habitat features required by native species such as hollow logs, rocky outcrops and woody debris.

The Project has potential to impact on the ecology of the local area, and without any amelioration, it also has potential to have a significant impact on threatened ecological communities, the Koala population within the Project Boundary and a suite of other threatened species. To mitigate these potential impacts, a substantial mitigation package has been proposed including a Koala Plan of Management (KPoM) and a Biodiversity Management Plan (BMP).

S5 Amelioration Package

A number of amelioration measures have been developed to minimise the ecological impacts of the Project. The approach is based upon the following hierarchy of principles of avoidance, mitigation and compensation and is consistent within the EPBC Act Environmental Offsets Policy:

- 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, including the avoidance of numerous areas of Box Gum Woodland. These include not mining the entire area of the mining lease within the 30 years, no disturbance of Breeza State Forest, no disturbance on Mt Watermark and no disturbance on the black soil plains. Further opportunities for impact avoidance will be identified during the detailed design stage.

S5.2 Mitigation Measures

The following mitigation measures will be implemented in addition to measures outlined in the Rehabilitation Management Plan:

- Minimise disturbance of native vegetation during construction and ahead of mining operations;
- Preparation of a BMP that contains detailed mitigation measures. This plan should include 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;
- Implementation of a two stage clearing protocol for all hollow-bearing tree clearing. All hollow-bearing trees to be felled, their species should be catalogued and approximate dimensions should be recorded 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; and
- Mitigation measures for Koalas including translocation of individuals combined with rehabilitation of suitable habitat, and both Onsite and Offsite Offset Areas. These measures are contained within the KPOM.

S5.3 Biodiversity Offsets Package

Shenhua Watermark is committed to developing the BOP that maintains and improves biodiversity within the Namoi CMA. The current version of the Offset Strategy entails acquisition of offset properties for permanent conservation of flora and fauna, including species predicted to be impacted by the Project, and by provision of indirect offsets. The Offset Strategy targets Box Gum Woodland and Derived Native Grassland and other habitats for all threatened fauna known to occur within the Project Boundary. The current composition of the BOP includes:

1. Onsite Offset Areas, comprising:

- a. Conservation and ongoing management of existing vegetated land within the Mt Watermark Offset Area and Offset Area 6 ;
- b. Restoration of vegetation communities and associated habitat within the aforementioned offset areas and the Mooki River Offset Area; and
- c. Rehabilitation of mined areas.

2. Offsite Offset Areas, comprising:

- a. Conservation of existing vegetated areas; and

b. Restoration of vegetation communities and associated habitat.

3. **Indirect Offsets**, such as funding for Landcare, targeted research or recovery planning.

The adequacy of the Watermark BOP will be assessed using the new SEWPaC offsets calculator in consultation with SEWPaC. Based on preliminary mapping, the Onsite and Offsite Offset Areas are likely to contribute 13,015 ha of native woodland and grassland communities. These offset properties contain 1,332 ha of remnant Box Gum Woodland and Derived Native Grassland, and a further 5,034 ha is proposed for revegetation and rehabilitation. The Onsite Offset Areas will also provide extensive areas of habitat for the Koala.

The offset properties also include various forms of woodland, which constitute habitat for threatened birds and microbats. Importantly, these properties would provide upfront mitigation of the Project's impacts on biodiversity. The inclusion of these lands as potential biodiversity offsets would provide additional conservation areas.

The BOP is substantial and will have a significant net benefit to flora and fauna. The current BOP will provide woodland and grassland habitat for threatened species at just under a 5:1 ratio for the life of the Project. The Project will provide over a 5:1 offset ratio of retained Box Gum Woodland and Derived Native Grassland in the first 10 years. When revegetation and rehabilitation is included, and a 50% discount is applied to the mine rehabilitation areas, the BOP provides an offset ratio of 7.3:1 for Box Gum Woodland and Derived Native Grassland CEEC, 45.6:1 for other EPBC Act listed EECs and 29.8:1 for other woodland vegetation. The available data indicates that in the medium to long term the mining activities will result in a net increase in woodland in and around the Project Boundary, and in the wider region.

S6 Conclusion

The Project will result in the clearance of large areas of native vegetation, including 937 ha of woodland and derived native grassland, of which 738 ha consists of Box Gum Woodland and Derived Native Grassland, as well as 33 ha of other threatened ecological communities listed under the EPBC Act.

The vegetation that is proposed to be cleared provides habitat for a range of threatened species. A suite of threatened flora and fauna species listed by the EPBC Act were recorded, or have potential to occur within the Project Boundary, including a population of the Koala.

In recognition of the potential ecological impacts of the Project, a substantial BOP is proposed. The BOP will protect approximately 4,603 ha of woodland and derived native grassland, revegetate 6,028 ha of woodland and derived native grassland and rehabilitate 2,384 ha of woodland. This includes a total of 6,366 ha of Box Gum Woodland and Derived Native Grassland, 1,529 ha of other EPBC Act listed EECs and 5,120 ha of other woodland vegetation. The BOP includes significant areas of known and potential habitat for the suite of species predicted to be impacted by the Project.

The proposed avoidance, mitigation and offset measures are likely to sufficiently ameliorate the impacts of the Project to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the BOP is to provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportions of native woodland in conservation tenure.

Chapter 1

Introduction

1.1 Background and Purpose

Cumberland Ecology was commissioned by Hansen Bailey on behalf of Shenhua Watermark Coal Pty Ltd (Shenhua Watermark) to undertake an Ecological Impact Assessment (EIA) of the Watermark Coal Project (the Project), which will entail the development of a 30 year open cut coal mining operation and associated infrastructure.

This EIA will form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities (SEWPaC) has determined that the Project (EPBC 2011/6201) is a “controlled action” under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This determination has been made because SEWPaC considers that the Project will have a significant impact on Matters of National Environmental Significance (MNES), in particular the EPBC Act listed Critically Endangered Ecological Community (CEEC) White Box-Yellow Box-Blakely’s Red Gum Grassy Woodland and Derived Native Grassland (Box Gum Woodland) and EPBC Act listed threatened and migratory species. SEWPaC considers that significant impacts are possible for a number of species and communities protected by the EPBC Act, including but not limited to the following:

- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia;
- Weeping Myall Woodlands;
- *Prasaophyllum* sp. *Wybong* (C.Phelps ORG 5269) (Wybong Orchid);
- *Pterostylis cobarensis* (Cobar Greenhood Orchid);
- *Swainsona murrayana* (Slender Darling Pea);
- *Thesium australe* (Austral Toadflax);

- *Tylophora lineraris*;
- *Anthochaera phrygia* (Regent Honeyeater), also Migratory;
- *Lathamus discolor* (Swift Parrot);
- *Polytelis swainsonii* (Superb Parrot);
- *Chalinolobus dwyeri* (Large-eared Pied Bat);
- *Petrogale penicillata* (Brush-tailed Rock-Wallaby);
- *Pseudomys novaehollandiae* (New Holland Mouse);
- *Pteropus poliocephalis* (Grey-headed Flying-fox);
- *Rostratula australis* (Painted Snipe), also Migratory;
- *Maccullochella peelii peelii* (Murray Cod);
- *Nyctophilus corbeni* (South-eastern Long-eared Bat);
- *Dasyurus maculatus maculatus* (Spotted-tailed Quoll); and
- *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko).

The Koala (*Phascolarctos cinereus*) was listed under the EPBC Act after the determination of the Project as a controlled action; however it has been considered within this document.

In accordance with the one-off accredited assessment process for the Project, the environmental assessment of the impacts of the controlled action must be assessed under the EP&A Act. The assessment should include enough information about the controlled action and its relevant impacts to allow the Commonwealth Minister for SEWPaC to make an informed decision whether or not to approve the controlled action under the EPBC Act.

The purpose of this document is to provide the requisite information about the controlled action and its relevant impacts to allow the Commonwealth Minister for SEWPaC to make an informed decision whether or not to approve the controlled action under the EPBC Act.

1.2 SEWPaC Assessment Requirements

Assessment requirements have been received from SEWPaC, specifying the information required for SEWPaC to assess the Project (see **Appendix A**). **Table 1.1** below reproduces the assessment requirements and indicates where each of the assessment requirements has been addressed in the document.

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
General information		
1 - The background of the action, including:		
a)	Title of the action	Section 2.2
b)	Full name and postal address of the designated proponent	Section 2.1
c)	A clear outline of the objective of the action	Section 2.2
d)	The location of the action	Section 2.2.1
e)	The background to the development of the action	Section 2.2.2
f)	How the action relates to any other actions (of which the proponent should be reasonably aware) that have been, or are being, taken or that have been approved in the region affected by the action	Section 2.2.8
g)	The current status of the action	Section 2.2.5
h)	The consequences of not proceeding with the action	Section 2.2.4i
Description of the controlled action		
2 – Description of the action including		
a)	All the components of the action	Section 2.2.3 and Figure 2.2
b)	The precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts	Figure 2.2
c)	How the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts	Section 2.2.3
d)	Timing and duration of the works to be undertaken; and	Section 2.2.3
e)	To the extent reasonably practicable, a description of any feasible alternatives to the controlled action that have been identified through the assessment and their likely impact, including: i) if relevant, the alternative of taking no action ii) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action iii) sufficient detail to make clear why any alternative is preferred to another	Section 2.2.4
Description of the existing environment		
3 – A description of the existing environment of the proposal location and the surrounding areas that may be affected by the action, including:		

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
a)	surveys using accepted methodology for targeting listed threatened species, ecological communities and their respective habitat, including but not limited to OEH's Survey and assessment guidelines (2009), available at: http://www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm , and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) species-specific survey guidelines for nationally threatened species, available at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl .	Chapter 3 presents the survey methodology utilised to survey within the Project Boundary.
In addition to the requirements outlined in OEH's Survey and assessment guidelines (2009) and DSEWPaC survey guidelines for relevant species, the following must also be included:		
b)	a description of the distribution and abundance of threatened species and ecological communities, as well as suitable habitat (including breeding, foraging, roosting habitat, habitat critical to the survival of threatened species) within the site and in surrounding areas that may be impacted by the proposal; and	Chapters 4, 5 and 6 present the results of the field surveys and desktop assessments, including this information
c)	the regional distribution and abundance of suitable and potential habitat surrounding the site	Chapters 4, 5 and 6.
Description of the relevant impacts of the controlled action		
4 - An assessment of all relevant impacts with reference to the EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance (2009) that the controlled action has, will have or is likely to have on relevant threatened species and/or threatened ecological communities (s18 and s18A), and migratory species (s20 and s20A). Information must include:		
a)	A description of the relevant impacts of the action on Matters of National Environmental Significance	Chapter 8 and Appendix J
b)	A detailed assessment of the nature and extent of the likely short term and long term relevant impacts	Chapter 8
c)	A statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Chapter 8
d)	Analysis of the significance of the relevant impacts	Chapter 8 and Appendix J
e)	Notwithstanding mitigation and offset, details on the cumulative impacts on matters of National Environmental Significance at a regional scale;	Section 8.7
f)	Any technical data and other information used or needed to make a detailed assessment of the relevant impacts	Technical data utilised has been referenced throughout, and a list of all technical data used is presented in the

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
		Reference List
5	A description of the relevant impacts on the ecological communities should include an analysis of the vegetation condition on the site, as well as the methods by which this was determined	Section 3.2.2.v – (methods) Section 4.1.6 – (analysis of condition)
It should also include direct, indirect, cumulative and facilitative impacts on the:		
a)	extent of the ecological community, including connectivity with other areas of the ecological communities;	Section 8.1, Appendix J
b)	quality or integrity of the ecological community including, but not limited to, assisting invasive species, that are harmful to the ecological communities to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the communities which kill or inhibit the growth of species in the ecological community;	Section 8.1, Appendix J
c)	EPBC Act listed species in, or in any way dependent upon, the ecological community;	Section 8.3, Section 8.4
d)	composition of the ecological community;	Section 8.1
e)	habitat present on site critical to the survival of the ecological community; and	Section 8.1, Appendix J
f)	abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community survival, for example increasing groundwater levels or making the site wetter, soil disturbance or substantial alteration of surface water drainage patterns.	Section 7.4.1, Section 7.4.2, Appendix J
These impacts should be described for the construction and operation phases of the controlled action.		The impacts of construction and operation are discussed in Chapter 8
This information should be provided with reference to the ecological community as it is defined and listed under the EPBC Act.		The EPBC Act definition of this community as used in this report is provided in Section 3.2.2ii
6 - Where there is a potential habitat for EPBC Act listed species (Appendix A), surveys must be undertaken. These surveys must be timed appropriately and undertaken for a suitable period of time by a qualified person. A subsequent description of the relevant impacts on such EPBC Act listed species should include, inter alia, direct, indirect, cumulative and facilitative impacts on the:		
a)	population of the species at the site;	Section 8.3 and 8.4
b)	area of occupancy of the species;	Section 8.3 and 8.4
c)	habitat critical to the survival of the species;	Section 8.3 and 8.4

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
d)	breeding cycle of the population; and	Section 8.3 and 8.4, Appendix J
e)	availability or quality of habitat for the species.	Section 8.3 and 8.4
If an endangered ecological community, threatened or migratory species listed at Appendix A is not believed to be present on the proposed site, detailed information must be included in the Environmental Assessment Report to provide certainty that this community will not be impacted.		This report provides a detailed assessment of the habitat requirements of these species and the habitat available within the Project Boundary in order to provide certainty on the levels of predicted impact. Even if a threatened species is not believed to be present on the site, if it is considered to have potential to occur it is assessed as if it does occur.
Information Relating to Water		
The Environmental Assessment Report must consider any water related impacts associated with the proposed project on MNES.		
7	How the proponent will comply with all relevant Commonwealth, state and local government environment laws and policies pertaining (either directly or indirectly) to water quality management;	Section 7.1
8	A description and maps of all surface water and groundwater sources relevant to the Project, and a delineation of their associated NWQMS environmental values;	Section 7.2, and Figures 2.3 and 7.2.
9	The results of surface water and groundwater hydrological assessments, including an assessment of hydrological interactions where water sources are connected;	Chapter 7
10	Hydro-geological reports;	See Appendix T of the EIS
11	A geological map showing fault lines;	See Figure 5.4 and 8.22 of Groundwater Impact Assessment (Appendix S of EIS)
12	A topographical map;	Figure 2.3
13	Hydrological modelling information;	Section 7.3

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
14	Baseline data and information on current water quality, including reference and test site data. Where this information does not exist, there should be an undertaking to carry out the necessary investigations in order to provide the required baseline data, including a description of how these investigations will be carried out (methodology and timeframe);	Section 7.2.2ii
15	Data and information on proposed discharge water quality, including timing of discharges, concentrations, and loads of toxicants and stressors;	There will be no controlled discharge of water – see Section 7.4.2i
16	Water quality issues, including planning, monitoring and management informed by the National Water Quality Management Strategy a. Sewage treatment; and, b. Water way crossings;	Section 7.4.2viii for details of sewage treatment. No waterway crossings are proposed for the Project
17	Modelling showing the cumulative environmental impacts of the action; and	Section 7.4
18	A comprehensive water quality risk management and monitoring plan for the project, including management triggers to detect potential issues in a timely manner and to avoid, minimise or ameliorate adverse impacts. This should include:	This detail will be contained in the Water Management Plan to be prepared for the Project (see Section 7.4.1viii and 7.4.2viii).
a)	Identification and description of all potential water quality hazards;	Section 7.4.1iv and Section 7.4.2iv
b)	Water quality risks should be considered and, where possible, quantified;	Section 7.4.1iv and Section 7.4.2iv
c)	Cumulative effects, including environmental impacts, should be considered;	Section 7.4.1vi and Section 7.4.1vii and 7.4.2vii
d)	Threshold trigger and/or guideline values that protect MNES should be considered;	Section 7.4.1viii
e)	Biological as well as chemical monitoring and assessment;	Section 7.4.1viii and Section 7.4.2viii
f)	Statistical analysis such as data averages, standard deviation and number of samples;	Section 7.4.1viii and 7.4.2viii
g)	Test and reference site locations;	Section 7.4.1viii and 7.4.2viii
h)	Sampling and analytical methods; and,	Section 7.4.1viii and 7.4.2viii.
i)	Quality control and quality assurance data	Section 7.4.1viii and 7.4.2viii.

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
19 - Some of the main water quality issues the proponent should consider include:		
a)	Salinity;	Section 6.3, 7.2 and 7.4
b)	Sedimentation;	Section 7.4.2vi
c)	Nutrients;	Section 6.3, Section 7.2.2ii and 7.4.1iv and 7.4.2iv
d)	Stressors such as pH, EC, turbidity;	Section 6.3, 7.4.1iv and 7.4.2iv
e)	Heavy metals and metalloids;	Section 7.2.2ii, 7.4.1iv and 7.4.2iv
f)	Macroinvertebrate species assemblages, compositions and assessment results	Section 6.4
g)	Disturbed/exposed acid sulfate soils;	Section 7.4.1iv and Section 7.4.2iv
h)	Hydrocarbons, hydrocarbon derivatives and PAHs.	Section 7.4.1iv and Section 7.4.2iv
Proposed Safeguards and Mitigation Measures		
20 - A description of feasible mitigation measures, changes to the controlled action or procedures, which have been proposed by the proponent or suggested in public submissions, and which are intended to prevent or minimise relevant impacts. Information must include:		
a)	a description of the mitigation measures that will be undertaken to prevent or minimise the relevant impacts of the action. These mitigation measure should be substantiated and based on best available practices;	A monitoring program will be developed for the Project, as described in Section 9.3
b)	an assessment of the expected or predicted effectiveness of the mitigation measures including the effect on abundance and condition of species, suitable habitat and ecological communities;	Section 9.5
c)	any statutory or policy basis for the mitigation measures;	Chapter 9
d)	the cost of the mitigation measures;	Section 2.2.7
e)	an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs (including any relevant thresholds for corrective actions) for the relevant impacts of the action. Include the person or agency responsible for implementing these programs and the effectiveness of all mitigation measures, including any provisions for independent	Section 9.4

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
	environmental auditing;	
f)	the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;	NSW Department of Planning and Infrastructure and SEWPaC
g)	identification of mitigation measures proposed to be undertaken by State governments, local governments or the proponent;	Section 2.1.1 and Section 9.2 outline the mitigation measures proposed to be undertaken by Shenhua Watermark. No mitigation measures are proposed to be undertaken by the local government or State Government
h)	any changes to the controlled action which prevent or minimise relevant impacts on listed threatened species and communities.	No changes to the action currently proposed have been made that would reduce impacts on threatened species or communities.
Offsets		
21 - Should any residual impact exist that cannot be mitigated it may be necessary for offset measures to be considered in order to ensure the protection of matters of National Environmental Significance in perpetuity. If required, the department may negotiate offsets with you during the assessment phase. Reference should be made to the Department's draft policy statement, including any revisions to this statement, at : http://www.environment.gov.au/epbc/publications/draft-environmental-offsets.html		
a)	the description of any offset package should include how the offset compensates for the residual impacts, when the offset will be delivered and how the offset will be managed;	Chapter 10
b)	an assessment of the impact of the offsets on other matters of environmental, economic, or social significance; and	Section 2.2.7
c)	analysis of cost, both financial and other, related to offsets.	Section 2.2.7
Other approvals and conditions		
22 - Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include:		
a)	Details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including: i) what environmental assessment of the proposed action has been, or is being, carried out under	The Project will be assessed under the New South Wales EP&A Act. See also Section 2.2.6.

Table 1.1 DGR's from SEWPaC and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
	the scheme, plan or policy ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts	
b)	A description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action	No approval has been obtained for the Project
c)	A statement identifying any additional approval that is required	Approval is required under the New South Wales EP&A Act. See also Section 2.2.6.
d)	A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action	Section 9.3 of this document and Section 7 of the EIS
Economic and Social Matters		
23 – A description of the short-term and long-term social and economic implications and/or impacts of the Project		Section 2.2.7
Environmental record of person proposing to take the action		
24 - Provide details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:		
a)	The proponent	Section 2.1.1
b)	For an action for which a person has applied for a permit, the person making the application	Section 2.1.1
25 – Details of the proponent's environmental policy and planning framework		Section 2.2.1
Information sources		
26 - For information given in an environmental assessment, the draft must state:		
a)	The source of the information	All sources are references throughout the document and a complete list of all references provided in the Reference List
b)	How recent the information	Each reference is cited and dated. The date of record of species recorded from the locality and/or the Project Boundary have been included in the document.

Table 1.1 DGR's from SEWPac and Section Reference		
ID	DGR	Section(s) in document where DGR addressed
c)	How the reliability of the information was tested	Much of the data regarding species occurrences comes from Government databases and there is no way to test the reliability of this data. Nevertheless, these sources are considered reliable.
d)	What uncertainties (if any) are in the information	This has been indicated where relevant throughout the document.
Consultation		
27 - Any consultation about the action, including:		
a)	any consultation that has already taken place;	Section 2.4
b)	proposed consultation about relevant impacts of the action;	Section 2.4
c)	if there has been consultation about the proposed action — any documented response to, or result of, the consultation.	Section 2.4
28 - Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.		Section 2.4

1.3 Terms and Abbreviations

Table 1.2 Terms and Abbreviations Used in this Report	
Terminology	Description
AusRivAS	Australian River Assessment System
BMP	Biodiversity Management Plan
BOP	Biodiversity Offsets Package
Box Gum Woodland and Derived Native Grassland	NSW and Commonwealth listing for the critically endangered open woodland community 'White Box- Yellow Box- Blakely's Red Gum Grassy Woodlands and Derived Native Grasslands'
CCC	Community Consultative Committee
CEEC	Critically Endangered Ecological Community
CMA	Catchment Management Authority
DP&I	Department of Planning & Infrastructure NSW
Disturbance Area	The total area of land to be disturbed by the Project is 4,084 ha. This

	disturbance can occur within the Disturbance Boundary.
Disturbance Boundary	The area delineated on Figure 2.2 (blue line) within which the Disturbance Area will occur. The area of disturbance within the Disturbance Boundary will not exceed 4,084 ha.
DGRs	Director- General's Environmental Assessment Requirements
EEC	Endangered Ecological Community
EIA	Ecological Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP&A Act	<i>NSW Environmental Planning & Assessment Act 1979</i>
EPA	NSW Environment Protection Authority
EPBC Act	<i>Federal Environment Protection and Biodiversity Conservation Act 1999</i>
EL 7223	Exploration Licence 7223
KPoM	Koala Plan of Management
LGA	Local Government Area
Locality	Land within 20 km radius of the Project Boundary
ML	Mining Lease
MNES	Matters of National Environmental Significance that are listed by the EPBC Act.
Mtpa	Million tonnes per annum
NP&W Act	<i>NSW National Parks and Wildlife Act 1974</i>
OEH	NSW Office of Environment and Heritage
Project Approval	Project Approval will be sought from the Minister of Planning and Infrastructure under Division 4.1 of Part 4 of the EP&A Act
Project Boundary	The Project Boundary encompasses all of the land required for the Project. Will also act as the Mining Lease Application Area.
SAT	Spot Assessment Technique
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
Shenhua Watermark	Shenhua Watermark Coal Pty Limited
SIGNAL	Stream Invertebrate Grade Number – Average Level
The Project	The Watermark Coal Project

Chapter 2

Proponent Details and Project Description

2.1 The Proponent

The Project proponent is Shenhua Watermark Coal Pty Ltd (Shenhua Watermark), a subsidiary of the Shenhua Corporation. The contact details for Shenhua Watermark are provided below:

Shenhua Watermark Coal Pty Limited
368-370 Conadilly Street
GUNNEDAH NSW 2380
Phone: (02) 6741 8800
Fax: (02) 6741 8817
<http://www.shenhuawatermark.com>

2.1.1 Environmental Record

Shenhua Watermark has not been the subject of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources.

Shenhua Watermark is committed to the implementation of leading practice environmental standards and performance in accordance with the objectives of its Environmental Policy (see **Appendix B**).

Since 2009, Shenhua Watermark has established an Environmental Monitoring Program for the purposes of obtaining relevant background monitoring data. The network includes a suite of meteorological, air quality, noise, surface water and groundwater monitoring stations.

Shenhua Watermark will develop and implement an Environmental Management System (EMS) for the Project which will include a variety of mitigation and management measures to minimise social and environmental impacts. The EMS will continue to be enhanced and revised as required for the Project to ensure proactive and ongoing environmental monitoring and management.

2.2 The Action

The title of the action is the Watermark Coal Project.

The objective of the action is the construction and operation of an open cut mining operation and associated infrastructure extracting up to 10 Million tonnes per annum (Mtpa) of Run of Mine (ROM) coal for a 30 year period.

2.2.1 Location

The Project is located within Exploration Licence (EL) 7223, approximately 25 km south south-east of the township of Gunnedah and to the immediate west of the village of Breeza, within the Gunnedah Local Government Area (LGA). The Gunnedah LGA is located on the Liverpool Plains of the Namoi River Valley, which forms part of the Brigalow Belt South bioregion. The Project is approximately 282 km by rail from the export Port of Newcastle (see **Figure 2.1**).

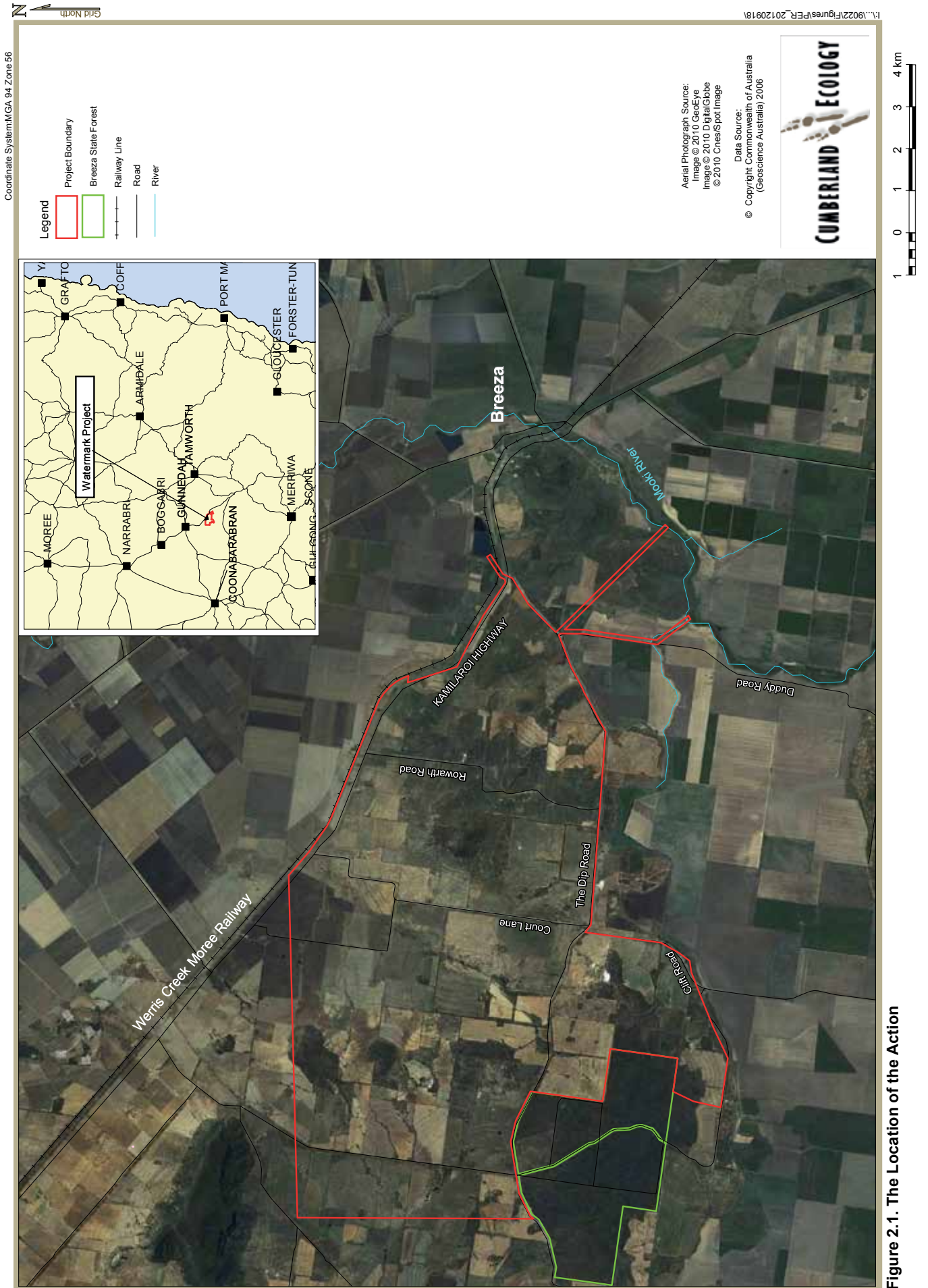


Figure 2.1. The Location of the Action

2.2.2 Background to the Development of the Action

EL 7223 was granted to Shenhua Watermark on 22 October 2008 over an area of 19,500 ha. EL 7223 enables Shenhua Watermark to prospect for minerals until 22 February 2016.

Since the granting of EL 7223, Shenhua Watermark has undertaken a detailed exploration program primarily focused on establishing the geology of the site, coal location and coal quality. Exploration undertaken to date has consisted of:

- Desktop studies;
- Aerial photography and regional airborne geophysical survey analysis;
- A Light Detection And Ranging (LiDAR) survey;
- Ground geophysical surveys using ground magnetic surveys, 2D seismic cross sections and resistivity traverses;
- Hydrogeological studies;
- Drilling (Core and Limit of Oxidisation (LOX) drill holes); and
- Geological Reconnaissance.

The resource for the Project has been defined and reported in accordance with Australasian Joint Ore Reserves Committee (JORC) requirements.

Approval is now being sought under the EP&A Act and the EPBC Act for the Project as described below.

2.2.3 Description of the Controlled Action

Shenhua Watermark is seeking State Significant Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project. The conceptual project layout, showing the Project Application Boundary (Project Boundary) is shown on **Figure 2.2**.

The Project generally comprises:

- The construction and operation of an open cut mining operation extracting up to 10 Mtpa of Run of Mine ROM coal for a 30 year period;
- An open cut mining fleet of excavators and shovels, supported by haul trucks, dozers, graders, drill rigs and water carts;
- Progressive rehabilitation of all disturbed areas;
- The construction and operation of a Coal Handling and Preparation Plant (CHPP) with a throughput of 10 Mtpa ROM coal;

- The co-disposal of tailings and coarse reject within the Overburden Emplacement Areas (OEA);
- The construction and operation of a rail spur, rail loop, Kamilaroi Highway rail overpass, associated load out facility and connection to the Werris Creek - Moree Railway Line;
- The construction and operation of a Mine Access Road;
- The construction and operation of administration, workshop and related facilities;
- The construction and operation of ground and surface water management and reticulation infrastructure including pipelines, pumping stations and associated infrastructure for access to water from groundwater aquifers, the Mooki River and private dams to the north-east of the Project Boundary;
- The installation of communications and electricity reticulation infrastructure; and
- A workforce of up to approximately 600 full-time equivalent employees during construction and up to 600 full-time equivalent employees during the operation of the Project.

The conceptual layout of the Project is shown in **Figure 2.2**. The Project will require 4,084 ha of land disturbance (Disturbance Area) which will generally be undertaken within the Disturbance Boundary as illustrated in **Figure 2.2**.

The maximum power requirement for the Project is estimated to be approximately 40 MW. In order to supply this power requirement, a 132 kilovolt (kV) or 66 kV electricity transmission line will be constructed from the existing Breeza substation to the substation within the Project Boundary. Existing 11 kV power lines from the Breeza substation to the Project Boundary will be upgraded in this regard as part of the Project. Importantly however, no new disturbance will be required for the upgrade as the powerlines are existing.

As an integral part of the action, a substantial suite of conservation measures have been developed, including the purchase and protection of extensive areas of land to be managed for conservation in perpetuity. These areas will be managed and regenerated to provide long term ecological benefits including habitat for native species such as the Koala and areas of Box Gum Woodland and Derived Native Grassland.

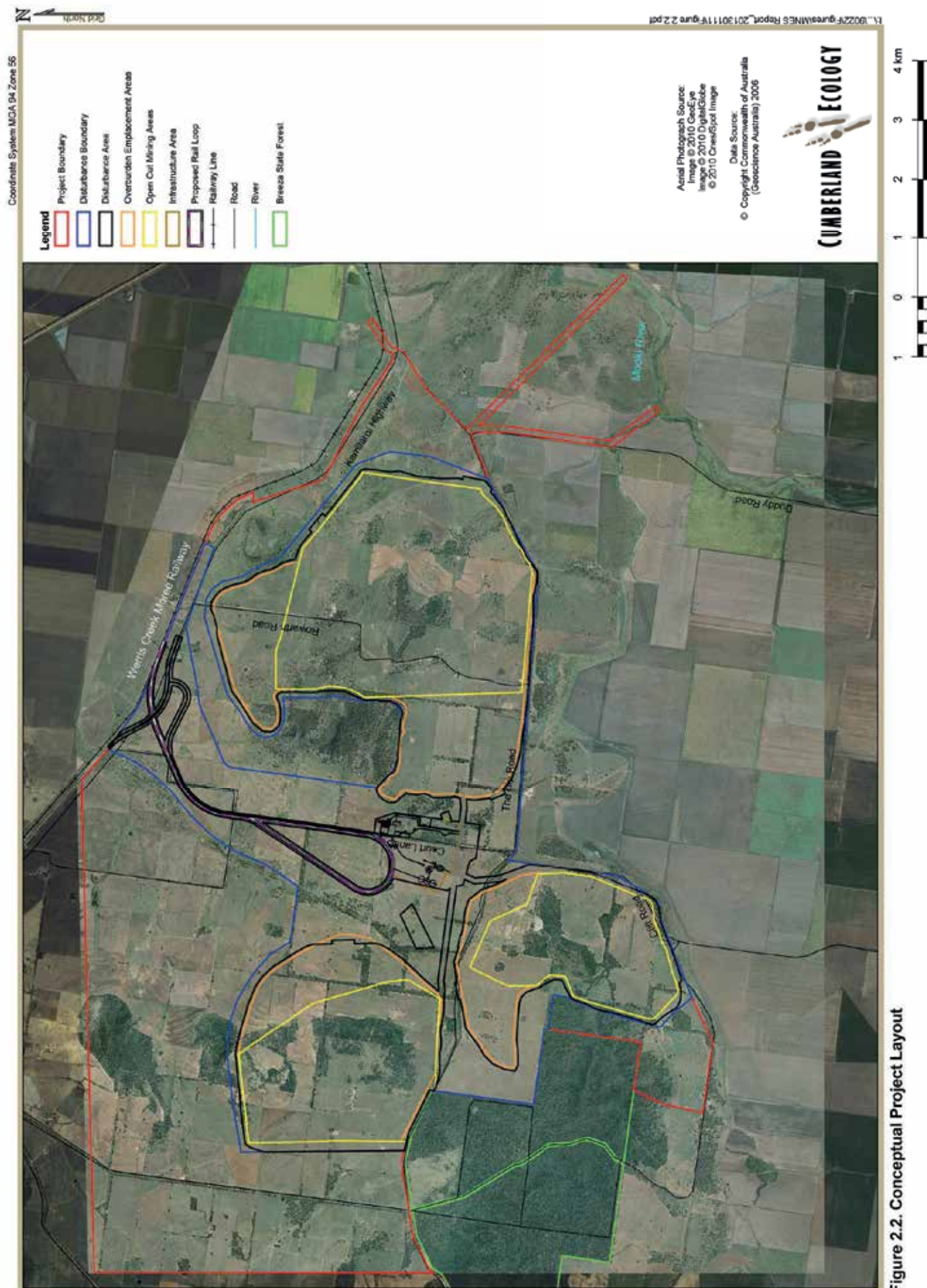


Figure 2.2. Conceptual Project Layout

2.2.4 Description of Alternatives

Since the granting of EL 7223, Shenhua Watermark has conducted an extensive exploration program and detailed feasibility studies in order to identify the most efficient and environmentally responsible mining operation possible to extract the coal reserves. This process included the consideration of numerous mine plans and operational alternatives. The primary objective of the studies was to develop a mine plan that considered the principles of Ecologically Sustainable Development (ESD), minimised potential environmental and social impacts whilst maximising coal recovery and retaining flexibilities going forward. The various Project alternatives that were considered during this process are summarised below. More detail is provided in the Mine Plan Justification Report, prepared by Hansen Bailey and appended to the EIS for the Project.

i. Option 1 – Do Nothing

The “do nothing” approach would result in the termination of EL 7223 which would then be relinquished to the NSW Government. This would result locally in a significant loss of employment opportunities as approximately 600 permanent employees would be required for construction and operations, in addition to a loss of benefits and royalties or other payments to both the Federal and NSW State Government.

This approach would avoid the clearing of 864 ha of woodland, including 771 ha of woodland and grassland listed as a CEEC under the EPBC Act. This would also avoid the clearing of 864 ha of woodland habitat for threatened flora and fauna species listed under the EPBC Act. However, as demonstrated in **Section 2.2.3**, approval of the Project would result in the protection of some 13,015 ha of woodland and grassland (including revegetation and rehabilitation areas) to be managed for long term conservation outcomes. This is a far greater area of land to that which is proposed to be cleared, and if the action does not proceed, these benefits would not be realised, and these lands would continue to be managed as grazing enterprises, with the associated ecological impacts.

This alternative failed to maximise resource recovery and therefore was not considered to be in satisfaction of the ESD object of encouraging the proper development of natural resources for the purpose of promoting the social and economic welfare of the community.

ii. Option 2 – Large Scale Open Cut and Underground operation

Option 2 involved the development of a large-scale open cut and underground mining operation, utilising all areas of EL 7223 to maximise resource extraction. This option would require disturbance of the Breeza State Forest and the black soil plains. This option would remove a greater area of woodland communities and habitats for threatened species known to occur in Breeza State Forest.

This alternative was rejected as it did not meet the objects of ESD and the EP&A Act for sustainable land use and conservation of biological diversity and ecological integrity.

iii. Option 3 – Underground Operation

The potential to mine the open cut mineable resource by underground mining methods has been investigated and deemed unviable for inclusion as part of this application. Although this approach would have a much lower impact on woodland communities and threatened species listed under the EPBC Act, it would result in the sterilisation of significant viable open cut coal reserves. Approval for access to the underground resource will be applied for as and when required in the future by a subsequent application supported by further environmental assessment.

iv. Option 4 – 21 Year Open Cut Mine

This option involved the development of an open cut mining operation for a period of 21 years with a maximum ROM coal production rate of 10 Mtpa. This alternative was investigated and considered feasible. This approach would have a lower impact on woodland communities and threatened species listed under the EPBC Act; however, the mine plan schedule for this alternative would result in a final void located adjacent to the black soil plains. This option would also limit the amount of coal extracted via open cut methods and would potentially result in the sterilisation of viable open cut coal reserves. This alternative was rejected as it may result in increased social and environmental impacts with a final void located adjacent to the black soil plains and for this reason, did not meet the objects of ESD.

v. Option 5 – The Project

The fifth alternative is the Project as it is proposed, a 30 year open cut mining operation within three separate mining areas. It will maximise the social and economic benefits from the Project. The final void will be located in the north-west of the Project Boundary remote from the black soil plains.

In addition, open cut mining will not be undertaken within the Breeza State Forest or on the black soil plains and Mt Watermark will remain intact. This option will include the protection for conservation of 13,015 ha of woodland and grassland (including revegetation and rehabilitation areas) in offset areas, which will contribute substantially to the ongoing conservation of these communities and will provide habitat for woodland and threatened species listed under the EPBC Act in the long term. This option is considered to be the best alternative in terms of meeting the principles of ESD and the objects of the EP&A Act.

2.2.5 Current Status of the Action

A referral of proposed action was submitted to the SEWPaC on 11 November 2011. The proposal was declared a Controlled Action on 22 December 2011, requiring assessment and approval under the EPBC Act before it can proceed. The assessment requirements of SEWPaC are outlined in **Section 1.2**.

2.2.6 Other Approvals and Conditions

In addition to the approval being sought from SEWPaC, Shenhua Watermark will seek State Significant Development Consent from the NSW Minister for Planning under Division 4.1 of Part 4 of the EP&A Act. A SSD is a development declared by a State Environmental Planning Policy or Regional Environmental Planning Policy to be a SSD, or development which the minister has called in for determination. The Project is considered to be a SSD and therefore approval will be sought from the Minister for Planning as the NSW consent authority for SSD.

An EIS has been prepared to accompany the application to the Minister for Planning. Section 5 of the EP&A Act states the objects of the Act, which contains details of the proposed mechanisms to prevent, minimise and manage impacts of the Project.

The offsite infrastructure required to provide adequate power to the Breeza Substation near the Project Boundary will be determined and will be subject to a separate approval process, and does not form part of this EIS. Preliminary design discussions with Essential Energy indicate that the preferred power supply option is to upgrade an existing 22 kV powerline from the Carroll substation to the Breeza substation, thereby minimising ground disturbance. No impacts to MNES are identified due to the powerline upgrade. A Review of Environmental Factors has been submitted for determination by Essential Energy in this regard.

2.2.7 Economic and Social Matters

The Project will secure and maintain up to 600 direct jobs over 30 years, further strengthen the local economy and create significant revenue at State and Federal levels. The Project will provide revenue to the State Government through the payment of royalties and taxes contributing to the NSW economy.

The Project will also result in additional and ongoing demands on community infrastructure and services (such as skill levels, trade, health and educational opportunities and population demographics) and impacts to the immediate environment.

An Economics Impact Assessment has been undertaken for the Project (see Appendix AE of the EIS). A Benefit Cost Analysis confirms that when production costs (acquisition costs for affected land, opportunity cost of land, operating costs, decommissioning costs, etc.) and production benefits (revenues from production, residual values of land, etc.) are considered, the Project will have net production benefits of \$3,047 Million with a minimum of \$1,310 Million of these net production benefits accruing to Australia. This net production benefit is distributed amongst a range of stakeholders including the local community, Shenhua Watermark, its shareholders and government.

Development costs of the Project are associated with the purchase of mining equipment, development of the CHPP, associated conveyors and stockpile areas, development of the mine infrastructure area, provision of services, engineering costs, land acquisitions, site decommissioning and rehabilitation costs, purchase of water allocations, realignment of the Kamilaroi Highway and the development of a road over rail overpass of the Kamilaroi

Highway. The incremental development costs over the life of the mine are estimated at \$2 billion. These development costs include an allowance for acquisition of land for ecological offsets, which is estimated at \$24.6 Million.

The establishment and maintenance of Project offsets also represents additional costs of approximately \$42 Million. These costs includes provisions for activities associated with the revegetation works required for the offsets properties (\$30.5 Million) and the ongoing land management and maintenance required over the proposed 30 year life of the Project (\$11.6 Million).

The environmental, cultural and social impacts of the Project may potentially accrue to a number of different stakeholder groups at the local, State, national and global level, however, are largely internalised into the production costs of Shenhua Watermark. It is estimated that the Project will invest approximately \$118 Million to mitigate a range of impacts.

The Project will also temporarily transfer land use within the Project Boundary from agricultural activity to mining purposes and result in the transfer of some water entitlement units from stock and domestic purposes and irrigation to mining purposes.

2.2.8 Relationship to Other Actions

Several other actions are being taken or are proposed to being taken in the region affected by the Project. A summary of the current and proposed developments in the region is provided in **Table 2.1**. The major mining developments in the immediate vicinity of EL 7223 are described below.

The Caroon Coal Exploration Project (EL 6505) held by BHP Billiton is located immediately to the south of EL 7223. This Project is still in the exploration stages and no details on the conceptual design of the Project are publicly available. Publicly available documentation relating to the EL 6505 works includes the Review of Environmental Factors (REF) Reports prepared for the exploration works drilling program (Umwelt 2009) and 3D seismic assessment program (Umwelt 2011). Potential impacts to MNES as a result of the EL 7223 exploration works were assessed in both REF documents and it was concluded that these were not likely to result in any significant impacts to EPBC Act listed CEEC.

The Werris Creek Coal Mine (operated by Whitehaven Coal) is located approximately 20 km south-east of the Project Boundary. Current approvals for the site allow the development of an open cut coal mine and associated support infrastructure, with coal extraction at a rate of up to 2.5 Mtpa. The *Werris Creek Coal Mine LOM Project* (R.W. Corkery 2010) for the mine includes an ecological impact assessment that describes impacts to EPBC Act listed species as a result of the development. Specifically this was found to include impacts to 194 ha of White Box Grassy Woodland and Derived Native Grassland and 0.35 ha of Brigalow – Belah Woodland. A detailed Biodiversity Offset Strategy for the Werris Creek Coal Mine was established as part of the Environmental Assessment process to offset the predicted impacts to MNES.

The Whitehaven Coal operations at Sunnyside and Canyon (located approximately 28 km north-west of the Project Boundary, and approximately 25 km north of the Project Boundary respectively) are both in 'care and maintenance' mode and thus, non-operational. Santos holds Petroleum Exploration Licence (PEL) No 1 over the Project Boundary and adjacent lands. Santos has commenced the Gunnedah Basin Gas Exploration Project at Caroona, adjacent to the Project Boundary.

Table 2.1 Summary of Mining and Gas Operations / Projects in the Region						
Project Type	Project Title	Proponent	EP&A Act Status 1	Approval Expiration	Production	Distance to Project
Coal Mining	Caroona Coal Project	BHP Billiton	EL Only	Not Available	Not Available	3 km south
	Werris Creek Mine	Whitehaven Coal Mining Ltd	Approved	2032	2.5 Mtpa (ROM)	20 km south-east
	Canyon Mine*	Whitehaven Coal Mining Ltd	Approved	2012	1.25 Mtpa (ROM)	25 km north
	Sunnyside Mine*	Namoi Mining Pty Ltd (Whitehaven Coal Mining Ltd)	Approved	2015	1 Mtpa (ROM)	28 km north-west
	Vickery South Project	Whitehaven Coal Mining Ltd	EL Only	Not Available	3 Mtpa (ROM) (estimation)	44 km north
	Vickery Mine	Whitehaven Coal Mining Ltd	Approved	2012	N/A	45 km north
	Vickery Coal Project	Whitehaven Coal Mining Ltd	DGRs Issued	2043	4.5 Mtpa (ROM)	45 km north
	Rocglen Coal Mine	Whitehaven Coal Mining Ltd	Approved	2022	1.5 Mtpa (ROM)	47 km north
	Tarrawonga Coal Mine	Whitehaven Coal Mining Ltd – 70%, Idemitsu Australia Resources Pty Ltd – 30%	Approved	2017	2 Mtpa (Product)	62 km north north-west
	Tarrawonga Coal Project	Whitehaven Coal Mining Ltd – 70%, Idemitsu Australia Resources Pty Ltd – 30%	Assessment	2030	3 Mtpa (Product)	62 km north north-west
	Goonbri Project	Goonbri Coal Company Pty Limited	EL Only	Not Available	Not Available	62 km north

	Boggabri Coal Mine	Idemitsu Australia Resources Ltd	Approved	2033	7 Mtpa (Product)	64 km north
	Maules Creek Coal Project	Whitehaven Coal Mining Limited	Approved	2033	13 Mtpa (ROM)	67 km north
	Narrabri Coal Mine	Narrabri Coal Pty Ltd (70% Whitehaven Coal Mining Ltd)	Approved	2031	8 Mtpa (Product)	76 km north north-west
Coal Seam Gas	Coonarah Gas Field	Eastern Star Gas Limited	Approved	Not available. Assume 2013	5.8 Petajoules (PJ) (proven and probable)	115 km north north-west
	Santos Gunnedah CSG Project	Santos	PEL only	2016	210 PJs	Includes all of North west slopes

1 – EP&A Act status and development phase as of 19 September 2012

* Both on care and maintenance / closure (i.e. not operational)

2.2.9 Future Development Plans

In addition to the Project as described in **Section 2.2.3**, there is a known coal resource within EL 7223 and the indicative Offset Area 6 but outside of the Disturbance Area that has the potential for development in future mining operations. The future plans for the remainder of EL 7223, within the Project Boundary but outside of the Disturbance Area, are as yet unknown. If this resource were to be proposed to be developed it would be subject to a separate development application, with the required approvals to be sought from the relevant NSW and Federal government agencies.

At this time, Shenhua Watermark is considering a range of mechanisms to secure and support the Onsite Offset Areas proposed for the Project. The options currently being considered for discussion with the relevant landholders and regulatory agencies are discussed further in **Section 10.5.6** and may include either the establishment of a voluntary conservation agreement, conservation covenant(s), zoning regulation application specific or implementation of conditions of land management. It should be noted that no EL is present on the remainder of the indicative Offset Area 6 and thus potential plans for underground mining in this area cannot be detailed further in this report.

2.3 Description of the Existing Environment

The Project is located within the Brigalow Belt South bioregion, which is one of the largest recognised bioregions in Australia. The vegetation of the New South Wales extent of the Brigalow Belt South bioregion is mainly grassy woodland dominated by box eucalypts (*Eucalyptus albens*, *E. populnea* and *E. pilligaensis*) and ironbarks (RACAC 2000). The

Brigalow Belt South bioregion is one of the most intensively cleared areas in Australia due to the high fertility of the soil and its consequent desirability for farming land. The majority of the remnant vegetation is highly fragmented and mostly occurs as fragmented narrow tracts of woodland along boundary fences and road verges, isolated patches of remnant or regrowth open forest or woodland patches on hills and steeper slopes, and scattered paddocks trees.

The vegetation within the Project Boundary has been extensively modified by historic clearing and ongoing agricultural activities. Vegetation communities include intact patches of native woodland and forest, partially disturbed woodland remnants, derived native grassland with remnant trees, exotic grassland and cropland. The most extensive and highest quality native vegetation remnants occur in the Breeza State Forest and its surrounds and on the side slopes of Mt Watermark. There are also linear strips of native vegetation which have survived in road reserves and along travelling stock routes. Decades of stock grazing has resulted in a variety of ecological impacts including weed invasion, nutrient enrichment and soil erosion.

i. Water Catchments, Drainage and Aquifers

No major watercourses occur within the Project Boundary. A number of small, mostly discrete drainage lines such as Watermark Gully and Native Dog Gully direct surface water in various directions, however these are ephemeral streams that only flow following rainfall. A larger, permanent river, the Mooki River, is located outside of the Project Boundary near the eastern boundary. The Mooki River is an inland river that joins the Namoi River, which is part of major Darling River system that extends across northern NSW. The Mooki River does not flow approximately 25% of the time, and its flow patterns are influenced by water extraction for domestic, agricultural and industrial purposes in the region. **Figure 2.3** shows the topography and drainage within the Project Boundary.

Water is proposed to be extracted from, and discharged into, the Mooki River as part of the Project. Water may be extracted from the river as part of the Project. Water intake pipelines may be constructed at two locations on the Mooki River, south of the Project Boundary.

The water bodies within the Project Boundary are primarily farm dam-type structures that are small, denuded of vegetation and degraded by livestock access. These dams are recharged from rainfall and are not than fed or diverted from any river sources. A naturally occurring ephemeral lake, Lake Goran is located to the west of the Project Boundary. Lake Goran is a natural wetland listed under the Directory of Important Wetlands in Australia.

Groundwater occurs within two main groundwater systems containing a number of local and regional aquifers. These are:

- The Quaternary / Tertiary age alluvial systems of the Gunnedah and Narrabri Formations; and
- The older, deeper and poorer quality consolidated bedrock that contains localised aquifers within weathered rock, porous sandstones, fractured zones, volcanics and coal seams.

ii. Land Use

The most prominent land use activities in the bioregion occur over the extensive areas of freehold land, including dry land and irrigation cropping as well as grazing and stock production. Other land 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 primary land use types within the Project Boundary include pastoral activities associated with the elevated ridge country and cropping activities associated with the black soil plains.

The conservation areas and forest reserves adjacent to the Project Boundary and in the wider locality include:

- Breeza State Forest;
- Doona State Forest;
- Spring Ridge State Forest;
- Goran State Forest;
- Wondoba State Conservation Area;
- Trinkey State Conservation Area;
- Melville Range Nature Reserve; and
- Somerton National Park.

Breeza State Forest is currently used for forestry and recreational purposes. The surrounding freehold land is predominantly used for dryland grazing and cropping.

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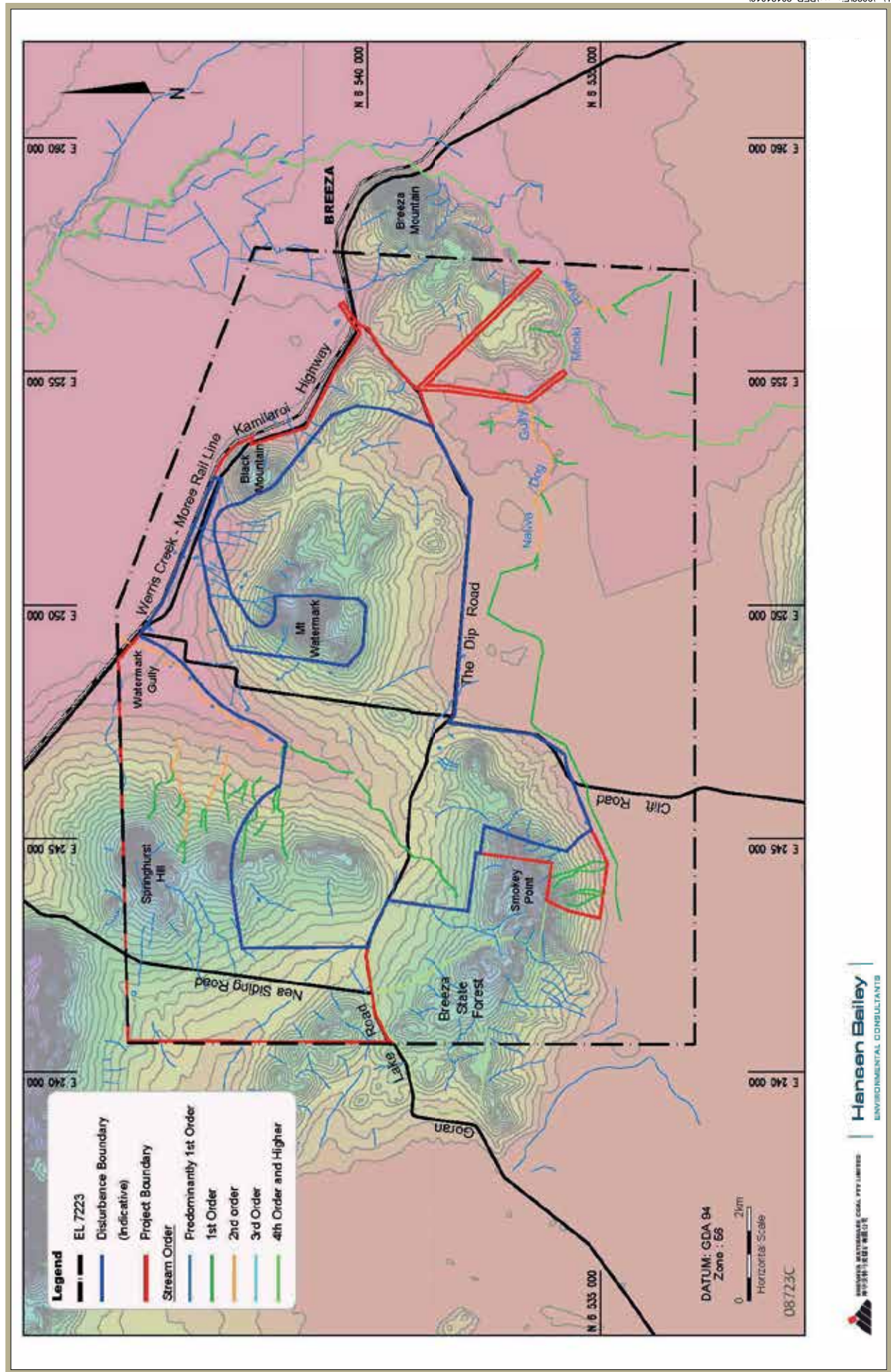


Figure 2.3. Topography and Drainage within the Project Boundary

2.4 Stakeholder Engagement

Since the granting of EL 7223 in October 2008, Shenhua Watermark has been actively undertaking stakeholder engagement for the Project, including:

- Establishment of a local office in Gunnedah with a designated community contact person available at all times and a free call 1800 community input telephone number, dedicated community email and reply-paid postal address;
- Dedicated community website;
- More than 300 separate meetings with stakeholders, including government agencies, the New South Wales Farmers Federation, Aboriginal groups and catchment management groups;
- Presentations to community groups / representatives and Non-Government Organisations;
- Active engagement with the local community on the Project through local media;
- Establishment of a Community Fund and Community Fund Advisory Committee; and
- Establishment of a Community Consultative Committee (CCC).

2.4.1 Identification of Affected Parties

Affected parties were identified through the stakeholder engagement strategy developed for the Project by Shenhua Watermark and Hansen Bailey and include:

- Federal government agencies;
- State government agencies;
- Local government agencies;
- Infrastructure owners and service providers;
- Neighbouring enterprises; and
- Community stakeholders, including:
 - Watermark CCC;
 - Individual near neighbours;
 - The townships of Gunnedah, Breeza, Curlewis, Carol, Quirindi, Carroona, Spring Ridge and Tamworth;

- Water, environment and Koala Community Reference Groups; and
- The Aboriginal community.

2.4.2 Consultation on the Action

i. Issue Scoping

Throughout the preparation of the EIS, Shenhua Watermark actively engaged with near neighbours and the local community through the distribution of Community Information Sheets, hosting of Community Information Sessions and the establishment of Community Reference Groups.

Community Reference Groups focussing on the assessment and management of Koalas, water and the environment in relation to the Project were established by Shenhua Watermark in March 2011. The primary purpose of the groups was to allow Shenhua Watermark to work directly with the community to ensure all issues and concerns were identified and addressed in the EIS.

Consultation with SEWPaC commenced on 4 March 2011 with an initial Project briefing meeting held in Canberra. The *Watermark Coal Project Background Document* (Hansen Bailey Environmental Consultants 2011) was later provided to SEWPaC in October 2011 with a Project update meeting held on 28 October 2011.

The Planning Focus Meeting was held on 4 November 2011 in Gunnedah and was attended by SEWPaC representatives. The Planning Focus Meeting included a presentation and discussion on the Project, identified potential environmental impacts, proposed assessment methodology and preliminary management and mitigation measures.

A Project update meeting and presentation was held with the Minister for Environment on 16 April 2012. This was followed by a presentation on the proposed Biodiversity Offset Strategy to SEWPaC on 21 June 2012 and a Project update provided on 11 October 2012.

In addition to numerous meetings and Project briefings, all three Community Information Sheets have been provided to with SEWPaC.

Issues and views raised as part of the issue scoping phase of the stakeholder engagement process are detailed in Section 5 of the EIS.

ii. Issue Response

The objective of the issue response stage of stakeholder engagement was to ensure that appropriate responses were provided for all stakeholder issues raised in relation to the Project and that relevant strategies for their management and mitigation were considered in this EIS and the Project design. Where possible, specific issues raised in relation to the Project were addressed with the relevant stakeholders.

This report has been compiled in response to the DGRs issued by SEWPaC which are provided in **Table 1.1**. Issues raised by other regulatory agencies and the broader community through the EIS stakeholder engagement process have been documented with a response to each issue provided in Section 5 of the EIS.

iii. Proposed and Ongoing Stakeholder Engagement

Shenhua Watermark is committed to the continuation of the stakeholder engagement plan developed for the Project and is seeking to achieve the best possible outcomes for all Project stakeholders.

Various mechanisms will be implemented to ensure the effective ongoing engagement with Project stakeholders, including:

- Regular consultation with neighbouring land owners;
- Regular meetings with the environment, water and Koala CRGs;
- Project updates to the Watermark CCC;
- Distribution of regular Community Information Sheets;
- Regular Community Information Sessions; and
- Provision of management plans and monitoring data via the Shenhua Watermark website.

Chapter 3

Methodology

Detailed ecological surveys have been conducted across the Project Boundary over several seasons to provide comprehensive flora and fauna baseline data in order to describe the distribution and abundance of threatened species and ecological communities and to determine the presence of suitable habitat (including breeding, roosting and foraging habitat, habitat critical to the survival of threatened species) within the Project Boundary and in surrounding areas.

The surveys have been conducted in compliance with the NSW Environment Protection Authority (EPA) guidelines for flora and fauna survey (DEC (NSW) 2004) and the Introduction to Field Survey Methods provided on the EPA website.

Floristic sampling for ecological communities was designed to meet SEWPaC guidelines for identifying the critically endangered Box Gum Woodland and Derived Grasslands, contained in the listing advice (Threatened Species Scientific Committee 2006), and the "Species list for the EPBC Act Policy Statement 3.5 - White box - yellow box - Blakely's red gum grassy woodlands and derived native grasslands (DEH 2006). The survey methodology was also designed to be compliant with SEWPAC species specific survey guidelines for nationally threatened birds, bats, and mammals and reptiles (DEWHA 2010a, b, SEWPaC 2011f, g).

3.1 Literature Review and Database Analysis

3.1.1 Literature Review

Recent relevant reports were reviewed to provide information for the Ecological Impact Assessment (EIA) undertaken for the Project (Cumberland Ecology 2013). Previous flora and fauna studies have been undertaken from within the Project Boundary by GHD in 2009 and these were reviewed to gain an understanding of the character and key environmental attributes. These results have been incorporated into the current survey results to provide a comprehensive assessment of the biodiversity present within the Project Boundary. Additionally, Umwelt (2009) have also prepared a preliminary report on the flora and fauna of the proposed Caroon Coal Project, located a short distance south of the Project Boundary, and the findings of this report were reviewed as part of the EIA.

Literature review was also conducted for the aquatic assessment. Surface water monitoring from in and near the Project Boundary is currently being undertaken by Carbon Based Environmental Pty Ltd as part of the Environmental Monitoring Program (EMP) for the Project.

This includes water sampling at a number of surface water monitoring stations along creek lines and streams both within and outside of the Project Boundary (Carbon Based Environmental Pty Ltd 2011). Data from March 2011 was used to complement the aquatic survey results collected as part of this report, as was surface water flow data obtained from the NSW Office of Water and the Australian Bureau of Meteorology.

In addition to ecological survey results, several important documents have been prepared to guide land management within the Namoi Catchment, and these were reviewed during the preparation of this report. These include

- Proposed Framework for Assessing the Cumulative Risk of Mining on Natural Resource Assets in the Namoi Catchment (Eco Logical Australia 2011);
- Draft Namoi CMA Catchment Action Plan (Namoi CMA 2011a); and
- Namoi CMA Biodiversity Offsets Policy (Namoi CMA 2011b).

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).

3.1.2 Database Analysis

Information on the biodiversity values of the Project Boundary and its surrounds were obtained via interrogation of the Atlas of NSW Wildlife (OEH 2012a) and EPBC Protected Matters Search Tool (SEWPaC 2012d). The Protected Matters Search Tool provides a list of MNES that are predicted to occur based on the presence of suitable habitat, and was used to inform threatened species searches during the field surveys.

The number and age of records of threatened species recorded within a 10 km radius of the Project Boundary provided information on the distribution of threatened species within the locality and was used to assess the likelihood of occurrence of threatened species within the Project Boundary.

3.2 Terrestrial Surveys

3.2.1 Dates of Survey by Cumberland Ecology

Field surveys took place between November 2010 and March 2012 and are summarised in **Table 3.1**. Flora surveys were conducted throughout the survey period. Fauna surveys for amphibians, reptiles and microbats were conducted mainly in the warmer months to maximise detection of these groups. The remaining fauna surveys were conducted in the cooler months.

Table 3.1 Dates of Field Survey	
Dates of Survey	Tasks Completed
3-5 November 2010	General flora and fauna reconnaissance
8-11 November 2010	Flora quadrat surveys
	Koala SAT/Area Search surveys
29 November - 2 December 2010	Flora quadrat surveys
13-15 December 2010.	Flora quadrat surveys
	Koala SAT/Area Search surveys
21-30 March 2011	Fauna surveys (terrestrial fauna trapping, harp trapping, Anabats, diurnal and nocturnal searches and call playback)
28 March – 1 April 2011	Koala SAT/Area Search surveys
2-6 May 2011	Flora quadrat surveys
	Fauna surveys (arboreal fauna trapping, hair tubes, IR cameras, Anabats, diurnal and nocturnal searches and call playback)
10-14 May 2011	Fauna surveys (arboreal fauna trapping, hair tubes, IR cameras, Anabats, diurnal and nocturnal searches and call playback)
30 May – 3 June 2011	Flora quadrat surveys
	Koala SAT/Area Search surveys
5-10 June 2011	Aquatic surveys
11-15 July 2011	Vegetation mapping
19-23 September 2011	Koala SAT/Area Search surveys
10-14 October 2011	Koala SAT/Area Search surveys
19-23 December 2011	Targeted threatened flora surveys
26-28 March 2012	Fauna surveys (harp trapping, Anabats, diurnal and nocturnal searches and call playback)

3.2.2 Flora Survey

Cumberland Ecology conducted flora surveys across all parts of the Project Boundary from November 2010 to December 2011. These flora surveys included vegetation mapping, quadrat sampling and threatened species searches, which are described in detail in the following sections. A summary of flora survey effort is provided in **Table 3.3**.

i. Vegetation mapping

Several vegetation mapping studies have been undertaken across the Project Boundary and surrounds, including broad scale mapping of the Namoi CMA.

The most recent detailed vegetation mapping to encompass the Project Boundary, prior to this ecological assessment, was undertaken by GHD (2009). Cumberland Ecology conducted additional vegetation surveys to revise and update the vegetation mapping prepared by GHD. The vegetation within the Project Boundary was ground-truthed to examine and verify the mapping of the condition and extent of the different vegetation communities. The following methods were utilised as part of the vegetation mapping:

- Quadrat sampling (20m x 50m) to characterise vegetation units by their species composition and community structure;
- Meander transect surveys to obtain information on community distribution within the Project Boundary and surrounds; and
- Detailed surveys 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. Mapping was completed using MapInfo Version 11.0 on a Windows XP platform.

Critically Endangered and Endangered Ecological Communities (C/EECs) listed under the EPBC Act that were considered likely to occur in the Project Boundary were determined by comparing quadrat data and field notes against published information, including descriptions within the SEWPaC Community and Species Profile and Threats (SPRAT) Database listing advice and community condition classes or thresholds and previous mapping undertaken by Namoi CMA and GHD (2009). Identification was based on community criteria such as geology, topography, known distribution, habitat descriptions and the number of recognised important or diagnostic species. Data was compared with the final determinations for listed communities under the EPBC Act to assess the presence of the C/EECs.

The vegetation mapping techniques undertaken for the Project are considered to be appropriate for identifying C/EECs that may occur. Surveys were designed to be consistent with available SEWPaC guidelines for the detection and identification of such communities, and to provide the requisite information to allow an informed identification to be made. Based on the number and distribution of quadrats undertaken, vegetation survey effort and timing (**Table 3.3**) is considered to have been adequate to assess the occurrence and condition of C/EECs across the Project Boundary.

Section 3.2.2.ii below outlines the criteria used to identify the EPBC Act listed C/EECs that occur in the Project Boundary.

ii. Criteria for Identifying EPBC Act Listed Threatened Ecological Communities

Based on existing vegetation information, the following C/EECs listed under the EPBC Act were considered to occur in the Project Boundary and were targeted during the field surveys:

- White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland;
- Brigalow (*Acacia harpophylla* dominant and co-dominant);
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia; and
- Weeping Myall Woodlands.

Listing advice and condition class guidelines used to identify these communities are summarised below.

a. Box Gum Woodland and Derived Native Grassland

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

The flow chart that summarises the SEWPaC method for identifying Box Gum Woodland and Derived Native Grassland is reproduced in **Appendix C**. It demonstrates that to confirm the presence of this CEEC as listed under the EPBC Act, it is firstly necessary to confirm the presence or historical presence of White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) and/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 dominant or co-dominant, a quadrat should be completed within a plot of 1,000 m² (0.1ha; the minimum area to be listed, see conditions below). SEWPaC has published a list of plants characteristics of Box Gum Woodland and Derived Native Grassland: if the survey plot contains 12 native understorey non-grassy 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. Floristic sampling was designed to meet SEWPaC guidelines for identifying the community, as well as the consideration of the listing advice. The field surveys were adequate to identify the distinguishing characteristics and condition thresholds of this community.

Mapping of the condition of Box Gum Woodland and Derived Native Grassland in the Project Boundary was guided by the condition classes provided within the SEWPaC listing advice, as reproduced below:

The White Box – Yellow Box – Blakely’s Red Gum grassy woodlands that existed prior to European settlement now exists as remnants in three different states.

The three states are:

- *An overstorey of eucalypt trees exists, but there is no substantial native understorey.*

- *A native understorey exists, but the trees have been cleared.*
- *Both a native understorey and an overstorey of eucalypts exist in conjunction.*

The Committee considers that areas in which an overstorey exists without a substantially native understorey are degraded and are no longer a viable part of the ecological community. Although some native species may remain, in most of these areas the native understorey is effectively irretrievable.

In order for an area to be included in the listed ecological community, a patch must have a predominantly native understorey.

The size and life-form of understorey species are such that viable populations can exist in very small areas (Prober & Thiele 1993). Therefore, in order to be the listed ecological community, an understorey patch, in the absence of overstorey trees, must have a high level of native floral species diversity, but only needs to be 0.1 hectares or greater in size. A patch in which the perennial vegetation of the ground layer is dominated by native species, and which contains at least 12 native, non-grass understorey species (such as forbs, shrubs, ferns, grasses and sedges) is considered to have a sufficiently high level of native diversity to be the listed ecological community. At least one of the understorey species should be an important species (e.g. grazing-sensitive, regionally significant or uncommon species; such as Kangaroo Grass or orchids) in order to indicate a reasonable condition.

Areas with both an overstorey and understorey present are also considered of sufficiently good condition to be part of the listed ecological community if the understorey meets any of the conditions above, or if they have a predominantly native understorey, are two hectares or above in size, and have either natural regeneration of the overstorey species or 20 or more mature trees per hectare.

The condition criteria outlined above are the minimum level at which patches are to be included in the listed ecological community. Such minimum conditions do not represent the ideal state of the ecological community. The larger and more diverse a patch is, the more important it is. Additionally, patches that link remnants in the landscape, that occur in depauperate areas, that contain rare, declining or threatened species and, that encompass the entire range of the ecological community, are important to the viability of the ecological community into the future. Such areas should accordingly be given priority in Australian Government NRM investments.

b. Brigalow EEC

Brigalow (*Acacia harpophylla* dominant and co-dominant) Ecological Community is characterised by the presence of Brigalow (*Acacia harpophylla*) as one of the three most abundant tree species within a community, which may include other *Acacia* or *Eucalyptus* species. The field surveys were adequate to identify the small scattered areas that contained Brigalow as one of the three most abundant species within an area.

The EPBC Act profile (SEWPaC 2012b) for Brigalow indicates the floristic composition and structure of the community can vary greatly. In accordance with the guidelines on condition classes found in the EPBC Act profile for this species, remnants of Brigalow in poor condition were excluded from the listed Brigalow ecological community. They include:

- *vegetation that has been comprehensively cleared (not just thinned) within the last 15 years,*
- *vegetation in which exotic perennial plants have more than 50% cover, assessed in a minimum area of 0.5 ha (100 m by 50 m), and*
- *individual patches of Brigalow that are smaller than 0.5 ha.*

c. Grey Box Grassy Woodlands and Derived Native Grasslands

The EPBC Act listing advice for Grey Box Grassy Woodlands and Derived Native Grasslands (recorded on the site as Inland Grey Box Woodland) provides a detailed description of key diagnostic characteristics and condition thresholds to identify the presence of this community as defined under the EPBC Act. The EPBC Act Policy Statement for assessing Grey Box Grassy Woodlands and Derived Native Grasslands (SEWPaC 2012e) provides two decision flow charts that summarise the SEWPaC method for identifying the woodland and grassland components of this community.

To confirm the presence of this EEC as listed under the EPBC Act, it is first necessary to confirm the presence of a tree canopy dominated ($\geq 50\%$ canopy crown cover) by *Eucalyptus microcarpa* (Grey Box). The mid layer comprises shrubs of variable composition and cover, from absent to moderately dense. The mid layer usually has a crown cover of less than 30% with local patches up to 40% crown cover. The ground layer also is highly variable in development and composition, ranging from almost absent to mostly grassy to forb-rich. Derived grasslands are a special state of the ecological community, whereby the canopy and mid layers have been mostly removed to $<10\%$ crown cover but the native ground layer remains largely intact, with 50% or more of the total vegetation cover being native. Condition thresholds are then applicable to any patch that has these characteristics. The condition thresholds for this community as provided by the SEWPaC listing advice are reproduced in **Table 3.2** below. The field surveys were adequate to identify the distinguishing characteristics and condition thresholds of this community.

Table 3.2 Condition Thresholds for Grey Box (<i>E. microcarpa</i>) Grassy Woodlands and Derived Native Grassland	
Category and rationale	Thresholds
Criteria that are broadly applicable	1a. The minimum patch size is 0.5 hectare;
	AND
	1b. The canopy layer contains Grey Box (<i>E. microcarpa</i>) as the dominant or co-dominant tree species;
	AND
	1c. The vegetative cover of non-grass weed species in the ground layer is less than 30% at any time of the year.
Additional criteria that apply to smaller woodland patches (0.5 to <2 ha in area) with tree crown cover >10%	2a. At least 50% of the vegetative cover in the ground layer comprises perennial native species at any time of the year;
	AND
	2b. 8 or more perennial native species (6 or more in the Flinders Lofty Block Bioregion of South Australia) are present in the mid and ground layers at any time of the year.
Additional criteria that apply to larger woodland patches with a well developed canopy (2 ha or more in area)	3a. At least 8 trees/ha are hollow bearing or have a diameter at breast height of 60 cm or more;
	AND
	3b. at least 10% of the vegetative ground cover comprises perennial native grasses at any time of the year;
	OR
	4a. At least 20 trees/ha have a diameter at breast height of 12 cm or more;
	AND
	4b. at least 50% of the vegetative
Additional criteria that apply to patches where the canopy is less developed or absent (derived grassland) (≥0.5 ha in area)	
	5a. Woodland density does not meet criteria 3a or 4a, or is a derived grassland with clear evidence that the site formerly was a woodland with a tree canopy dominated or co-dominated by <i>E. microcarpa</i> ;
	AND
	5b. At least 50% of the vegetative cover in the ground layer is made up of perennial native species at any time of the year;
	AND
	5c. 12 or more native species are present in the ground layer at any time of the year.

d. Weeping Myall Woodland

A patch of Weeping Myall must meet the following criteria to conform to the EPBC Act listing for the EEC:

- Tree canopy dominated (at least 50% of trees present) by living, dead or defoliated Weeping Myall trees; and
- The overstorey with at least 5% tree canopy cover or at least 25 dead or defoliated mature Weeping Myall trees / ha; and
- An area at least 0.5 ha in size; and
- Either two layers of regenerating Weeping Myall present; or, the tallest Weeping Myall trees is at least 4 m tall and vegetative cover present is comprised of 50% native species.

The field surveys were adequate to identify these distinguishing characteristics of this community.

iii. *Quadrat Sampling*

A total of 90 quadrats were sampled in 20 x 50 metre plots. The locations of these quadrats were chosen so that sampling was conducted in areas most representative of the condition and composition of the target vegetation patch. These quadrat locations are shown in **Figure 3.1**. Flora quadrat data is provided in **Appendix D**. In each quadrat, the following information was recorded:

- 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 within an internal 20 x 20 m plot;
- Vegetation structural data (i.e. height and percentage cover of each stratum);
- A waypoint to mark the location of the quadrat, obtained using a handheld GPS; and
- Photographs of the quadrat.

The relative abundance and cover of each species within the internal 20 x 20m quadrat was approximated using a scoring system based on the Braun-Blanquet scoring system (Braun-Blanquet 1927). The following scoring system was utilised during quadrat surveys:

- 1 = Sparse (less than 5% cover);
- 2 = Any number – (less than 5% cover);

- 3 = 5-25% cover;
- 4 = 26-50% cover;
- 5 = 51-75% cover; and
- 6 = 76-100% cover.

All vascular plants recorded or collected were identified using keys and nomenclature provided in (Harden 1990-1993). Other references used to assist identification of plant taxa include (Richardson et al. 2006), (Jacobs et al. 2008) and (Brooker and Kleinig 1990). Where known, taxonomic and nomenclatural changes have been incorporated into the results, as derived from *PlantNET* (Botanic Gardens Trust 2012). Any specimens that were not readily identifiable were lodged for identification with the National Herbarium of NSW at the Royal Botanic Gardens, Sydney.

iv. Targeted Surveys

Targeted threatened flora surveys were undertaken across the Project Boundary. These surveys were undertaken as part of the vegetation mapping ground-truthing and quadrat surveys, and included targeted searches within suitable habitat and, where applicable, at particular times of the year to increase the chance of detection. Searches were also conducted in the vicinity of recorded specimens. The locations of threatened flora specimens were recorded using a hand held GPS.

The following EPBC Act listed flora species were targeted as part of threatened flora surveys of the Project Boundary; *Dichanthium setosum* and *Bothriochloa biloba*. The targeted surveys undertaken for these species are discussed in more detail below.

a. *Dichanthium setosum* (Vulnerable)

No specific sampling methodology exists for *Dichanthium setosum*. The species was targeted during summer surveys to coincide with its flowering time, and thus increase its detectability. As per its conservation advice (Threatened Species Scientific Committee 2008b), the species was also targeted in areas of the Project Boundary that support suitable habitat, such as where *Dichanthium setosum* distribution overlaps the following relevant EPBC Act-listed C/EECs:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions;
- Brigalow (*Acacia harpophylla* dominant and co-dominant); and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

According to Atlas of NSW Wildlife data, several individuals of *Dichanthium setosum* have been previously recorded within the Project Boundary along parts of Court Lane and The Dip

Road. These locations were visited on two separate occasions during flowering periods in 2010 and 2011. The area around each record was thoroughly searched by two botanists for a period of 30 minutes or more depending on the size of the search area. The size of the search area reflected the accuracy, which accompanied the Atlas of NSW Wildlife data. For example, if the accuracy of the record was 10m, then a 10m x 10m area was searched around the recorded location. Within search areas *Dichanthium spp.* were randomly sampled and fertile spikelets measured repeatedly for the duration of the search. Any *Dichanthium spp.* observed to have slightly different vegetative growth was also sampled and fertile spikelets measured.

Throughout the entire survey period all *Dichanthium spp.* recorded in quadrats or during random meanders and vegetation mapping were sampled and fertile spikelets measured.

b. *Bothriochloa biloba* (Vulnerable)

No specific sampling methodology exists for *Bothriochloa biloba*. The species was targeted during summer surveys to coincide with its flowering time, and thus increase its detectability. As per its conservation advice (Threatened Species Scientific Committee 2008e), the species was targeted in areas of the Project Boundary that support suitable habitat, such as where *Bothriochloa biloba* distribution overlaps the following relevant EPBC Act-listed C/EECs:

- Brigalow (*Acacia harpophylla* dominant and co-dominant), and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

Targeted searches for *Bothriochloa biloba* were undertaken along Court Lane and The Dip Road in the vicinity of incidentally observed specimens. Each individual observed was given a GPS location. If more than one individual was observed in close proximity to another/others, then the number of individuals was estimated and recorded for that single location. A population estimate was calculated by totalling the number of individuals recorded within the Project Boundary.

v. *Vegetation/Habitat Condition Assessment*

The condition of the vegetation and associated habitat within the Project Boundary was assessed by two methods. The first included a general assessment of the vegetation based on field observations, vegetation type (i.e. woodland vs. grassland) and edge to area ratio. The vegetation communities were ranked into Low, Moderate and Good vegetation condition by following these general rules:

- **Low** = Grassland;
- **Moderate** = Woodland with a perimeter to area ratio ≥ 0.1 ; and
- **Good** = Woodland with a perimeter to area ratio < 0.1 .

The second method utilised for the vegetation condition assessment included comparing BioBanking data that was collected at each quadrat with benchmark data for the applicable vegetation community in which the quadrat was located. This included amalgamation of the ten plot data values (see Step 3 below) into one site attribute score per plot by using the BioBanking scoring and weighting methodology for site attributes. Below is a step-by-step description of this method.

- 1) Match each vegetation community with the closest-matching BioBanking Vegetation Type;
- 2) Retrieve BioBanking benchmark data for the vegetation type;
- 3) Calculate site attribute scores by comparing the following data elements that were recorded at each vegetation quadrat, as per the BioBanking methodology (DECC 2009), to the BioBanking benchmark data for the applicable vegetation type:
 - Native species richness recorded within each stratum of the 20 m x 20 m plot;
 - Native overstorey projected foliage cover recorded at 10 points along a 50m transect;
 - Native midstorey projected foliage cover recorded at 10 points along a 50m transect;
 - Native groundcover projected foliage cover recorded at 10 points along a 50m transect for three life forms (shrubs, grasses and other);
 - Weed species projective foliage cover expressed as a percentage of overstorey, midstorey and ground cover along a 50m transect;
 - Number of trees with hollows where entrance width is over 5cm and hollow is at least 1m above ground within the 20 m x 50 m plot. The percentage of regenerating canopy species within the vegetation zone; and
 - The total length in metres of fallen logs over 10cm in diameter within the 20 m x 50 m plot.
- 4) To obtain the final site attribute score, each individual attribute score is multiplied by its weighting factor, summarised and the final result divided by 300. The overall site attribute score is expressed as a fraction of 1, where 1 is a perfect score indicating that the vegetation is within the benchmark score for that community in every aspect, and smaller fractions indicating that the quadrat does not meet the benchmark score for that community.

5) The following condition ratings for each quadrat are based on the site attribute score for each vegetation quadrat as follows:

- **Low** = 0 to 0.249;
- **Moderate** = 0.25 to 0.499; and
- **Good** = 0.5 to 1.

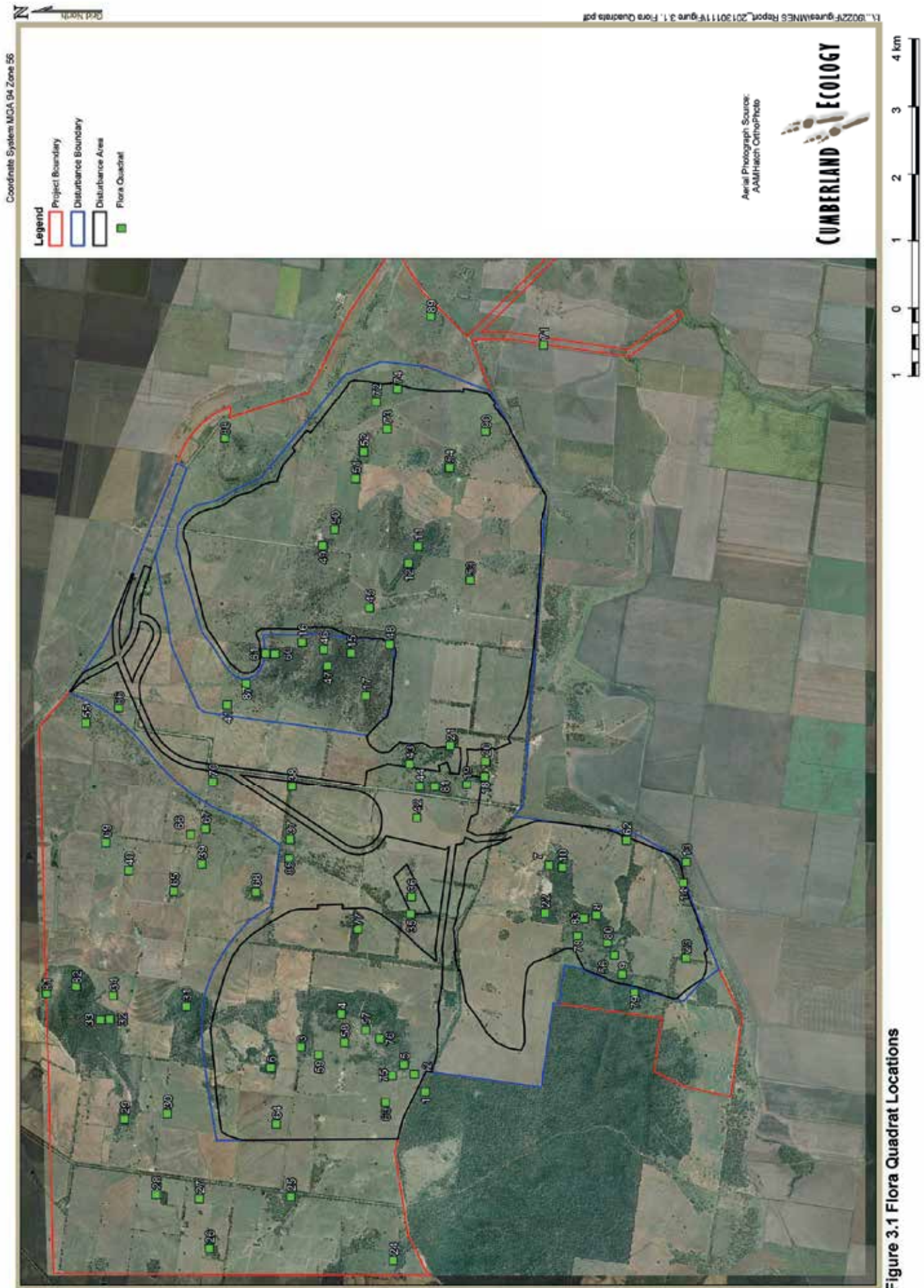
The vegetation condition scores reflect how closely the plot data matches the BioBanking Benchmark Values, with lower scores indicating lower condition vegetation that does not meet the BioBanking Benchmark Values for that community. It is to be noted that under the BioBanking methodology, the ranking of vegetation community conditions is different from the ranking applied in this assessment. The BioBanking ranking allows only two conditions only, i.e. vegetation is in low condition or in moderate/good condition.

The condition ratings for each quadrat were plotted on the map produced by the general assessment for comparison.

vi. Survey Effort

Flora survey methods and survey effort based on the broad areas of habitat and using OEH survey guidelines (DEC 2004) are summarised in **Table 3.3** below. Note that the final total numbers of grassland quadrats were lower than recommended because during the field inspections it was clearly apparent that broad areas of “grassland” were cultivated fields containing crops such as wheat and as such required no quadrat surveys to verify that they were not native vegetation. Also, due to the importance of woodland habitats double the recommended survey effort (i.e. quadrat number) was completed in such vegetation.

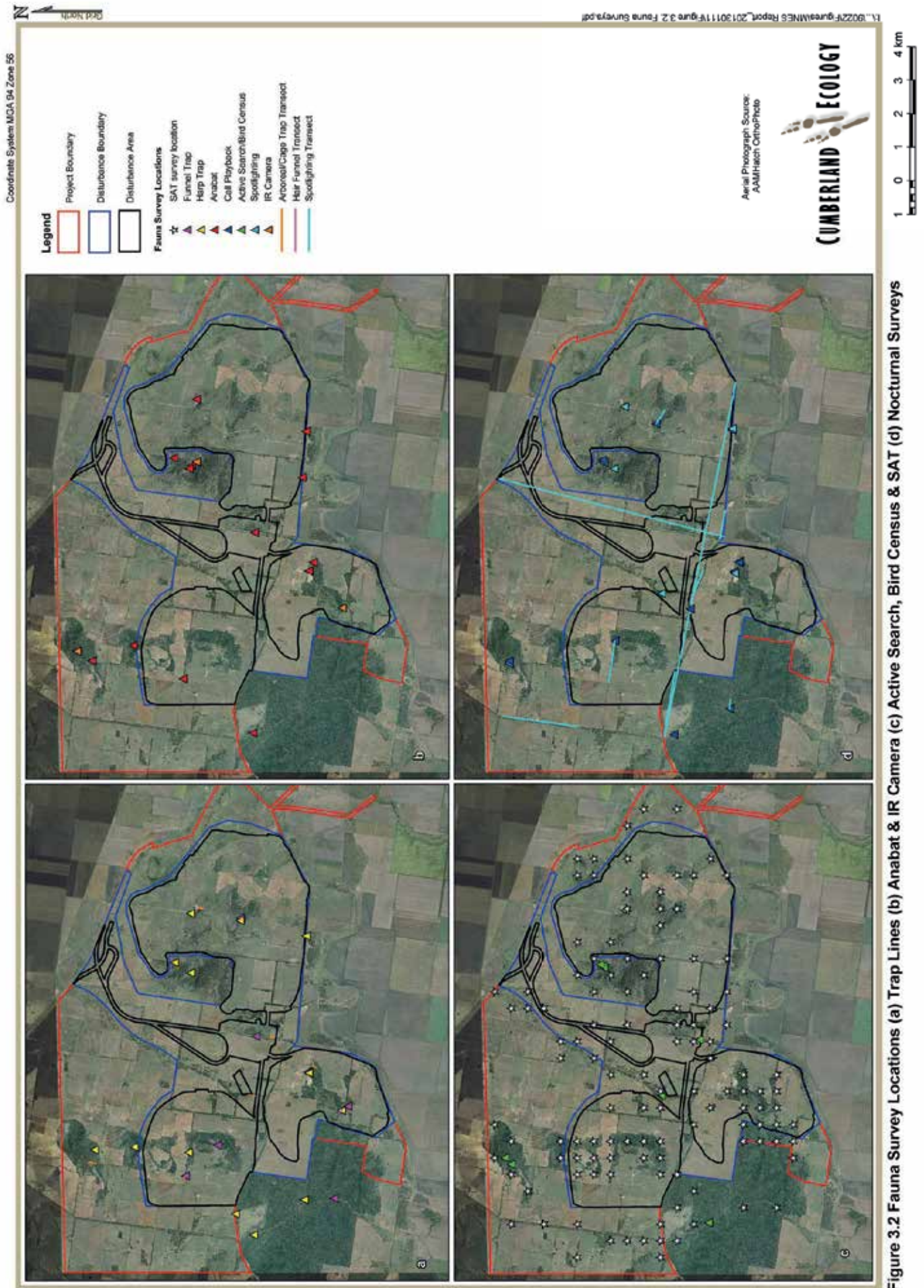
Table 3.3 Flora Survey Effort		
Survey Technique	Recommended Survey Effort (based on total area)	Survey Effort
Vegetation mapping	n/a	29 days (some concurrently with quadrat sampling)
Quadrat sampling	80 quadrats within grassland, 30 quadrats within woodland	29 quadrats within grassland, 61 quadrats within woodland
Random meanders	80 x 30 minutes within grassland, 30 x 30 minutes within woodland	Throughout survey period
Targeted threatened plant species searches	During plot surveys, random meanders or by opportunistic observations	Five days for two people (targeted) and additional observations throughout survey period



3.2.3 Fauna Surveys

Fauna surveys were conducted where possible, in accordance with SEWPaC Survey Guidelines for Nationally Threatened Species (DEWHA 2010a, b, SEWPaC 2011f, g) and EPA Threatened Biodiversity Survey and Assessment; Guidelines for Developments and Activities (Working Draft) (DEC (NSW) 2004). Surveys were undertaken over several survey sessions and timed appropriately to increase the seasonal range of sampling to maximise detection of threatened species. Surveys were conducted by qualified ecologists, including fauna specialists.

As the recommended survey methods are based upon stratification units, the Project Boundary was stratified into eight zones as a surrogate for fauna habitat and survey effort was allocated accordingly. Zones were established using the four proposed disturbance areas (Eastern, Western and Southern Mining Areas, and the Mining Infrastructure Area (MIA)) as well as four remaining non-disturbance areas. Based on preliminary mapping, grassy and shrubby woodlands covered approximately one quarter of the Project Boundary, with exotic and native grasslands dominating the remaining area. The grassland communities do not provide suitable habitat for the majority of threatened fauna species, and therefore trapping surveys were confined to the woodland communities within the Project Boundary, although other survey methods were also employed in grassland areas.



i. Koala Surveys

Field surveys for the Koala were undertaken throughout the Project Boundary, Breeza State Forest and Offset Area 6 (collectively referred to as the Survey Area). The following survey methods were used:

- Koala activity: Spot Assessment Technique (SAT) as described within Phillips and Callaghan (2011); and
- Density and population estimates: Area searches as described in Phillips et al. (submitted).

No specific survey guidelines have been prepared for the Koala by SEWPaC, and the SAT protocol is a well known and acknowledged technique to survey for Koalas.

A total of 168 sites were surveyed within the Survey Area using the SAT methodology and area search methodology. Surveys were predominately undertaken at sites within a 750 m x 750 m primary sampling grid with additional surveys undertaken at sites within a 500 m x 500 m secondary sampling grid.

At each SAT survey site, a maximum of two person minutes were spent searching for faecal pellets (scats) within a one metre radius of the base of a central mature Koala feed tree (or another species if no feed trees were present) and each of the closest 29 additional trees. Trees that were targeted included those listed in **Table 3.4** that are listed as Koala feed trees for the Western Slopes and Plains Koala Management Area (KMA) in the approved Koala Recovery Plan for the Koala (DECC (NSW) 2008). Searching ceased if a Koala faecal pellet was located before this time expired. Searching for faecal pellets involved an initial inspection of the ground surface followed by a robust disturbance (raking) of the leaf litter if necessary to search for faecal pellets. The species of each tree searched was recorded along with presence/absence of Koala faecal pellets.

Area searches for the Koala were undertaken at each of the SAT survey sites, irrespective of result of the faecal pellet searches. At each of the SAT survey sites, a five minute visual inspection of trees was conducted within a 25 m radius of the central tree. During this inspection, any individual Koalas present were recorded. Area search data analysis involved the calculation of Koala densities across the surveyed area. Only data collected from the primary sampling grid (i.e. the 750 m x 750 m sampling grid) was used to determine density as they provide the least biased density estimate across the surveyed area. A detailed assessment of the Koala population impacted by the Project is provided in the Project specific Koala Plan of Management (KPOM).

Whilst the data collected provides a good basis for calculating density and population estimates, additional surveys or further techniques could be considered to refine the estimates including strip or line transects, spotlighting searches, mark and recapture and radio-tracking.

Table 3.4 Koala Feed Trees for the Western Slopes and Plain KMA (DECC (NSW) 2008)	
Scientific Name	Common Name
Primary Food Tree Species	
<i>Eucalyptus camaldulensis</i>	River Red Gum
<i>Eucalyptus coolabah</i>	Coolabah
Secondary Food Tree Species	
<i>Eucalyptus chloroclada</i>	Dirty Gum
<i>Eucalyptus populnea</i>	Bimble or Poplar Box
<i>Eucalyptus pilligagensis</i>	Narrow-leaved Grey Box
<i>Eucalyptus conica</i>	Fuzzy Box
<i>Eucalyptus microcarpa</i>	Western or Inland Grey Box
<i>Eucalyptus albens</i>	White Box
<i>Eucalyptus melliodora</i>	Yellow Box
<i>Eucalyptus dwyeri</i>	Dwyer's Red Gum
<i>Eucalyptus dealbata</i>	Tumbledown Gum
<i>Eucalyptus blakelyi</i>	Blakely's Red Gum
<i>Eucalyptus bridgesiana</i>	Apple Box
<i>Eucalyptus largiflorens</i>	Black Box
<i>Eucalyptus nandewarica</i>	Mallee Red Gum
<i>Eucalyptus vicina</i>	n/a
<i>Eucalyptus volcanica</i>	n/a
<i>Eucalyptus polyanthemus</i>	Red Box
<i>Eucalyptus prava</i>	Orange Gum
Supplementary Species	
<i>Eucalyptus macrorhyncha</i>	n/a
<i>Eucalyptus sparsifolia</i>	Narrow-leaved Stringybark

ii. Trap Lines

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

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

Arboreal trap lines were established with Elliott (B) traps and set approximately 20m apart depending on available habitat. 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 to act as an attractant.

During each survey period arboreal traps were established at four locations and left for a period of four nights. Each trap line contained 10 traps. A total of 320 arboreal trap nights were completed over the entire survey period.

In addition to the arboreal Elliott (B) traps, six cage traps were placed in each of the terrestrial trap lines to target medium to large sized mammals. The cage traps were baited with chicken necks. Each of the two survey periods consisted of two, four-night trapping periods. A total of 96 cage trap nights were completed over the entire survey period. Traps were checked early each morning, and any fauna captured were identified and released.

Funnel traps were utilised to survey for small terrestrial fauna. Funnel trap lines were established for four nights at eight locations throughout the Project Boundary. Each funnel trap line consisted of six funnel traps placed approximately five metres apart. Drift fencing was erected along each funnel trap line to direct fauna towards the traps. Funnel traps were checked early each morning, and any fauna found were identified and released. A total of 192 funnel trap nights (48 traps for 4 nights) were completed over the entire survey period.

These trapping surveys were used to gain an appreciation of the diversity of fauna species in the Project Boundary, and to specifically target threatened species such as the Spotted-tailed Quoll (*Dasyurus maculatus*) (in the large cage traps).

iii. *Hair Tubes*

'Faunatech' hair tubes were used during field surveys to detect small and medium sized terrestrial mammals, in particular the Spotted-tailed Quoll (*Dasyurus maculatus*), which is listed as Endangered under the EPBC Act and has potential to occur in the Project Boundary. During the survey period, three transects were established. Each transect contained 20 hair tubes. All hair tubes were placed on the ground along each transect. Hair tubes were baited with rolled oats, peanut butter and honey. A total of 600 hair tube nights were completed over the entire survey period. Hair samples were analysed by Georgeanna Story of 'Scats About', Majors Creek, NSW.

The extensive hair tube surveys are considered to be appropriate for targeting the Spotted-tailed Quoll. These were supplemented by infra-red (IR) camera surveys, further habitat assessments and diurnal searches as detailed below.

iv. *Microchiropteran Bat Surveys*

Microchiropteran bats (microbats) were surveyed using a combination of ultrasonic echolocation call recordings from Anabat Z-CAIM units and harp traps.

Anabat Z-CAIM units were employed for a total of 31 survey nights to record calls of microbats. During the first round of fauna surveys (undertaken in March 2011) Anabat units were placed at six locations for two whole nights, resulting in a total of 12 Anabat survey nights. In addition, one Anabat unit was carried while spotlighting during four additional nights. This combined with fixed location data resulted in 16 nights of Anabat Z-CAIM recordings being collected over the survey period.

During the second round of fauna surveys (undertaken in May 2011) nine nights of Anabat data was collected (one Anabat unit at three locations for two nights each and at one location for three nights).

A final round of Anabat surveys was conducted in March 2012. During this period three Anabats were deployed over two nights each, resulting in six nights of Anabat data for this survey period.

Calls recorded on each Anabat unit were analysed to determine which species were present within the Project Boundary.

Harp traps were employed at 12 suitable flyway locations for a total of 24 trap nights to capture microbats across the Project Boundary. During the March 2011 survey period, nine harp trapping locations were surveyed for two nights at each survey location, resulting in a total of 18 harp trap nights. A second round of harp trap surveys was conducted in March 2012. During this period three harp trap locations were surveyed for two nights each, resulting in six trap nights for this period.

Microbats were collected from harp traps at dawn and the bat species subsequently identified. All microbats collected from harp traps were kept in a cool dark place during the day, and released at the point of capture the following evening to prevent unnecessary stress on collected individuals.

Two threatened microbat species listed as Vulnerable under the EPBC Act are known to occur in the locality and considered to have potential to occur within the Project Boundary; the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*). The EPBC Act survey guidelines for bats indicates that Anabat surveys are appropriate to detect the Large-eared Pied Bat, and that they are the best form of non-invasive survey (DEWHA 2010a). The calls of the South-eastern Long-eared Bat are not distinguishable reliably from other sympatric *Nyctophilus* species using Anabat detectors, and therefore capture techniques such as harp trapping and mist nets are preferred (DEWHA 2010a). The surveys for microchiropteran bats that were undertaken in the study area are considered to be appropriate to detect these two species if they were present. Anabat surveys were conducted that were suitable to detect the Large-eared Pied Bat, and harp trapping was conducted that was appropriate to detect the South-eastern Long-eared Bat.

v. *Diurnal Bird Surveys*

Visual observation and call identification of diurnal birds was carried out during each survey period. Sixty-six 30 minute diurnal bird census points were surveyed throughout the Project

Boundary from November 2010 to March 2012. Diurnal birds were also identified and recorded as they were encountered throughout the Project Boundary during all other surveys. GPS coordinates were recorded near sightings of any threatened bird species.

Bird species particularly targeted during the diurnal bird surveys were the threatened bird species listed under the EPBC Act that were considered to have potential to occur; the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*). According to the EPBC Act survey guidelines for birds (DEWHA 2010b), all of these species are most appropriately surveyed for using area surveys of suitable habitat. The extensive diurnal bird surveys conducted within the Project Boundary are considered appropriate for the detection of these threatened bird species.

vi. *Nocturnal Bird Surveys*

Nocturnal bird surveys were undertaken over 11 nights for all known nocturnal threatened bird species within the Gunnedah LGA, identified in Government database searches. Surveys were conducted between March 2011 and March 2012.

Nocturnal birds were surveyed by broadcasting taped calls through an amplifier. Calls were played for two minute periods at five minute intervals, for approximately half an hour at each location. This was followed with quiet listening and spotlighting. GPS coordinates were recorded near sightings of any threatened bird species.

vii. *Spotlighting Surveys and Call Playback*

Nocturnal spotlighting was conducted for nocturnal mammals, birds and reptiles 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. Several threatened species have potential to occur in the study area that are recommended to be targeted using spotlight surveys including the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) and the Five clawed worm skink (*Anomalopus mackayi*), and these species were targeted during the spotlighting surveys.

During spotlighting surveys, call playback of taped nocturnal mammal calls were broadcasted using a megaphone to illicit a response from targeted threatened nocturnal species including the Spotted-tailed Quoll (*Dasyurus maculatus*). Calls were played for two minute periods at five minute intervals. This was followed with quiet listening and spotlighting.

Koalas (*Phascolarctos cinereus*) were frequently recorded during diurnal and nocturnal searches throughout the Project Boundary. For this reason, and to prevent unnecessary stress on Koalas in the locality, call playback was not employed as a survey method for Koalas.

viii. *Infra-red Cameras*

Infra-red (IR) cameras were set up at four locations throughout the Project Boundary to identify fauna species. The cameras were attached to trees and focused upon nearby buried bait (chicken necks). The cameras begin recording when nearby fauna movement activates the motion sensor. The bait was replenished as necessary. Three cameras were used and left for 10 nights, resulting in a total of 30 IR recording nights. Recorded footage was collected and analysed to identify the detected fauna species.

IR cameras are considered by the EPBC Act survey guidelines for mammals (SEWPaC 2011f) to be the most cost-effective way to survey for the Spotted-tailed Quoll (*Dasyurus maculatus*), and also are beneficial as they record other carnivores, particularly exotic cats and foxes.

ix. *Amphibian and Reptile Surveys*

Diurnal and nocturnal searches of suitable habitats for amphibians and reptiles were conducted within the Project Boundary.

Diurnal active searches of 66 locations were conducted within the Project Boundary and Breeza State Forest, including some in conjunction with the Koala SAT surveys. Searches involved lifting of bark, fallen logs, bushrock and scraping and raking of top soil and litter. Captured animals were identified and then released. Reptiles were also recorded incidentally at all remaining Koala SAT survey locations. Koala SAT surveys involved raking of leaf litter beneath trees, which is also an effective method for detecting fossorial reptiles.

These searches recorded all the amphibians and reptiles that were recorded, however particular focus was placed on three reptile species listed under the EPBC Act that were considered to have potential to occur. These were the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*), the Pink-tailed Worm-lizard (*Aprasia parapulchella*) and the Five clawed worm skink (*Anomalopus mackayi*). The survey guidelines contained in the EPBC Act survey guidelines for reptiles (SEWPaC 2011g) state that searches underneath sheltering habitat and bushrock are appropriate methods to detect these species, and the surveys conducted in the Project Boundary are considered to have been appropriate to detect these species if they were present. The survey guidelines for the Border Thick-tailed Gecko state that it is preferable to search sheltering sites during the day and to conduct spotlighting searches at night for this species as well as conduct funnel trapping at night. Spotlighting and funnel trapping was undertaken as part of the survey effort and together with the diurnal searches described in this section, are considered to constitute an appropriate level of survey effort for this species.

Amphibian surveys included diurnal and nocturnal habitat searches of damp and watery sites including wet tracks and road-side ditches.

x. *Incidental Observations*

Any vertebrate fauna species observed, detected on the basis of calls, tracks, scats, scratch markings or otherwise, were recorded and listed in the total species list for the Project.

Incidental records of threatened flora and fauna from areas adjacent to the Project Boundary have also been considered in the assessment.

xi. Survey Effort

Fauna survey methods and survey effort are summarised in **Table 3.5**. The recommended survey effort is based upon the OEH guidelines (DEC 2004), which in turn provide recommendations based upon total survey area of habitat. Survey effort for most species achieved or exceeded guideline requirements, with some exceptions. However, in such circumstances, alternate methods were deployed to complement the recommended survey effort and provide for an appropriate level of survey, as explained in **Table 3.6** and **Section 3.5.2**. Note that a “trap night” means one trap set for one night, and as there were many traps being used on any one survey night, there are many more trap nights than survey nights.

The surveys are considered to have been adequate to record the threatened species that are been considered to have potential to occur in the Project Boundary. An assessment of the adequacy of the survey effort to detect the EPBC Act listed threatened species with potential to occur within the Project Boundary area is provided in **Table 3.6**.

Table 3.5 Fauna Survey Effort		
Survey Technique	Recommended Survey Effort based on area of habitat: 1,997 ha of Woodland	Survey Effort
Amphibians		
Systematic day habitat search	1 hour	66 x 30 min census points within suitable habitat on multiple days
Night habitat search of damp and watery sites	30 minutes on two separate nights	Walking and driving - 41 hours on multiple nights
Reptiles		
Habitat search	10 x 30min searches on separate days targeting specific habitat	66 x 30 min census points on multiple days
Spotlighting	10 x 30min searches on separate days targeting specific habitat	Walking and driving - 41 hours on multiple nights
*Funnel traps	n/a	192 trap nights
Diurnal Birds		
Area search	Throughout survey period – no total effort specified	66 x 30 min census points during multiple days

Table 3.5 Fauna Survey Effort		
Survey Technique	Recommended Survey Effort based on area of habitat: 1,997 ha of Woodland	Survey Effort
Nocturnal Birds		
Call playback	8 call playback nights per site	11 sites for one night over multiple nights
Day habitat search	Throughout survey period	Throughout survey period
*Nocturnal spotlight search	n/a	Walking and driving - 41 hours
Non-flying Mammals		
Arboreal Elliott traps	504 trap nights	320 trap nights (this was complimented by the use of hair tubes)
Wire cage traps	504 trap nights	96 trap nights (this was complemented by the use of IR cameras and extra hair tubes)
Pitfall traps with drift nets	504 trap nights	Funnel traps - 192 trap nights (this was complemented by the use of extra hair tubes).
Hair tubes	440 trap nights	600 trap nights using Faunatech hairtubes which comprise both small and large sizes
Spotlighting on foot	20 x 1 hour (1km) over separate nights	Walking and driving - 41 hours over multiple nights
Spotlighting from vehicle	20 x 1km tracks over separate nights	see above
Call playback	Playback on two nights for 19 sites	11 sites for one night over multiple nights (for the Koala, this was also complemented by the SAT/Area Searches)
Search for scats and signs	21 x 30min searching each relevant habitat, including trees for scratch marks	Throughout survey period (this was also complemented by the SAT technique for Koala, which surveyed Koala scats over 168 sites)
Collection of predator scats	Opportunistic collection of predator scats for hair analysis	Throughout survey period

Table 3.5 Fauna Survey Effort		
Survey Technique	Recommended Survey Effort based on area of habitat: 1,997 ha of Woodland	Survey Effort
*Koala SAT/Area Search surveys	n/a	168 SAT/Area Search sites
*IR camera detection	n/a	30 survey nights
Bats		
Harp trapping	1 harp for 2 nights at 40 sites (80 trap nights)	24 trap nights (complimented by ultrasonic call recordings)
Ultrasonic call recording	1 anabat for 2 nights at 40 sites (80 trap nights)	31 trap nights (complimented by harp trapping)

*Survey technique not described within survey guidelines for targeted fauna group

Table 3.6 Assessment of the Adequacy of Surveys to Detect Threatened Species with Potential to Occur within the Project Boundary			
Species	Survey Guidelines	Surveys Conducted	Assessment of Adequacy
Swift Parrot	No survey guidelines beyond description of call and habits	Sixty-six 30 minute diurnal bird census points were surveyed throughout the Project Boundary from November 2010 to March 2012 in areas of suitable habitat	This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
Regent Honeyeater	The recommended method for surveying the Regent Honeyeater is to conduct area searches in suitable habitat such as in patches of woodland that have heavily-flowering trees or that are infested by lerp, especially near water points such as creeks and dams, and observers should also inspect flocks of other nectarivorous birds such as Rainbow Lorikeets (<i>Trichoglossus haematodus</i>) and other honeyeaters. Broadcast surveys can be useful if conducted immediately prior to or during the breeding season. Surveys should be conducted in the morning if possible, although birds can be detected at other times of the day. Detection is easiest during the breeding season, when birds respond strongly to broadcast calls. Detection can be difficult during the non-breeding season, as birds ignore broadcast calls, and are often quiet and difficult to observe.	Sixty-six 30 minute diurnal bird census points were surveyed throughout the Project Boundary from November 2010 to March 2012. These were located in the most likely places to record this species, such as woodland areas and near dams.	The timing of the surveys was optimum to record this species. The level of survey effort is considered adequate to record this species if it was present at the time of the surveys. The surveys coincided with the breeding time of this species which is the optimal time to survey
Superb Parrot	The Superb Parrot can be surveyed using area searches or transect surveys of suitable habitat, preferably in the early to mid-morning and evening. Vehicle-based transects are appropriate in areas where most habitat is restricted to roadside remnants. It can be detected by sight, usually while in flight, or by its	Sixty-six 30 minute diurnal bird census points were surveyed throughout the Project Boundary from November 2010 to March 2012 in areas of suitable habitat	This bird has a highly distinctive call and is readily identified. The level of survey effort is considered adequate to record this species if it was present at the time of the surveys.

Table 3.6 Assessment of the Adequacy of Surveys to Detect Threatened Species with Potential to Occur within the Project Boundary			
Species	Survey Guidelines	Surveys Conducted	Assessment of Adequacy
	distinctive call.		
Koala	No survey guidelines for the Koala exist that are prepared by SEWPaC. The Spot Assessment Technique (SAT) was used which is recognised as a valid technique.	A total of 168 SAT/Area Search survey sites were sampled across the Project Boundary, Breeza State Forest.	The Koala was recorded several times in the Project Boundary and the SAT surveys provided a very good indication of its patterns of usage of the site
Spotted tailed quoll	Techniques to survey Spot-tailed Quolls include searches for latrine sites, searches for scats of other predators (which may contain quoll hair and bone fragments) and hair sampling tubes. Other recommended techniques include daytime searches for potentially suitable habitat resources, such as areas associated with gullies or ridges and potential den sites (caves, hollow logs or dense understorey vegetation such as Lantana (Lantana spp.) that provides suitable cover), daytime searches for signs of activity, including tracks, scats and latrines, hair sampling device (hair-funnels) surveys, using a mixture of sardines, tuna oil and flour for bait.	A total of 600 hair tube nights were completed in the Project Boundary. In addition, habitat assessments were undertaken to identify areas of potential habitat for this species. All unknown scats observed during the field surveys were collected and identified. During the field survey, observations were made of any fauna species on the basis of sighting or indirect signs of its presence.	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
New Holland Mouse	No survey guidelines exist other than a description of their preferred habitat.	Funnel trapping is recognised as an appropriate method to target small fauna species, and this was undertaken in the Project Boundary. A total of 192 funnel trap nights were surveyed.	This species is considered unlikely to occur due to the known distribution of the New Holland Mouse and the habitat on site (which if highly fragmented and has high densities of feral predators). Accordingly, more targeted surveys were not necessary.

Table 3.6 Assessment of the Adequacy of Surveys to Detect Threatened Species with Potential to Occur within the Project Boundary			
Species	Survey Guidelines	Surveys Conducted	Assessment of Adequacy
Brush tailed rock wallaby	Recommended survey techniques to detect the presence of the Brush-tailed Rock-wallaby include: Daytime searches for potentially suitable habitat resources, such as shelter sites (caves, rock boulders and rock ledges) in suitable boulder pile, escarpment and cliff-line habitats. Daytime searches for signs of activity, including tracks, scats and rock shelters worn smooth from resting. Possibly the collection of predator scats, owl casts or remains, targeting predatory bird/mammal nests/dens. Observations for rock-wallabies basking during the day, or becoming active at dusk, using binoculars from a location on the ground beneath suitable habitat or possibly from a helicopter.	Habitat assessments were conducted across the Project Boundary to determine areas of potential habitat for the Brush-tailed Rock Wallaby. All unknown scats were collected and identified. Observations of any fauna present in the Project Boundary were made during the field surveys.	Taking this into consideration, the funnel trap surveys undertaken are considered to have been appropriate to detect this species. The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
Grey headed flying fox	The Grey-headed Flying-fox occupies most areas in their distribution in highly irregular patterns, and, therefore, surveys based on animal sightings are unlikely to be reliable. A more effective survey method is to search appropriate databases and other sources for the locations of camps, and to conduct vegetation surveys to identify feeding habitat.	A database analysis was conducted to identify the location of any camps in the area. Habitat assessments were made across the Project Area to determine areas of suitable habitat. Reference was made to the results of the flora survey to identify areas that contained suitable food trees.	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
Large eared pied bat	The use of electronic bat detectors is the best means of non-	Anabat Z-CAIM units were employed	The surveys utilised recognised

Table 3.6 Assessment of the Adequacy of Surveys to Detect Threatened Species with Potential to Occur within the Project Boundary			
Species	Survey Guidelines	Surveys Conducted	Assessment of Adequacy
	invasive survey, and the most efficient in terms of data collection and area coverage. Trapping with harp traps and mist nets, and roost searches in caves, mines, rock overhangs, culverts and crevices could be undertaken to confirm presence or roosting. Harp traps are effective in areas of lower densities, but mist nets are not. Surveys are best conducted from October through to March.	over three survey periods for a total of 31 survey nights to record calls of microbats. Surveys were undertaken in March 2011, May 2011 and March 2012. Harp traps were employed at 12 suitable flyway locations for a total of 24 trap nights to capture microbats across the Project Boundary.	techniques to detect this species. They were largely conducted at the recommended time of year (March) and the weather at this time of the year was considered to be adequately warm for bats to be still active and able to be recorded. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
South-eastern Long eared Bat	Calls are not distinguishable reliably from other sympatric <i>Nyctophilus</i> species using Anabat detectors, and therefore capture techniques such as harp trapping and mist nets are preferred. For an area of up to 50 ha, a total of 20 harp trapping nights should be conducted for a minimum of 5 nights.	Harp traps were employed at 12 suitable flyway locations for a total of 24 trap nights to capture microbats across the Project Boundary.	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys
Border Thick-tailed Gecko	It is recommended that rock-turning searches not be undertaken and that a torch be used to search sheltering sites by day or that funnel traps be used at night. To detect the presence of the species in an area, it is recommended that survey work be undertaken in the warmer months of the year (November to February). Both day searches of sheltering sites and spotlighting of rocky habitat and adjacent woodland for active animals in the first three hours of darkness should be undertaken.	Diurnal active searches of 66 locations of suitable habitats for reptiles were conducted within the Project Boundary and Breeze State Forest. Nocturnal spotlighting was also conducted for reptiles using a hand-held spotlight while walking and while travelling between transects at night. A total of 192 funnel trap nights were surveyed. Surveys were	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys. The timing of the surveys was slightly later than recommended (March instead of February), however weather conditions were considered to be

Table 3.6 Assessment of the Adequacy of Surveys to Detect Threatened Species with Potential to Occur within the Project Boundary				
Species	Survey Guidelines	Surveys Conducted	Assessment of Adequacy	
the Pink-tailed Worm-lizard	The Pink-tailed Worm-lizard can be found throughout the year by searching under rocks, however, it appears to be more difficult to detect during hot dry periods. Peak seasonal activity is likely to be late spring and early summer during warm, but not overly dry, conditions. The following survey methods were adopted by Osborne and colleagues (1991): Searches are restricted to an area of relatively homogeneous habitat within each site and a search beneath all rocks that can be turned is made. Rock cover density rather than fixed area size determines a plot, and 150–200 rocks need to be turned to be reasonably confident of determining the species' presence.	Diurnal active searches of 66 locations of suitable habitats for reptiles were conducted within the Project Boundary and Breeza State Forest. Nocturnal spotlighting was also conducted for reptiles using a hand-held spotlight while walking and while travelling between transects at night.	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys. Surveys were undertaken in the optimum times to survey for this species as they are outside the hottest months.	warm enough to detect this species during the field surveys.
Five clawed worm skink	It is recommended that the establishment and monitoring of artificial shelter sites be used as the primary survey technique. Active searching of microhabitats by hand should be conducted as a supplementary technique when and where there is a possibility of finding a specimen under natural or artificial debris, during periods when topsoils underneath are likely to be moist. Sufficient time is required to thoroughly search the area by day and to spotlight by night. The minimum survey effort required includes: a minimum of three survey days and nights and at least one replicate survey employing all of the recommended techniques, if the species has not already been detected.	Diurnal active searches of 66 locations of suitable habitats for reptiles were conducted within the Project Boundary and Breeza State Forest. Nocturnal spotlighting was also conducted for reptiles using a hand-held spotlight while walking and while travelling between transects at night. Surveys were undertaken in March 2011, May 2011 and March 2012.	The surveys utilised recognised techniques to detect this species. This level of survey effort is considered adequate to record this species if it was present at the time of the surveys	

3.2.4 *Habitat Assessment*

The characteristic attributes of fauna habitats generally influence the assemblage of fauna species and the general value of the habitat for fauna. The Project Boundary contains four broad habitat types:

- Woodland;
- Wetland;
- Riparian vegetation associated with minor tributaries and drainage lines; and
- Grassland.

Habitat condition was assessed by noting ground, shrub/understorey and canopy cover, the number and size of hollows present, habitat features such as rocky outcrops and coarse woody debris, 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, coarse woody debris, rocky outcrops 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.

Habitat assessments focussed on the occurrence of potential habitat for MNES that were considered to have potential to occur in the Project Boundary. This included the Brush-tailed Rock Wallaby (*Petrogale penicillata*), the Spotted-tailed Quoll (*Dasyurus maculatus*), threatened birds such as the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*), and reptiles such as the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*), the Pink-tailed Worm-lizard (*Aprasia parapulchella*) and the Five clawed worm skink (*Anomalopus mackayi*). The EPBC Act survey guidelines for mammals and reptiles indicate that habitat assessments for the threatened mammals and reptiles listed above is a recommended survey technique.

i. Hollow Assessment

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

Regularised hollow assessments were conducted at 31 of the 168 SAT sampling points used for the Koala assessment described in **Section 3.2.3.i**. At each sampling point, searches for hollow-bearing trees were made within a 20x 50m quadrat. For each hollow-bearing tree identified, the following details were recorded:

- Species;
- Height and diameter at breast height (DBH);
- Number of hollows; and
- Size class of hollows.

Hollow size classes are defined in **Table 3.7** below. The data obtained was used to determine densities of tree hollows per hectare.

Table 3.7 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

3.3 Aquatic Surveys

Surveys were conducted of aquatic environments within and surrounding the Project Boundary. These surveys provide baseline habitat and water quality data for development of future monitoring programs for the Project. CBE conducts monthly environmental monitoring for Shenhua Watermark. Surface water quality data collected by CBE was used to complement the aquatic survey results, as was surface water flow data obtained from the NSW Office of Water. Rainfall records were accessed from the Australian Bureau of Meteorology. These results have been incorporated into the current survey results to provide a comprehensive assessment of the biodiversity recorded within the Project Boundary.

3.3.1 Aquatic Surveys

Aquatic surveys were conducted from 6 to 9 June 2011 in a number of artificial water bodies (farm dams) within the Project Boundary and along the Mooki River and the Native Dog Gully. As a precautionary measure, water quality sampling was also undertaken at Lake Goran, a recognised wetland and known groundwater sink located to the west of Project Boundary,

Aquatic surveys were conducted at the following sites (see **Figure 3.3**):

- Eight surface water monitoring (SWM) stations along the Mooki River and Native Dog Gully, including upstream, downstream and at the proposed pipeline locations;
- Four farm dams within the Project Boundary; and
- The eastern portion of Lake Goran, which is located approximately 8.5 km west of the Project Boundary.

Aquatic surveys were conducted in accordance with The Australia Wide Assessment of River Health: NSW AusRivAS Sampling and Processing Manual (Turak and Waddell 2001b). This approach involved undertaking habitat assessments, in-situ water quality measurements and collecting aquatic macro-invertebrate samples to provide an indication of the current condition of the aquatic survey locations.

Literature reviewed indicates that several threatened species of fish are known from the Namoi catchment, which drains into the Murray-Darling Basin. This includes the Murray Cod (*Maccullochella peellii peellii*) (Murray-Darling Basin Authority 2008), which is listed as Vulnerable under the EPBC Act. The aquatic survey did not include vertebrate sampling (e.g. fish) as no permanent watercourses occur throughout the Project Boundary.

i. Aquatic Habitat Assessments and Water Quality Measurements

GPS coordinates were taken at each aquatic survey location and the following observations and water quality measurements were recorded to assess habitat potential:

- Current land use and visual site assessment of disturbance related to human activities;
- Site attributes including the following:
 - Topography;
 - Water level;
 - Riparian vegetation;
 - Water body width; and
 - Weather conditions at the time of survey.
- Attributes of riffle and edge habitats including:
 - Natural substrate description; and
 - Depth (m).
- In situ water quality measurements collected using a calibrated multiple parameter water quality meter, including:

- Alkalinity (as mg/L of CaCO₃): Measure of the buffering capacity of the water;
- Conductivity (µS/cm): Measure of the total concentration of inorganic ions (salts) in the water;
- Dissolved oxygen (DO) (ppm): Reflects the equilibrium between oxygen consuming processes (e.g. respiration) and oxygen releasing processes (e.g. photosynthesis);
- Temperature (°C): Temperature of the water at the time of sampling;
- pH: Measure of the acidity or alkalinity of the water; and
- Turbidity (NTU): Measures the presence of suspended particulate and colloidal matter such as suspended clay, silt, phytoplankton and detritus.

ii. *Macro-invertebrate Sampling*

At each survey location, sampling for macro-invertebrates was conducted which involved laying a 250 micron mesh “kick net” into the stream and then disturbing the substratum, debris and bank edges at each survey location to dislodge sediment and organisms into the net. Where possible, 10 m of habitat was surveyed along a 100 m stretch at each location.

Sediment samples were live-sorted for a minimum of 40 minutes to maximise the diversity of macro-invertebrates collected. Active, common taxa were selected first, followed by searches for cryptic and/or smaller taxa. Specimens were preserved in 70% ethanol and labelled for further analysis. Macro-invertebrate analysis involved identification to family level. Some taxa were sorted to phylum, sub-family and class, as recommended by the AusRivAS guide. All macro-invertebrates were identified using taxonomic keys and aquatic invertebrate guides (Hawking and Smith 1997, Turak and Waddell 2001b, Chessman 2003).

iii. *AusRivAS and SIGNAL Analysis*

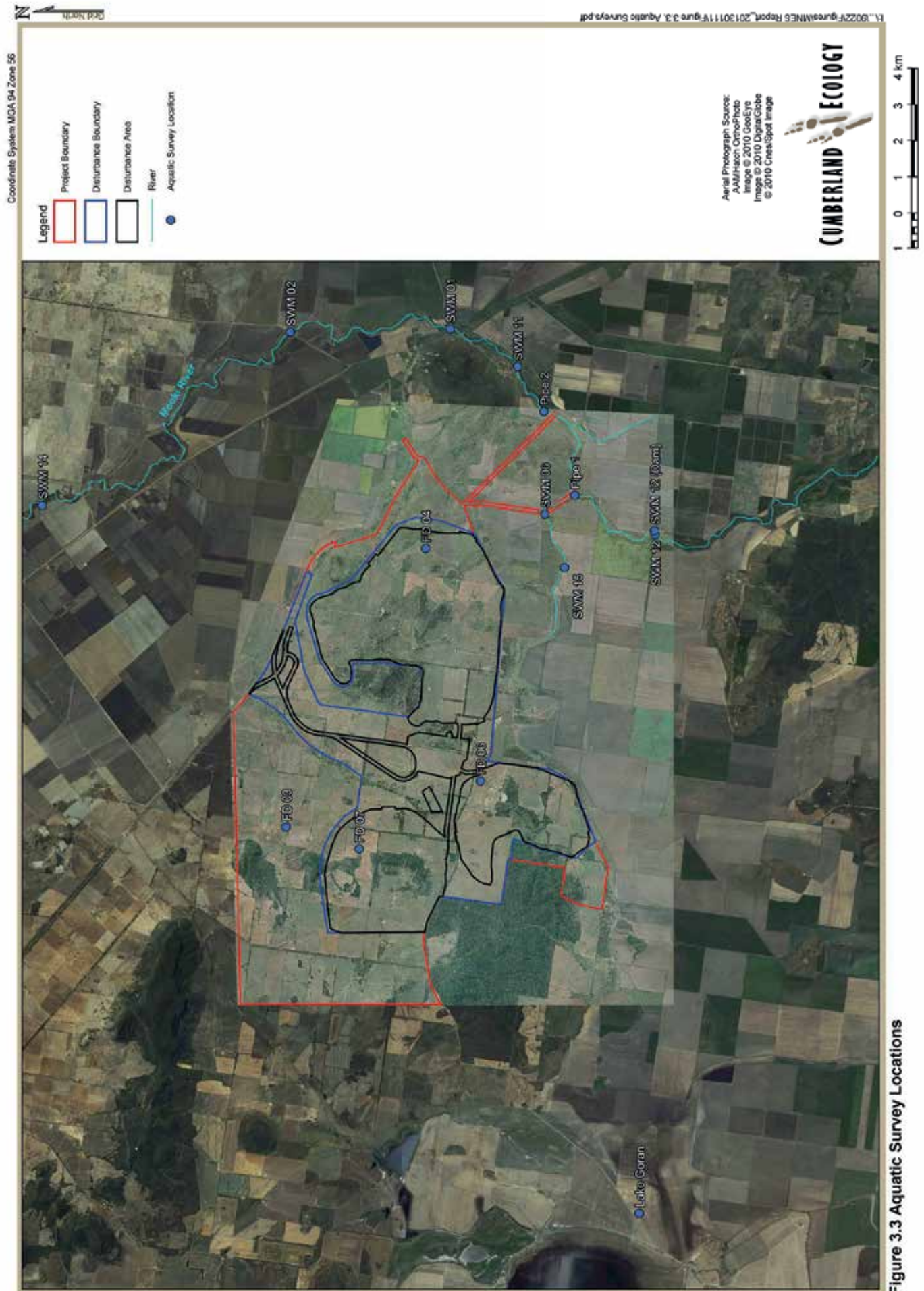
The macro-invertebrate data collected was analysed using AusRivAS and Stream Invertebrate Grade Number – Average Level (SIGNAL) Analysis, which are two separate macro-invertebrate scoring methods that can provide an indication of the water quality and therefore aquatic health at the sample collection sites.

AusRivAS is a set of computer models that compare the abundance and identity of macro-invertebrates collected from a sample site with a database from a large number of reference sites throughout Australia. The AusRivAS models compare the sample site to reference sites for similar types of streams in the same State or region; reference sites are those believed to be least altered by human activity. If the test site is lacking the macro-invertebrate families that are expected to occur, according to the reference site database, it is likely that the test site is more affected by human influences than the reference sites (Turak and Waddell 2001a).

It should be noted that AusRivAS uses rapid bio-assessment procedures to calculate river condition. This method is less sensitive than traditional quantitative procedures that are often more time-consuming, however it provides a preliminary indication of aquatic health. AusRivAS is designed to assess riffle and edge habitats within rivers as these can easily be accessed by land based surveyors. It is therefore not an ideal bio-assessment method for lakes and dams as no comparable reference sites are available in the model and the habitat predictor variables fall outside the values of the model. Nevertheless, it provides a broad indication of the habitat quality.

SIGNAL analysis was used to provide an indication of water quality in the sampling sites based on an analysis of the macro-invertebrates present at each site. SIGNAL assigns a value to each invertebrate family based on its sensitivity to pollution. A grade of 10 represents high sensitivity to pollution, while a grade of 1 represents high tolerance to pollution. Based on the invertebrates recorded from each site, SIGNAL assigns each site an overall 'score' between 1 and 10. High numbers of pollution sensitive taxa would indicate that the aquatic site has relatively high water quality, as these species do not occur in polluted sites. Conversely, the present of pollution tolerant taxa indicate a level of pollution. SIGNAL scores are then plotted to assess aquatic health.

To gain an appreciation of how similar the survey sites were in terms of invertebrate assemblages, invertebrate abundance and community composition data for each site was run through the PRIMER statistical program, which creates a Multi-Dimensional Scaling (MDS) plot. The MDS plots show graphically how similar invertebrate communities at each site are in comparison to other invertebrate communities within the Project Boundary; the closer the symbols, the more similar the assemblage.



3.4 Weather Conditions During Surveys

Surveys have been conducted in all seasons and in a wide variety of weather conditions. This means that the database of ecological information collected by Cumberland Ecology is detailed and reliable.

The weather conditions during surveys were generally appropriate for detection of a wide variety of flora and fauna, and due to high rainfall in summer 2010 and autumn 2011; conditions were generally optimal for undertaking flora surveys. The high rainfall was favourable for plant growth and reproduction, and features such as flowers and fruits, which are required for identification of most plants to species level, were available. Grasses, herbs and creepers were readily identifiable in most instances.

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 recorded a relatively high amount of rainfall, with most other days remaining dry.

Conditions leading up to and during the first survey period (3 to 5 November, 2010) were generally warm with a considerable amount of rain in the middle of the period. The second survey period (8 to 11 November, 2010) was generally warm with occasional rains.

Conditions leading up to the third survey period (29 November to 2 December, 2010) were generally warm despite a large amount of rain towards the end of the survey period. There was an extensive amount of rainfall throughout the Namoi Catchment leading up to the third survey period. This rainfall caused extensive flooding throughout the region and provided excellent survey conditions for amphibian fauna and some migratory wading birds.

Conditions during the fourth survey period (13 to 15 December 2010) were also warm, with heavy rainfall experienced soon after this survey period.

Targeted amphibian, reptile and bat surveys were undertaken during the fifth and sixth survey period (overlapping survey periods from 21 March to 1 April 2011). Warm, dry weather was experienced throughout these periods which made it suitable for surveying these groups.

Cool to cold, predominantly dry weather was experienced during surveys in winter 2011. Warmer conditions occurred during spring 2011 surveys. Summer 2011/2012 and autumn 2012 were warm and mainly dry, although some rainfall occurred in December 2011. Conditions in March 2011 were suitable for detecting amphibians, reptiles and microbats, and these groups were targeted during this period.

A summary of weather conditions in the locality of the Project Boundary during the 2010 and 2011 surveys is provided in **Table 3.8**.

Table 3.8 Survey Weather Conditions			
Date	Max Temp (°C)	Min Temp (°C)	Rain (mm)
3/11/2010	24.9	3.7	0
4/11/2010	26.3	10.3	0
5/11/2010	20	12.5	0
8/11/2010	29.8	14.1	12.8
9/11/2010	29.9	17.1	0
10/11/2010	29.9	15.5	0
11/11/2010	23.9	17.5	39.2
29/11/2010	29	18.4	0
30/11/2010	26.1	17.8	11
1/12/2010	20.3	18	10.2
2/12/2010	27.7	16.4	21.4
13/12/2010	30.8	14.6	0.2
14/12/2010	31.3	17.1	0
15/12/2010	31.9	16.4	0
21/03/2011	29.5	18	0
22/03/2011	31.8	18.1	2.8
23/03/2011	29.6	15.4	0
24/03/2011	27.7	9.5	0
25/03/2011	26.5	8.8	0
26/03/2011	29.6	8.2	0
27/03/2011	28.8	13.6	0
28/03/2011	30.1	12.8	0
29/03/2011	28.6	12.8	0
30/03/2011	30.2	13.7	0
31/03/2011	31	11.6	0
1/04/2011	29.8	13.6	0
2/05/2011	22.6	8.4	0
3/05/2011	20.4	8.6	0
4/05/2011	23.5	4.4	0
5/05/2011	22.5	4.3	0
6/05/2011	21.4	3.3	0.4
10/05/2011	20.2	9.2	0
11/05/2011	18.4	-1.8	0
12/05/2011	16.9	0.9	0.4

Table 3.8 Survey Weather Conditions			
Date	Max Temp (°C)	Min Temp (°C)	Rain (mm)
13/05/2011	18.3	3	0.2
14/05/2011	17.9	6.1	0
30/05/2011	11.7	9.4	4.4
31/05/2011	16.7	8.5	16
1/06/2011	20.4	5.9	0.4
2/06/2011	21.5	6.8	2.6
3/06/2011	20.1	4.4	2.6
5/06/2011	20.5	4.2	2
6/06/2011	18.2	1.2	1.8
7/06/2011	17.6	-1.3	2.2
8/06/2011	14.5	1.3	2.2
9/06/2011	14.3	-3	2
10/06/2011	16.1	-0.3	2
11/07/2011	15.7	6.5	0
12/07/2011	15.9	-5.5	0
13/07/2011	11.6	-1.5	0
14/07/2011	13.8	3.2	0.4
15/07/2011	17.0	-0.7	0
19/09/2011	29.5	8.5	0
20/09/2011	27.5	8.1	0
21/09/2011	22.5	1.2	0
22/09/2011	26.5	2.8	0
23/09/2011	29.0	6.0	0
10/10/2011	23.5	8.5	0
11/10/2011	23.2	4.6	0
12/10/2011	24.6	1.9	0
13/10/2011	26.5	10.5	0
14/10/2011	27.3	12.6	0
19/12/2011	23.8	17.5	0
20/12/2011	29.5	16.0	12.0
21/12/2011	29.1	16.6	1.0
22/12/2011	29.1	16.2	4.0
23/12/2011	27.2	18.0	0
13/02/2012	31.8	15.8	0

Table 3.8 Survey Weather Conditions			
Date	Max Temp (°C)	Min Temp (°C)	Rain (mm)
14/02/2012	31.0	14.0	0
15/02/2012	30.3	15.5	0
16/02/2012	31.0	15.2	0
17/02/2012	32.1	14.4	0
26/03/2012	27.7	14.5	0
27/03/2012	28.7	13.2	0
28/03/2012	28.6	14.9	0

All weather data has been collected from the Australian Bureau of Meteorology for Gunnedah, NSW (2010/2011/2012).

3.5 Survey Limitations

The flora and fauna of the Project Boundary and surrounds have been subject to a series of surveys over several years. Consequently, the ecology within the Project Boundary and the flora and fauna of the locality is well documented. The recent surveys built upon an existing database of flora and fauna information, including surveys undertaken for BHP Billiton's Caroon Coal Project, located to the south of the Project Boundary. Therefore this report has been prepared using extensive baseline flora and fauna data, including vegetation mapping, and information about individual species.

The habitats within the Project Boundary and surrounds are typical of Australian farmland in eastern Australia. They include a mosaic of woodland remnants on hilltops and along roadsides and streams that occur amid broad areas of cleared grassland and crop land. The original habitats of this landscape were predominantly woodland habitats and as a result of historic clearing artificial habitats (grasslands) now dominate. The resultant fragmentation of remaining woodland patches limits their size (many are small) and many have large edge to area ratios (especially the woodland strips remaining along roadsides).

3.5.1 Flora

During flora surveys conducted in May and June 2011, seasonal conditions were not favourable for the identification of perennial herbs and grasses as many of these species die back in autumn and winter. However, flora surveys have been conducted in all seasons and it is considered that the floral conservation significance of the site has been adequately assessed.

The number of quadrats that were completed within grassland within the Project Boundary was lower than the recommended number according to the OEH guidelines (DEC 2004) but the recommended number is based solely on the total area of grassland.

During the field surveys it became apparent that much of the “grassland” was cropland that was, or recently had been used for crops such as wheat. As such no quadrats were required to be completed in such areas to verify the vegetation. The number of quadrats completed in the non-cropped grassland areas was sufficient to comply with the OEH guidelines (DEC 2004),

At the time of European settlement, and now, woodland is the predominant native vegetation type in the Project Boundary. For this reason, it was intensively sampled during flora surveys, with more than double the recommended numbers of quadrats being completed. This was appropriate given that a number of different types of woodland occur.

3.5.2 Fauna

The fauna surveys were undertaken with reference to OEH guidelines (DEC (NSW) 2004) and to the nature of faunal habitats in the Project Boundary. Data obtained from the fauna surveys are a “snapshot” in time and illustrate 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 vertebrate fauna species occurring within the Project Boundary. It is likely that if continued field sampling was undertaken within the Project Boundary, additional species could be identified.

The fragmented woodland habitats that predominate in the Project Boundary are relatively uniform in terms of their structure and habitat values for fauna. This was considered during the design of the field surveys. Such disturbed habitats favour some species or groups of species above others. For example Koalas are relatively abundant and well represented throughout the woodland patches. However, ground dwelling small mammals and reptiles are underrepresented as they are generally depleted in highly modified, fragmented woodland/farmland areas where introduced Foxes are abundant. Survey effort thus included large numbers of SAT plots to survey the Koala population across the Project Boundary. However, it justifiably entailed less survey effort for smaller ground dwelling mammals. Additionally, fauna surveys were focussed on the woodland areas rather than the very highly modified grassland areas. Fauna observed within the grassland areas were therefore incidentally recorded throughout the survey period.

As well as providing an overall census of the vertebrate fauna recorded within the Project Boundary, the survey techniques utilised were also targeted towards threatened species predicted to occur. The targeted threatened species surveys generally utilised the OEH guidelines, however in some instances the recommended techniques were not utilised, including terrestrial Elliott A trapping. This approach is considered to be consistent with the guidelines which state that “*Selection of the survey methods required will depend on the investigator’s assessment of the types of animals (and habitats) potentially present on the site, based on the preliminary assessment and habitat assessment*” (DEC (NSW) 2004).

Some additional survey techniques were used in conjunction, or as substitutes for, the techniques listed within the guidelines, particularly SAT/Area Search survey for Koala, IR cameras and funnel trapping.

Key variations to the minimum requirements for surveys are explained below:

- **Wire cage traps:** were deployed in lower numbers than guidelines suggest, as the number of cages utilised was considered appropriate for the one threatened species targeted, Spotted-tailed Quoll (*Dasyurus maculatus*) given the highly fragmented nature of woodland habitats. The lower numbers of wire cage traps were compensated for by analysis of database records for this species this species and by the use of IR cameras in selected woodland areas;
- **Hair Tubes:** As conical 'Faunatech' hair tubes, which can sample both small and large mammals, were utilised, it negated the need to use two different sizes of hair tubes;
- **Arboreal hair tubes:** were deployed in lower numbers than guidelines suggest, as the number of arboreal hair tubes utilised was considered appropriate for the species targeted. Other survey methods supplemented the survey effort for these species, such as arboreal Elliott B trapping and IR cameras;
- **Call playback** was not repeated at each fauna survey site as it was considered more appropriate to undertake surveys across the Project Boundary instead of a few locations;
- **Pitfall Traps:** Some pitfall traps were used in the field surveys, but the least invasive collapsible funnel traps were used instead of the full complement of pitfall traps to target reptiles; and
- **Bat Survey:** A combination of harp trapping and Anabat detection was used to target microbat species considered likely to occur in the locality.

The Commonwealth listed threatened Swift Parrot (*Lathamus discolor*) and Superb Parrot (*Polytelis swainsonii*) are relatively rare, migratory and only present in winter time. Targeted surveys for these species have been limited to within the Project Boundary, however available information suggests that the area surrounding Breeza State Forest is not a major area for either species and it is considered that the survey effort for these species has been sufficient.

It is considered that the fauna species of conservation value have been adequately targeted to enable a comprehensive assessment of MNES and are considered to be consistent with the OEH guidelines for threatened species surveys (DEC (NSW) 2004). The guidelines state that "*where limitations cannot be overcome, an assessment of the likelihood of threatened animals utilising the habitat must be made in order to comply with legislation*"... *If it is not possible to sample for threatened species (eg. bats, frogs) previously recorded in the general area during appropriate seasons and weather conditions, it must be assumed that these species occur in the study site if suitable habitat exists*... A precautionary approach was used in the preparation of this report to assume the presence of species (particularly threatened species) where the presence of suitable habitat was recorded.

3.6 Investigation of Potential Offset Areas

The nature, magnitude and location of most open cut coal mining projects mean that in the majority of cases broad areas of forest, woodland, open grassland and threatened species habitat will be cleared. In this regard it was apparent during the early design and assessment phases that the Project would be required to develop a biodiversity offsets strategy to compensate for the residual ecological impacts of the Project, particularly those to threatened vegetation communities and the Koala. This section provides details about how potential offset land was screened, including criteria for the survey and selection of offsets and the surveys undertaken within the offsets to date.

3.6.1 *Selection Criteria*

A high level desktop analysis of suitable areas in which to prioritise searches for candidate offset properties was completed for the Project in March 2011. This analysis was guided by consideration of the local context of the Project and any potential offset areas. Important considerations included the following:

- The presence of Koala habitat (particularly areas located in close proximity to the Disturbance Area);
- The known occurrence of Box Gum Woodland and Derived Native Grassland;
- The likely availability of habitat for all relevant threatened flora and fauna species that could be impacted by the Project;
- Linkages to sustainable ecological features (particularly permanent water sources);
- Linkages to rehabilitated mining areas;
- The potential to form new, or improve existing ecological corridors;
- Provision of land that contributes to other existing or proposed offsets; and
- Land currently owned Shenhua Watermark and land within the predicted zone of affectation.

3.6.2 *Field Investigations*

Cumberland Ecology has to date conducted preliminary site inspections of numerous properties in order to develop a short list of candidate properties for further consideration. Notes were made regarding the following: threatened species and their habitat; key habitat features (rock outcrops, streams, etc.); major weed infestations; current and historical land use; dominant vegetation types and broad patterns of occurrence; and other relevant attributes or management issues. This work was supplemented with a desktop review of available information of threatened species occurrences in the locality of each property.

A number of areas of land have been selected for inclusion within the offsets package for the Project. Of these areas of land, portions the Mt Watermark Offset Area and Offset Area 6, had been surveyed as part of the surveys for impact assessment within the Project Boundary. Additional surveys specifically to furnish information about offset lands have been undertaken within Offset Area 6 and the Offsite Offset Areas (Clonmeen Offset Area and Aandra Offset Area). A summary of surveys undertaken within the proposed offset areas is provided in **Table 3.9**. In addition to the survey techniques utilised within the Project Boundary (see **Section 3.2.2** and **Section 3.2.3**), rapid grassland plots were also undertaken. A description of this survey technique is provided below. The locations of surveys within the Onsite and Offsite Offset Areas are shown in **Figure 3.4** and **Figure 3.5**, respectively.

i. Rapid Grassland Plots

A total of 22 rapid grassland plots were collected to supplement the quadrat dataset. The purpose of collecting rapid plots was to maximise the sampling coverage of large areas of grassland as much as possible in a limited survey timeframe and to determine if the grassland conformed to Box Gum Woodland and Derived Native Grassland.

Rapid grassland plots were sampled within 20 x 50 m quadrats exclusively in native grassland units dominated by grass species (i.e. shrublands and herbfields would be excluded from rapid sampling if they were present). Data collected included native herb species present (sampling ceased when 12 native herbs were recorded), dominant native grasses and percentage cover of weeds in the ground stratum. Although the data collected from rapid plots cannot be analytically compared to the remaining dataset, they provide enough information to determine the condition and composition of grassland areas at their respective locations.

Table 3.9 Summary of Additional Surveys Undertaken within the Onsite and Offsite Offset Areas			
Survey Technique	Offset Area 6	Clonmeen Offset Area	Aandra Offset Area
Flora			
Vegetation mapping	3-4 August 2011, 20-24 March 2012	2, 4-5, 20 July 2012	16-20 July 2012
Quadrat surveys	22-24 March 2012	4-5 July 2012	18-19 July 2012
Rapid Grassland Assessments	22-24 March 2012	4-5 July 2012	17-20 July 2012
Fauna			
Koala SAT/Area Search surveys	9-13 July 2012 (47 sites)		
Anabat Detection	28-29 March 2012 (6 survey nights)		

Table 3.9 Summary of Additional Surveys Undertaken within the Onsite and Offsite Offset Areas			
Survey Technique	Offset Area 6	Clonmeen Offset Area	Aandra Offset Area
Harp Trapping	28-29 March 2012 (6 trap nights)		
Active Search/Bird Census	29 March 2012 (2 hours)		
Diurnal Bird Survey	28-30 March 2012	2, 4-5, 20 July 2012	16-20 July 2012
Spotlighting	29 March 2012 (1 hour)		
Call Playback	29 March 2012 (survey night)		

3.6.3 Limitations

Adequate data exists for the assessment of the suitability of the proposed offsets for the Project. 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 offset areas.

It is considered that sufficient data has been collected from the Mt Watermark Offset Area and Offset Area 6. This is because these lands occur within or adjacent to the Project Boundary and contain essentially the same habitats as have been surveyed within the Project Boundary. Survey information from the Project Boundary can be extrapolated and used to predict the flora and fauna values within the Onsite Offset Areas.

The Offsite Offset Areas are more remote and although they support some Box Gum Woodland and habitat for most threatened fauna that are known to occur within the Project Boundary, they are not identical to the Project Boundary lands. Some limitations to the data currently obtained apply:

- Detailed survey of the intact woodland and forest within the Offsite Offset Areas was constrained by access; and
- Limited fauna surveys have been undertaken within the Offsite Offset Areas.

For the purposes of this report, the aforementioned limitations were overcome by the use of remote sensing techniques, whereby aerial photography, geology maps and other GIS data was examined. Also, as detailed surveys have been conducted of fauna in the nearby Wirradale and Mount Lindesay areas (Cumberland Ecology 2012), and in Mount Kaputah National Park, threatened species records from the locality were used as a guide to what is likely to occur in the Offsite Offset Areas.

No surveys have been undertaken within the Mooki River Offset Area; however the entire parcel of land is assumed to have limited ecological value in its current largely cleared state and is proposed to be revegetated.

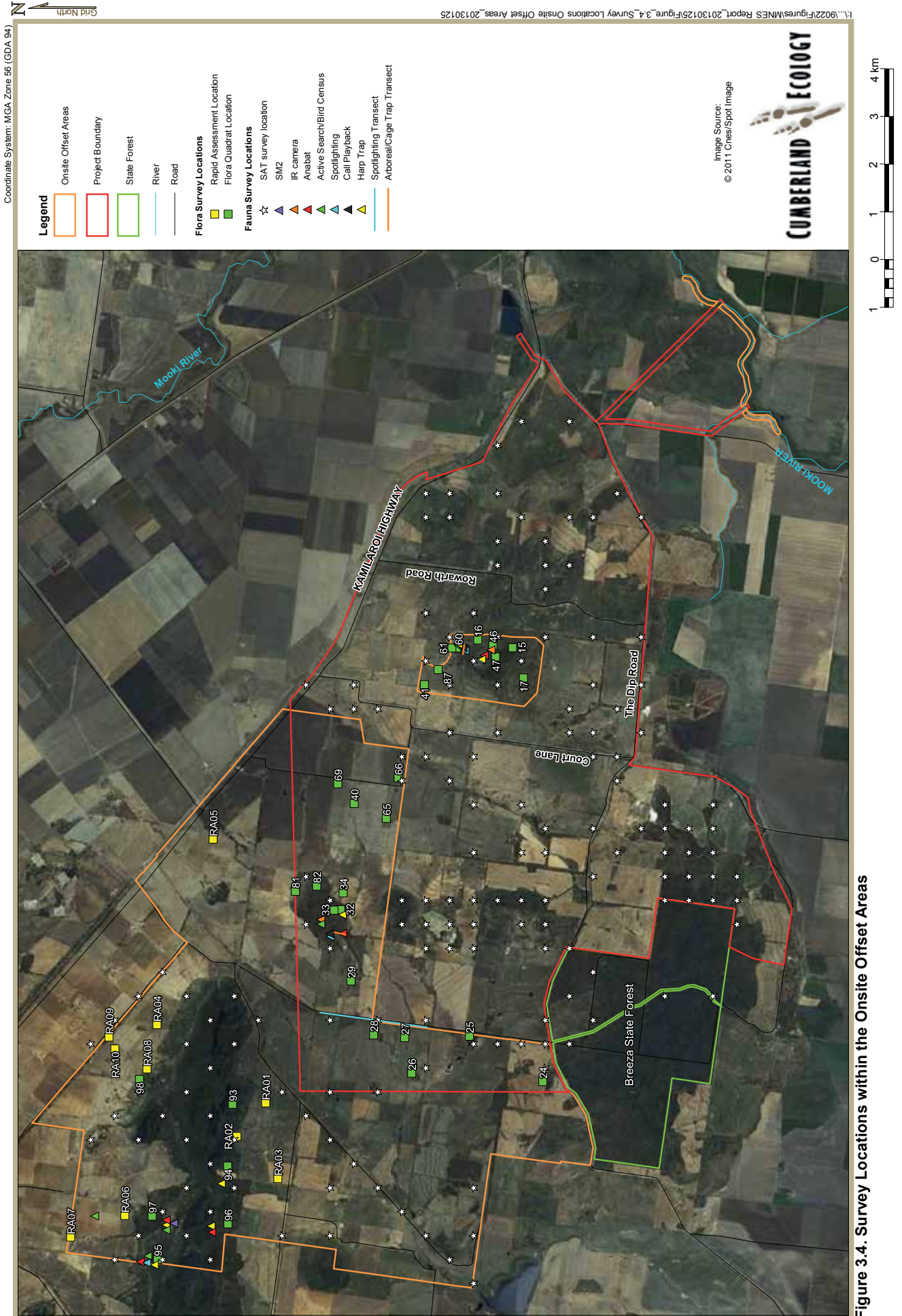


Figure 3.4. Survey Locations within the Onsite Offset Areas

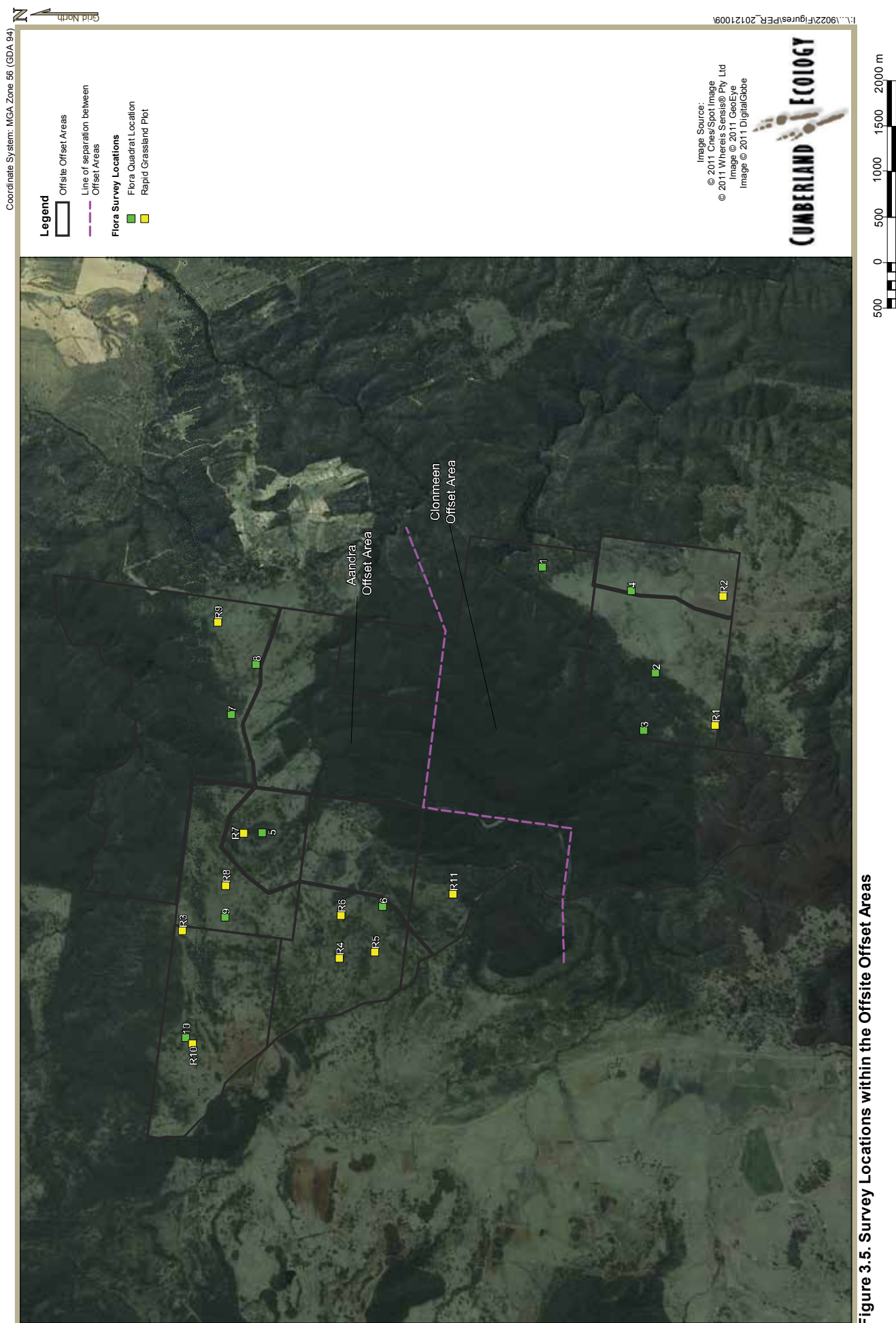


Figure 3.5. Survey Locations within the Offsite Offset Areas

Chapter 4

Flora Results

The majority of the Project Boundary has been cleared of its pre-existing vegetation, and is now dominated by grassland, with some small areas of woodland. This chapter presents the results of the flora field surveys with particular focus on species and communities listed under the EPBC Act. An assessment of the condition of the vegetation within the Project Boundary has also been provided as well as consideration and mapping of the potential occurrence and extent of Groundwater Dependent Ecosystems (GDE).

A comprehensive list of flora species recorded within the Project Boundary during the survey is provided in **Appendix E**.

4.1 Vegetation Communities

The vegetation within the Project Boundary is predominantly cleared and used as cattle grazing or crop production, and consequently the vegetation is dominated by grassland that has been derived from the previous clearance of the pre-existing woodland. Derived grassland (also known as secondary grassland) can remain relatively intact but 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.

The derived grasslands within the Project Boundary vary in their degree of modification: from severely modified croplands where the land has been cultivated to grow a crop, and consequently all the pre-existing understorey is removed; to pasture improved, where exotic pasture grasses and chemical fertilizer have been applied to improve their grazing value for stock, but where some native species remain; to native grasslands that have had relatively little modification and are dominated by native species. Decades of stock grazing has resulted in a variety of ecological impacts including weed invasion, nutrient enrichment and soil erosion. These areas afford minimal habitat for native species due to their lack of structural complexity and habitat resources. The vegetation has also been further impacted by weeds and feral animal invasion.

Treed vegetation within the Project Boundary is characterised by a mixture of grassy and shrubby open forests and woodland types. These mostly occur as fragmented narrow tracts of woodland along boundary fences and road verges, isolated patches of remnant or regrowth open forest or woodland patches on hills and steeper slopes, and scattered paddocks trees.

The distribution of the vegetation communities is controlled largely by soil type and topography. Within the Project Boundary *Eucalyptus blakelyi* (Blakely's Red Gum) and *Callitris glaucophylla* (Cypress Pine) are largely found on well-drained soils, particularly on ridges and rises, whilst the box Eucalypt species have an affinity with the lower-lying parts of the landscape on more fertile soil derived from colluvial wash off the sandstone hills within the Project Boundary. The presence of box Eucalypts (e.g. *Eucalyptus albens* (White Box)), *Acacia pendula* (Weeping Myall) and *Casuarina cristata* (Belah) trees typically indicate dark soils derived from basalts and/or alluvium and since much has been cleared for crop lands, is commonly observed as fragmented remnant vegetation on the fringes of cropping land and road verges.

The vegetation within the Project Boundary consists of several broad associations consisting of grassy woodlands, shrubby woodlands, and grasslands. As discussed above, grasslands are areas where the vast majority of trees have been removed and the remaining vegetation consists of grasses with varying proportions of native species. Grassy woodlands are areas of woodland where the understorey is comprised predominantly of native grasses, and where a shrub layer is either very sparse or absent. Shrubby woodlands comprise areas where there is a well developed shrubby layer in the understorey as well as a grassy stratum underneath. This distinction between grassy and shrubby woodlands is important as it is a key diagnostic feature of several EECs.

The most extensive vegetation community within the Project Boundary is White Box, Yellow Box, Blakely's Red Gum Woodland and Derived Native Grasslands (commonly referred to as Box Gum Woodland), which is listed as a CEEC under the EPBC Act. There is some variation in this community within the Project Boundary, but all conform to the listing under the EPBC Act.

In addition to this community, several other communities listed by the EPBC Act have been recorded from the Project Boundary, as well as some unlisted vegetation types. The vegetation communities recorded from the Project Boundary and their conservation status are indicated in **Table 4.1** below, and are shown in **Figure 4.1**. Subsequent sections discuss the EPBC Act listed communities recorded within the Project Boundary in more detail, and these communities are shown on **Figure 4.2**.

Table 4.1 Vegetation Communities Recorded from the Project Boundary		
Vegetation Community	EPBC Act Status	Project Boundary (ha)
Box Gum Woodland	CEEC	1,192
Derived Native Grassland	CEEC	73
Subtotal Box Gum Woodland and Derived Native Grassland		1,265
Inland Grey Box Grassy Woodland	EEC	55
Weeping Myall Woodland	EEC	22

Table 4.1 Vegetation Communities Recorded from the Project Boundary		
Vegetation Community	EPBC Act Status	Project Boundary (ha)
Brigalow	EEC	9
Semi-evergreen Vine Thicket	EEC	n/a*
<i>Subtotal Other EEC</i>		86
Fuzzy Box Woodland		36
Poplar Box Woodland		223
Belah Woodland		7
Whitewood Woodland		76
Tumbledown Red Gum Grassy Open Woodland		50
White Box Shrubby Woodland		234
Regenerating White Box Shrubby Woodland		72
Blakely's Red Gum Shrubby Woodland		6
Blakely's Red Gum Motherumbah Shrubby Woodland		15
<i>Subtotal Other Woodland</i>		719
Low Diversity Grassland, Planted & Exotic Pasture		7,290
Cleared Areas (roads, dams, buildings, etc.)		141
<i>Subtotal Other</i>		7,431
GRAND TOTAL		9,501

*Area of occurrence is <0.1ha and has therefore not been mapped

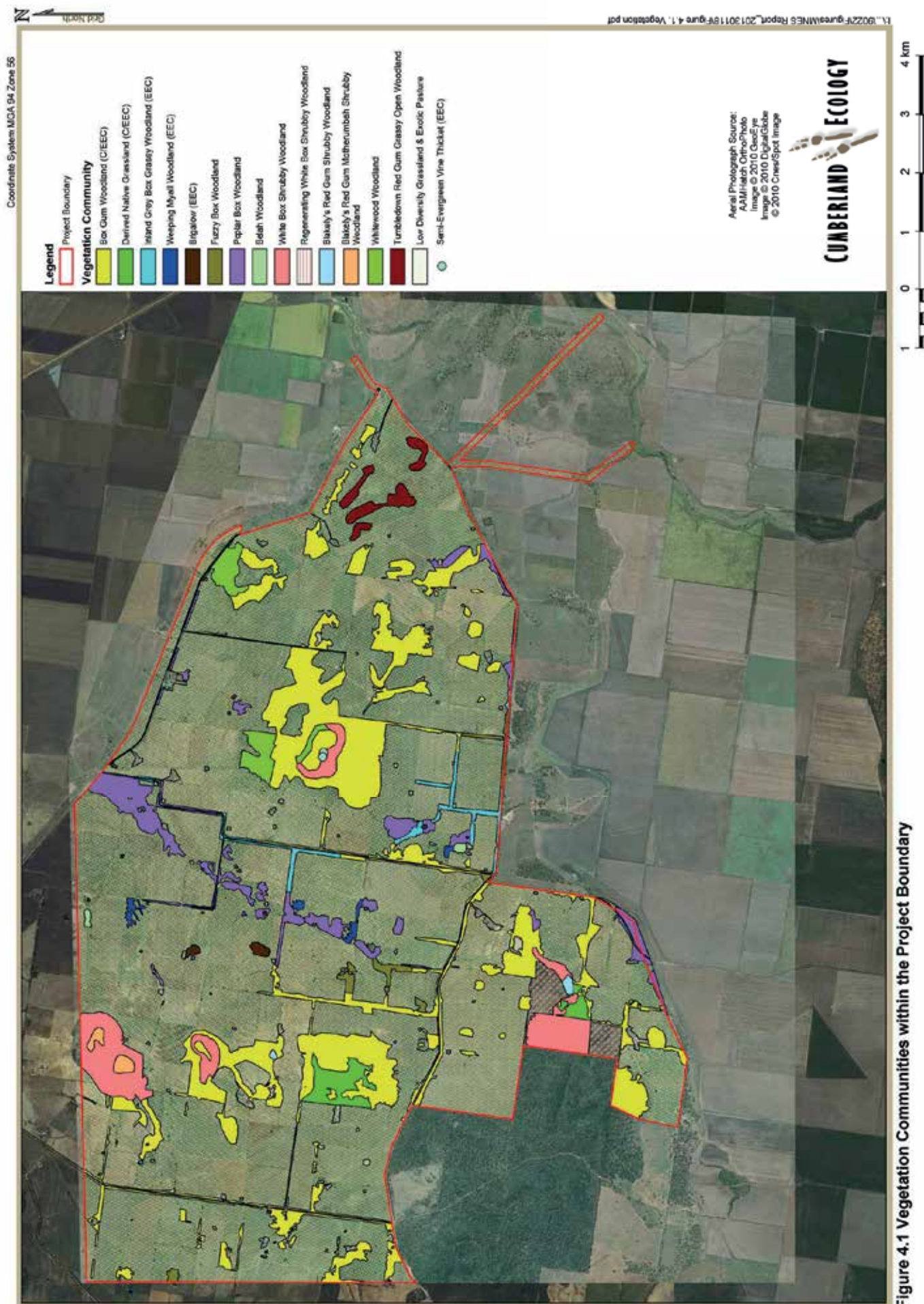


Figure 4.1 Vegetation Communities within the Project Boundary

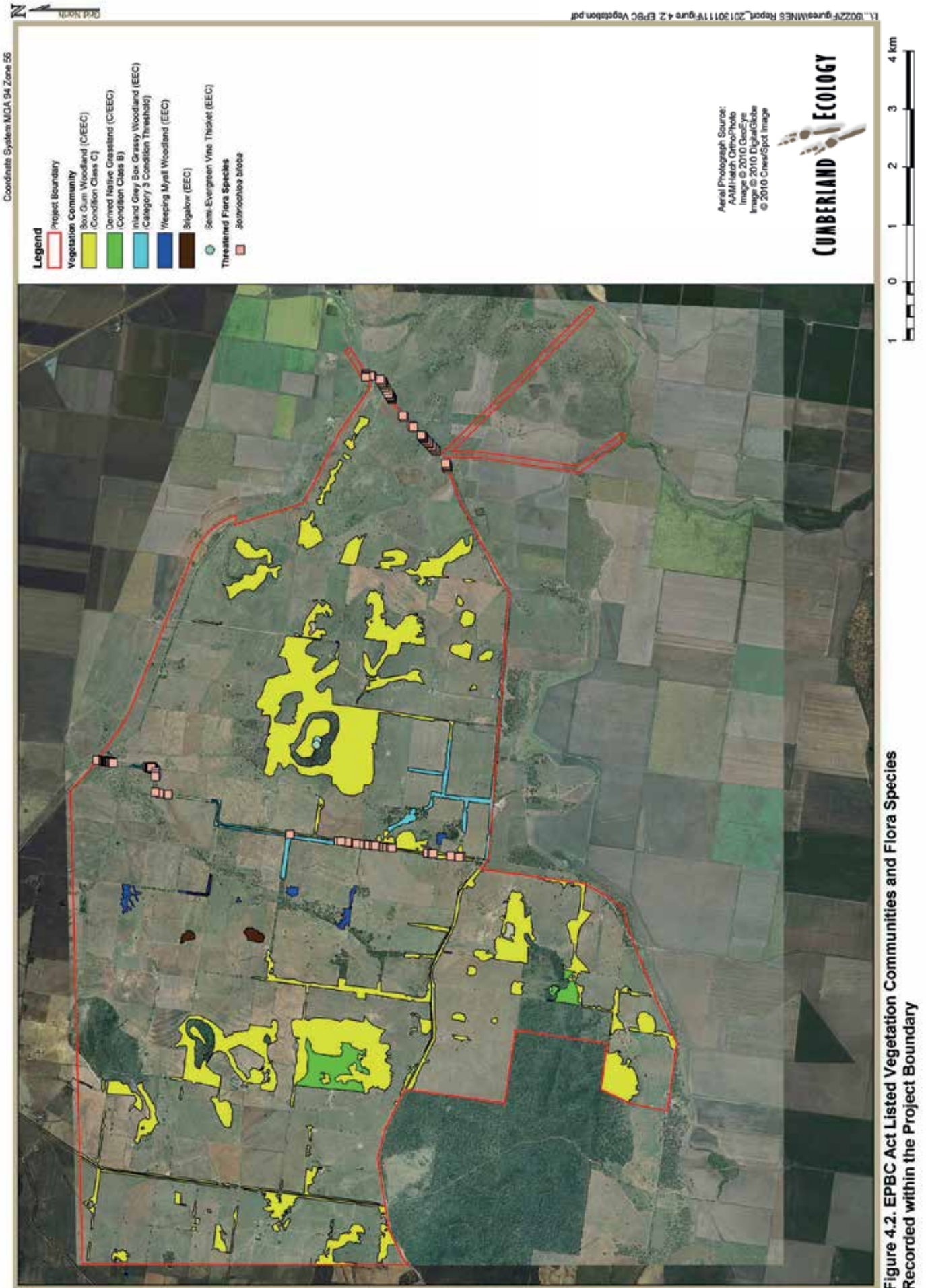
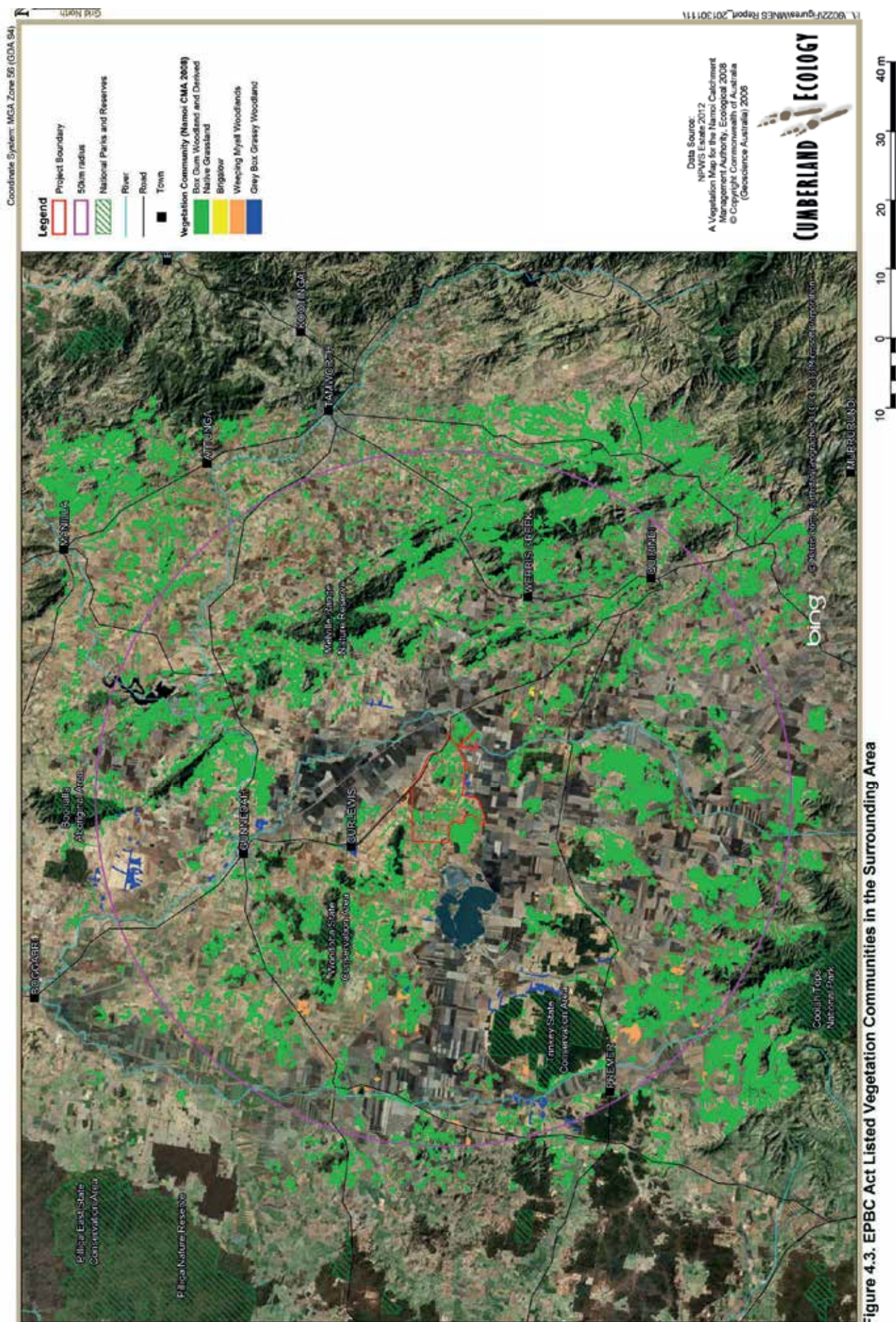
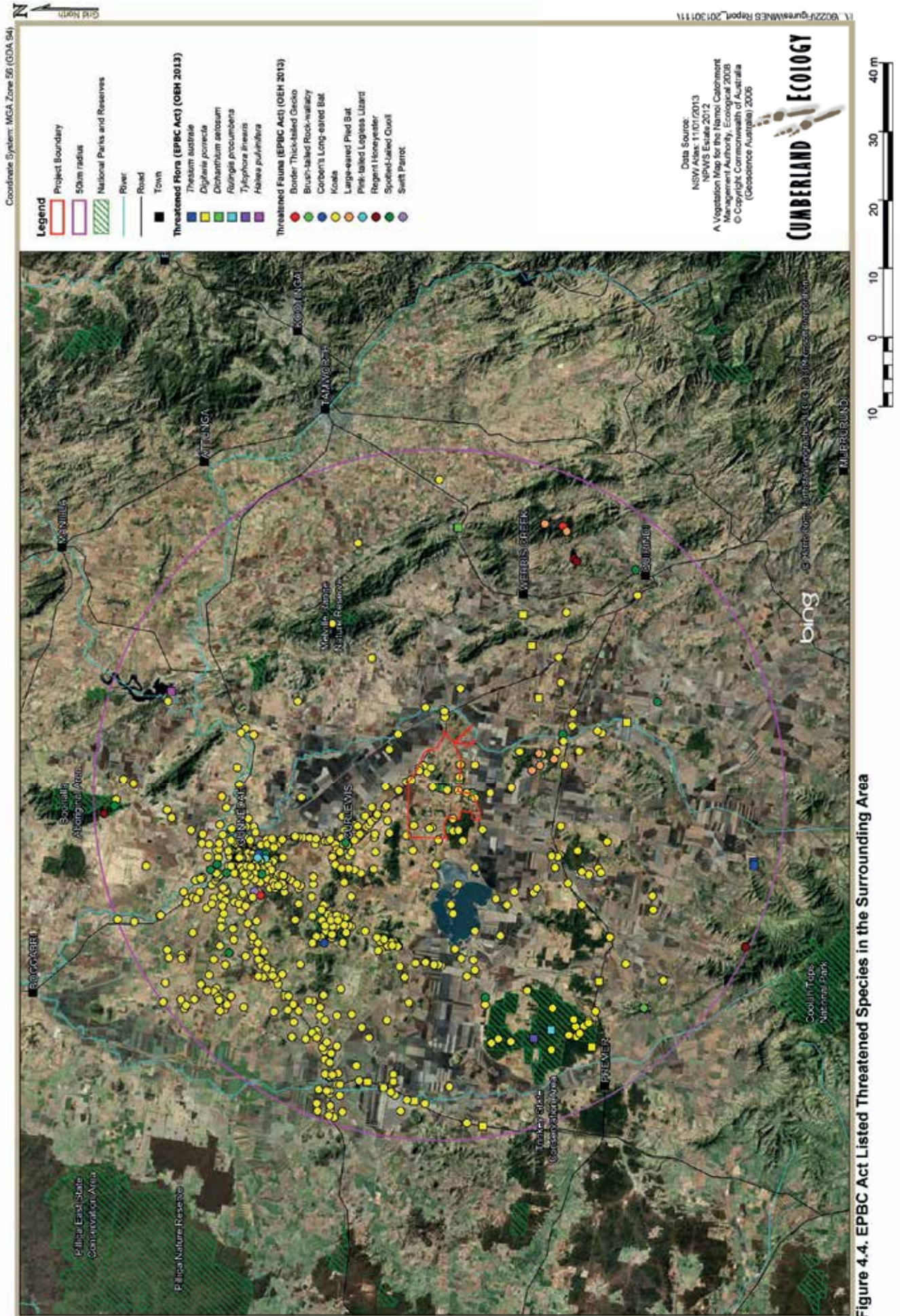


Figure 4.2. EPBC Act Listed Vegetation Communities and Flora Species Recorded within the Project Boundary





4.1.1 *White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland*

EPBC Act Status: White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

White Box, Yellow Box and Blakely's Red Gum Woodland and Derived Native Grassland (Box Gum Woodland and Derived Native Grassland) is listed as a CEEC under the EPBC Act. Approximately 1,265 ha of this community has been mapped in the Project Boundary.

This grassy woodland complex occupies a range of landscape positions on a gradation of semi-fertile to fertile soils. These communities are dominated or co-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).

i. *Regional Extent and Connectivity to the Project Boundary*

Based on the Namoi CMA regional vegetation mapping (2012), the current extent of the woodland form of this community in the Namoi catchment is approximately 204,939 ha. Up to a further 18,800 ha of woodland may also conform to this community, where areas support an abundance of the dominant tree species listed above. Some portions of the Namoi CMA grassland mapping units (RVCs) conform to the Derived Native Grassland component of this CEEC. These RVCs total approximately 1,240,400 ha; however, it is unclear as to the extent of which is actually Derived Native Grassland CEEC.

Box Gum Woodland and Derived Native Grassland in the Project Boundary is connected to large areas of surrounding vegetation that has been mapped as the same community (see **Figure 4.3**). The Project Boundary is bordered by cropping land to the south and east, and connectivity to other areas of woodland does not exist in this area. To the north-west however, Box Gum Woodland in the Project Boundary is connected loosely to a band of Box Gum Woodland extending further to the north-west (see **Figure 4.3**). As can be seen in **Figure 4.3**, Box Gum Woodland is the most common vegetation type in the locality. This map is based on mapping undertaken by the Namoi CMA, and only includes areas mapped as woodland. Additional areas of Derived Grasslands that conform to the description of Box Gum Woodland and Derived Native Grassland are likely to occur.

ii. *Identification of Box Gum Woodland and Derived Native Grassland in the Project Boundary*

For a vegetation community to be classified as Box Gum Woodland and Derived Native Grassland CEEC listed under the EPBC Act, each patch of woodland must have the following features:

- The overstorey is dominated or co-dominated by *Eucalyptus albens*, *E. melliodora* or *E. blakelyi* or *E. microcarpa* in the Nandewar bioregion. The Project Boundary is located within the Brigalow Belt South Bioregion so the latter does not apply;
- A sparse shrub cover of less than 30%;

- A predominantly native understorey;
- Must be 0.1 ha or greater in size;
- Each patch of 0.1 ha in size must contain at least 12 native non-grassy understorey species (forbs, shrubs, ferns and sedges) and contains at least one important grazing sensitive species in order to indicate reasonable condition; or
- If the patch does not contain 12 native non-grassy understorey species it must be larger than 2 ha and the patch contains an average of 20 or more mature trees per hectare or there is natural regeneration of the dominant overstorey eucalypts.

The Listing Advice for Box Gum Woodland and Derived Native Grassland describes the following states, or Condition Classes to assist in determining the state of existing vegetation:

Condition Class 'A' = where an overstorey of eucalypt trees exists, but there is no substantial native understorey;

Condition Class 'B' = where a native understorey exists, but the trees have been cleared; and

Condition Class 'C' = where both a native understorey and an overstorey of eucalypts exists in conjunction.

Field surveys indicated that Box Gum Woodland and Derived Native Grassland that meet Condition Classes B and C occur within the Project Boundary, as Derived Native Grassland and as woodland, respectively. The approximate area of each Condition Class in the Project Boundary as defined in the Commonwealth Listing Advice for the community is as follows:

- 0 ha of Condition Class A;
- 73 ha of Condition Class B, Derived Native Grassland; and
- 1192 ha of Condition Class C, Box Gum Woodland.

In the Project Boundary, *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. *Eucalyptus melliodora* and *E. blakelyi* are generally confined to low points within the landscape, including on terraced flats above creek lines and drainages. Contrary to this within some areas *E. blakelyi* was found on higher elevations where there are sandier soils. Other native tree species co-occurring within the Project Boundary include *E. conica* (Fuzzy Box), *E. populnea* (Poplar Box), *E. pilliagensis* (Narrow-leaved Grey Box), *E. microcarpa* (Inland Grey Box) and *Allocasuarina leuhmannii* (Buloke).

The understorey in this community is variable. At lower points in the landscape, the understorey is largely grassy with a sparse small tree and shrub stratum dominated by *Geijera parviflora* (Wilga), *Notelaea microcarpa* (Native Olive), *Capparis mitchelli* (Native Orange) *Callitris glaucophylla* (White Cypress Pine), *Swainsona galegifolia* (Smooth Darling Pea), *Bursaria spinosa* (Blackthorn) and *Mairena microphylla* (Bluebush). At higher reliefs approaching shallower soils on ridgelines, the understorey becomes denser as it grades into shrubby White Box and shrubby Blakely's Red Gum Woodland.

The ground stratum is generally continuous 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), *Calotis lappulacea* (Yellow Burr-daisy) *Vittadinia cuneata*, *V. dissecta*, *Glycine tabacina*, *Einadia hastata*, *Oxalis perennans*, *Dichondra* sp. A., *Cymbonotus lawsonianus* and *Daucus glochiadiatus*. The dominant grass species present are *Cymbopogon refractus* (Barb-wire Grass), *Dichanthium sericeum* (Silky Blue-grass), *Bothriochloa decipiens* var. *decipiens*, *Austrodanthonia induta* (Wallaby Grass), *Austrostipa scabra* var. *scabra*, *A. verticillata* and *Sporobolus creber*, although a number of other grass species are also present.

Photograph 4.1 to **Photograph 4.3** indicate various examples of Box Gum Woodland in the Project Boundary that contain different diagnostic canopy trees. **Photograph 4.4** shows Derived Native Grassland, which is also a component of Box Gum Woodland.



Photograph 4.1

White Box Dominated Box Gum Grassy Woodland



Photograph 4.2 **Blakely's Red Gum Dominated Box Gum Grassy Woodland**



Photograph 4.3 **Yellow Box Dominated Box Gum Woodland**

Native grasslands within the Project Boundary that were derived from the clearing of woodlands dominated by White Box, Yellow Box, or Blakely's Red Gum trees are referred to as Derived Native Grassland. Approximately 73 ha of this community as it occurs within the Project Boundary meets the criteria for Condition Class B and retains sufficient conservation value to be considered a MNES as defined under the EPBC Act.

The main structural features of this community are shown in **Photograph 4.4**. This community conforms to the grassland component of Box Gum Woodland and Derived Native Grassland under the EPBC Act as it contains at least 12 native non grassy understorey species (such as forbs, ferns shrubs and sedges) within a 0.1 ha plot with at least one being a recognised "important" species (as identified by the species list for the EPBC Act policy statement - White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (DEH 2006)). This community aligns with Condition B which is defined in the SEWPaC listing advice as having '*a native understorey exists, but the trees have been cleared*'. Most occurrences of Derived Native Grassland within the Project Boundary 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.



Photograph 4.4 **Derived Native Grassland (component of Box Gum Woodland)**

4.1.2 Inland Grey Box Grassy Woodland

EPBC Act Status: Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia (EEC)

Approximately 55 ha of this community have been mapped in the Project Boundary. This community generally occurs in areas of low relief within the Project Boundary such as flat to undulating floodplains, usually at lower elevations than White Box Grassy Woodland Poplar Box Woodland, Fuzzy Box Woodland or Weeping Myall Woodland. The community is dominated by *Eucalyptus microcarpa* (Inland Grey Box), with *Casuarina cristata* and *Eucalyptus pilligaensis* (Narrow-leaved Grey Box) also common. Small trees include *Geijera parviflora* and *Pittosporum angustifolium* (Weeping Pittosporum). This community generally follows road verges or occurs between paddocks within the Project Boundary. Due to constant grazing, this community is in poor condition. The understorey is sparse and species-poor at most sites. The main structural features of this community are shown in **Photograph 4.5**.

i. Regional Extent and Connectivity to the Project Boundary

Based on CMA regional vegetation mapping (2012), the current extent of this woodland community in the Namoi catchment is approximately 1,295 ha. This is approximately 9% of the former extent of the community, which has been extensively cleared in the region for grazing and cropping. The EEC is poorly represented in formal conservation reserves in the Namoi catchment and over its full range (Namoi Catchment Management Authority 2012).

According to mapping undertaken by the Namoi CMA, there is little Inland Grey Box Woodland present in the locality. What does occur, is present in small discrete patches that are not connected to remnants within the Project Boundary. Patches within the Project Boundary and those outside form discrete units and there is no direct connectivity between them, other than a broader link via stepping stone patches of other vegetation such as Box Gum Woodland.

ii. Identification of Inland Grey Box Grassy Woodland in the Project Boundary

This community is consistent with the description of Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia, which is listed as an EEC under the EPBC Act. The Inland Grey Box Grassy Woodland recorded within the Project Boundary is considered to comprise Category 1 condition threshold as defined in the listing advice for this community (Threatened Species Scientific Committee 2010). The criteria to meet the Category 1 condition threshold are outlined below:

- The minimum patch size is more than 0.5 ha;
- The canopy layer contains *Eucalyptus microcarpa* as the dominant tree species; and
- The vegetative cover of non-grass weed species in the ground layer is less than 30%.

The community in the Project Boundary also meets the additional criteria for Category 3 condition threshold that applies to larger (>2 ha) woodland patches with a well developed canopy:

- At least 20 trees/ha have a diameter of breast height of 12 cm or more; and
- At least 50% of the vegetative ground cover comprises perennial native species.

Even though the patches of Inland Grey Box Woodland are heavily grazed, approximately 55 ha of this community (Category 3 Condition Threshold) that occur within the Project Boundary still retain sufficient conservation value to be considered an MNES as defined under the EPBC Act.



Photograph 4.5 **Inland Grey Box Grassy Woodland**

4.1.3 *Weeping Myall Woodland*

EPBC Act Status: Weeping Myall Woodland (EEC)

Approximately 22 ha of Weeping Myall Woodland has been mapped in the Project Boundary. This community occurs on heavier clay soils on flat areas and shallow depressions within the Project Boundary. This community usually occurs within the Project Boundary as small isolated patches which have been heavily grazed. Some sites have been used as cattle camps and for cattle fodder. The tree canopy layer is dominated by *Acacia pendula* (Weeping Myall) which in some areas exists as monotypic stands and can vary in structure

from woodland to open forest. This community goes through regular cycles of senescence and regeneration.

Other tree species which co-occur and share similar habitat within the landscape include *Eucalyptus populnea* and *E. microcarpa*. The shrub layer and ground layer are typically bare, with few native species present and comprised mostly of weed species, which is a result of intense regular grazing and continual cattle presence. The main structural features of this community are shown in **Photograph 4.6**.

i. Regional Extent and Connectivity to the Project Boundary

Based on CMA regional vegetation mapping (2012), the current extent of this woodland community in the Namoi catchment is approximately 3,160 ha. This is approximately 6% of the former extent of the community, which continues to be threatened by clearing, grazing, weeds and lack of recruitment. The EEC is poorly represented in formal conservation reserves in the Namoi catchment and over its full range (Namoi Catchment Management Authority 2012).

Although some discrete patches of Weeping Myall Woodland occur in the Project Boundary, they are not directly connected to other areas of this community outside of the Project Boundary. Some connectivity is present between areas of this community inside and outside the Project Boundary through patches of other vegetation communities, particularly as discussed previously through the north-west. Some patches occur also to the south of the Project Boundary, however intervening cropping land has removed all direct connectivity to these areas.

Identification of Weeping Myall Woodland in the Project BoundaryThe Weeping Myall Woodland community identified within the Project Boundary conforms to the EPBC Act description of Weeping Myall Woodland as it meets the criteria outlined below:

- The tree canopy is dominated (more than 50%) by living, dead or defoliated *Acacia pendula*;
- The overstorey is more than 5% tree canopy;
- Each patch of woodland are greater than 0.5 ha in size;
- More than two layers of regeneration of *Acacia pendula* are present or the tallest layer of living, dead or defoliated *A. pendula* trees is at least 4 m tall; and
- 50% of the vegetative cover present (shrub and ground layers), is comprised on native species.

Using these criteria, approximately 22 ha of Weeping Myall Woodland that occurs within the Project Boundary retain sufficient conservation value to be considered an MNES as defined under the EPBC Act.



Photograph 4.6 **Weeping Myall Woodland**

4.1.4 *Brigalow*

EPBC Act Status: Brigalow (*Acacia harpophylla* dominant and co-dominant) (EEC)

Approximately 9 ha of this community have been mapped in the Project Boundary. Brigalow within the Project Boundary occurs in floodplains and valley floors with heavy clay soils adjacent Poplar Box Woodland, Inland Grey Box Woodland and Weeping Myall Woodland. Within the Project Boundary, the community occurs as open forest or woodland within the Project Boundary and is dominated by *Acacia harpophylla* (Brigalow) forming monotypic stands. Other trees co-occurring in lower frequencies include *Eucalyptus populnea*, *E. microcarpa*, *E. albens* and *Casuarina cristata*. The understorey is open and sparse. This community occurs within a cleared landscape used for grazing. This is evident in the understorey as the dominant shrub in one patch is *Lycium ferocissimum* (African Boxthorn). Other native shrubs common to these soil types are the chenopod spp. *Maireana microphylla*, *Sclerolaena muricata* var. *semiglabra*. The ground layer contains tussock grasses such as *Austrostipa verticillata*, *Chloris truncata* and herbs including *Einadia nutans*, *Enchylaena tomentosa*, *Rumex brownii* and *Alternanthera pungens*. The main structural features of this community are shown in **Photograph 4.7**.

i. Regional Extent and Connectivity to the Project Boundary

Based on CMA regional vegetation mapping (2012), the current extent of this woodland community in the Namoi catchment is approximately 8,220 ha. This is approximately 22% of the former extent of the community, which continues to be threatened by clearing, grazing,

weeds and lack of recruitment. The EEC is poorly represented in conservation reserves in the Namoi catchment, with 6% of the community formally reserved (Namoi Catchment Management Authority 2012).

Only a very small area of Brigalow has been recorded from the Project Boundary and there is no connectivity to other patches of this community in the locality. Some small patches have been mapped by the Namoi CMA in the locality, however there is no connectivity between these patches and the area of Brigalow in the Project Boundary.

Identification of Brigalow in the Project Boundary The Brigalow community identified within the Project Boundary is in relatively good condition and conforms to the EPBC Act description of the community as it meets the criteria outlined below:

- Brigalow regrowth retains the species composition and structural elements typical of that found in the undisturbed listed regional ecosystems and is typically more than 15 years old;
- Vegetation occurs in all strata and has not been comprehensively cleared or thinned within the last 15 years;
- Contains less than 50% cover of exotic perennial plants, assessed in a minimum area of 0.5 ha (100 m by 50 m), and
- Individual patches of Brigalow are no smaller than 0.5 ha.

Using these criteria, approximately 9 ha of Brigalow that occurs within the Project Boundary retain sufficient conservation value to be considered an MNES as defined under the EPBC Act.



Photograph 4.7 **Brigalow**

4.1.5 ***Semi-evergreen Vine Thicket***

EPBC Act Status: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (EEC)

Less than 0.1 ha of this community have been mapped in the Project Boundary. Based on CMA regional vegetation mapping (2012), the current extent of this forest community in the Namoi catchment is approximately 589 ha. This is approximately 21% of the former extent of the community, which continues to be threatened by clearing and grazing as it occurs on high nutrient soils, fire and weeds. The EEC is considered to be inadequately reserved in the Namoi catchment (Namoi Catchment Management Authority 2012).

Only a very small area of Semi-evergreen Vine Thicket has been recorded from the Project Boundary. No Semi-evergreen Vine Thicket has been mapped by the Namoi CMA in the locality, and there is therefore no connectivity between the area in the Project Boundary and other areas.

i. Identification of Semi-evergreen Vine Thicket in the Project Boundary

Semi-evergreen vine thicket is a community that is dominated by low trees, shrubs and vines that occurs mainly on hills on deep, high nutrient clay soils derived from basalt. In NSW, remnants of this community usually occur as isolated patches scattered in other shrubby vegetation, with major occurrences in the vicinity of Gunnedah, Bingara and Narrabri (SEWPaC 2012i).

It has been reported that most 'pure' vine thicket patches occupy an area of less than 1 ha within the more extensive shrubby matrix and/or generally fragmented landscape in which they occur (SEWPaC 2012i).

Semi-evergreen Vine Thicket was recorded from two locations on Mt Watermark within the Project Boundary. This area has not been mapped as it covers an area of less than 0.1 ha and is located outside the Disturbance Area on Mt Watermark. The vegetation is a shrubland dominated by *Atalaya hemiglauca*, *Ehretia membranifolia* (Peach Bush), *Geijera parviflora* (Wilga), *Psyrax oleifolia* and *Notelaea microcarpa* (Native Olive) with emergent *Eucalyptus albens* (White Box). A number of the shrub species observed are consistent with, and diagnostic of this community. Vines recorded include *Pandorea pandorana subsp. Pandorana* (Wonga Wine) and *Jasminum suavissimum*, the former species considered a diagnostic species for this community.

4.1.6 Condition Assessment

The results of the vegetation/habitat condition assessments are shown in **Figure 4.5**. In most instances the BioBanking attribute score reflects and confirms the underlying general vegetation condition assessment mapping. The results of the vegetation/habitat condition assessments indicate the majority of patches of woodland that have low edge to area ratios are in good condition; however there are some areas in moderate condition. Patches of woodland that have a high edge to area ratio are of varying condition. The highly modified portions of the Project Boundary are generally of low condition.



Figure 4.5. Vegetation/Habitat Condition Assessment of the Project Boundary and Disturbance Area

4.2 Groundwater Dependent Ecosystems

This section discusses the potential for Groundwater Dependent Ecosystems (GDE) to occur within the Project Boundary. Initially the definition of what constitutes a GDE is discussed, followed by a discussion of previous mapping by others that have identified GDEs that occur in the Namoi CMA. This previous mapping is used to identify the areas that potentially conform to the description of GDE within the Project Boundary and subsequently an assessment is made of the likelihood of occurrence of GDEs within the Project Boundary.

4.2.1 *Definition of a Groundwater Dependent Ecosystem*

GDEs are defined as those that rely in some part for their survival on groundwater. Dependence ranges from complete reliance for some systems to others that rely partially on groundwater, particularly during times of drought. The degree and nature of dependency influences the extent to which ecosystems are affected by changes to groundwater aquifers, both in quality and quantity (DECCW 2009). In general, the majority of Australian ecosystems have little dependence on groundwater, however, there are some localised or extensive ecosystems in Australia with at least a high dependence on groundwater (Hatton and Evans 1998).

Four main types of GDEs have been identified (Hatton and Evans 1998), as described below:

- Terrestrial vegetation – may depend on diffuse discharges of shallow groundwater to varying degrees, either to sustain transpiration and growth through a dry season or to maintain perennially lush ecosystems in otherwise arid environments;
- Wetland ecosystems – may depend on groundwater to keep them seasonally waterlogged or flooded;
- River baseflow systems – many river reaches have a baseflow component of groundwater discharge. This groundwater component may be vital to the character and composition of in-stream and near-stream ecosystems; and
- Aquifer and cave ecosystems – the biology of karst or limestone caves, particularly micro-organisms and invertebrates, are heavily dependent on groundwater availability.

The only potential GDE type within the Project Boundary is Terrestrial Vegetation, as no permanently flowing rivers with a baseflow rate maintained by groundwater occur, no limestone or karst environments occur, and there are no wetlands that are seasonally waterlogged.

Knowledge of GDEs and their sustainability is relatively low and little is known about their location or condition (Eamus and Froend 2006). For most wetlands and terrestrial ecosystems, it is unknown what the critical depth to the water tables is, and the characteristic dynamics (Hatton and Evans 1998).

4.2.2 Potential Groundwater Dependent Ecosystems in the Namoi Catchment and the Project Boundary

The presence of GDEs in the Namoi Catchment has been addressed by two main studies; Eco Logical (2011) and SKM (2010). The results of this work are presented below. A desktop assessment was also conducted by the then Department of Water and Energy in 2008, which identified high priority GDEs in the Namoi region, however this assessment did not include terrestrial ecosystems and is therefore not of relevance to the habitats within the Project Boundary (DECCW 2010).

i. Potential Groundwater Dependent Ecosystems in the Namoi Catchment

The ecosystems in the Namoi Catchment that are considered to comprise GDEs have been identified by (SKM 2010). These ecosystems and their level of dependence on groundwater are shown in **Table 4.2**. None of these communities occurs within the Project Boundary. The communities identified in **Table 4.1** are those that occur in and near waterways, and no such habitat occurs within the Project Boundary. Although there is some potential for vegetation within the Project Boundary to comprise a GDE, none are obviously groundwater dependent.

Table 4.2 Potential Groundwater Dependent Ecosystems in the Namoi Catchment	
Level of Dependence	Ecosystem
Entirely Dependent	Mound spring ecosystems in the Great Artesian Basin
	Streamside eucalypt and related vegetation (e.g. <i>Eucalyptus camaldulensis</i>) along inland (frequently dry) rivers and streams in the arid zone
Highly dependent	Base flow systems of the south-eastern uplands
Proportionally dependent	Base flow systems of the south-eastern uplands
	Swamp sclerophyll forests on the inland floodplains of the south-eastern uplands
	Eleocharis and Baumea sedgeland in lagoons of the inland rivers of the south-east
	Permanently flooded swamps and lakes of inland portions of the south-eastern uplands, supporting Phragmites and Typha grasslands (e.g. the permanently flooded portions of the Macquarie Marshes)
Opportunistic or limited extent dependence	Lignum shrublands on inland river systems

ii. *EcoLogical GDE Mapping of the Namoi Catchment and Project Boundary*

Vegetation communities in the Namoi Catchment that are considered to comprise GDEs were identified by Eco Logical (2011). One vegetation community recorded from the Project Boundary is considered by Eco Logical to comprise a GDE; this is Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions. Approximately 36 ha of this community occurs within the Project Boundary. Fuzzy Box Woodland is likely to have been considered as a potential GDE as it is often found upslope from River Red Gum communities, above the more frequently inundated areas of the floodplain and on the lower slopes and valley flats.

No river baseflow GDEs identified as occurring within the Namoi Catchment by Eco Logical (2011) were recorded from the Project Boundary and none are expected to occur. This is because no permanently flowing rivers occur within the Project Boundary. All waterways within the Project Boundary are ephemeral drainage lines only and do not have a groundwater component. The Mooki River is located adjacent to the Project Boundary, and this has potential to comprise a river baseflow GDE. Although the Mooki River near the Project Boundary periodically ceases to flow and forms pools, there is potential for there to be a groundwater component to the flow. Although the originally existing riparian vegetation along the Mooki River has all been removed, there is potential for it to have been at least partially dependent on river baseflow. This is not the case now however, and the grassland that occurs is unable to access groundwater as discussed previously.

No wetland GDEs identified as occurring within the Namoi Catchment by Eco Logical (2011) are present within the Project Boundary, and this type of GDE is considered to be extremely unlikely to occur due to the lack of wetlands. The only water bodies within the Project Boundary that may be considered to be wetlands are artificial farm dams that depend on runoff from rainfall events to fill, and are not dependent on groundwater. One wetland community identified as a GDE by Eco Logical occurs in the locality; Lake Goran is likely to correspond to the description of "Permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains". This lake may be dependent on groundwater to maintain its water level, and therefore the vegetation surrounding this lake may comprise a GDE. However, Lake Goran is outside of the Project Boundary and it is not considered likely that impacts to this lake will occur as a result of the Project.

iii. *SKM GDE Mapping of the Namoi Catchment and Project Boundary*

Although as shown in **Table 4.2**, no known groundwater dependent communities identified by SKM (2010) are present within the Project Boundary, modelling conducted by SKM indicate that some vegetation within the Project Boundary has potential to be dependent on groundwater. The modelling undertaken used remote sensing to generate evapotranspiration (water use) maps across the CMA, which were combined with rainfall data to identify areas of high evapotranspiration in low rainfall periods. The rationale of this approach was that if vegetation is active during dry periods it is likely it is accessing water other than rain fed infiltration, and this is likely to be groundwater, thereby indicating a degree of groundwater dependency. According to this model, the distribution of potential GDEs in the Namoi Catchment has been mapped and categorised into High, Moderate, Low and Very

Low potential of dependency on groundwater. The SKM (2010) mapping shows four levels of potential groundwater dependency within the Project Boundary including 986 ha of Very Low potential, 485 ha of Low potential, 839 ha of Moderate potential and 58 ha High potential.

4.2.3 Assessment of the Occurrence of GDEs within the Project Boundary

Typical GDE communities such as wetlands and riparian vegetation do not occur within the Project Boundary, and there are no obvious areas of heavy groundwater dependence. Analyses of groundwater depth and site inspections have indicated that none of the vegetation communities within the Project Boundary are GDEs that are completely dependent on groundwater. Additionally, large areas of the groundwater within the Project Boundary is highly saline and this would preclude reliance upon it by native vegetation (AGE Consultants 2012).

4.3 Flora Species

The area within the Project Boundary supports vegetation containing a high diversity of native species. Several hundred flora species have been recorded within the Project Boundary and the surrounding landscape (**Appendix E**). The dominant plant families within the Project Boundary include the Myrtaceae, Fabaceae, Asteraceae and Poaceae families. The most common genus encountered is *Eucalyptus* (canopy tree species). The Poaceae (grasses) family is has the highest diversity of species within the Project Boundary, although it is not strongly represented by any one genus.

The floral assemblage is typical of dry sclerophyll vegetation. The box, gum, cypress pine and acacia species occur most frequently as is demonstrated by the vegetation mapping of the Project Boundary (**Figure 4.1**). 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, however it mainly comprises tussock grasses in low frequency as well as diverse herbaceous species.

One Commonwealth-listed threatened flora species, *Bothriochloa biloba* (Lobed Blue Grass), has been recorded during surveys within the Project Boundary (see **Figure 4.1**). In addition, Atlas of NSW Wildlife database records indicate that several other threatened plant species listed under the EPBC Act have been recorded from the Gunnedah LGA. Several EPBC Act listed threatened species have been recorded from the area surrounding the Project Boundary, and those that have been recorded within a 50 km radius of the Project Boundary are shown in **Figure 4.4**. An analysis of the likelihood of occurrence within the Project Boundary of threatened plants known or predicted to occur within the Gunnedah LGA is presented in **Appendix F**. Based on this analysis, four plant species listed under the EPBC Act are considered to have potential to occur within the Project Boundary due to the presence of suitable habitat:

- *Dichanthium setosum*;
- *Digitaria porrecta*;

- *Cadellia pentastylis*; and
- *Swainsona murrayana*.

In addition, the SEWPaC assessment requirements indicate that the following species should be considered in this assessment:

- *Prasaophyllum* sp. Wybong (C.Phelps ORG 5269);
- *Pterostylis cobarensis*;
- *Thesium australe*; and
- *Tylophora lineraris*.

These species are all considered below in subsequent subsections.

i. *Bothriochloa biloba*

a. Species Description

Bothriochloa biloba (Lobed Blue Grass) is listed as Vulnerable under the EPBC Act. *Bothriochloa biloba* is known to occur from the Darling Downs district in Queensland, south to North Star, Warialda, Bingara and Merriwa in NSW and west to Dubbo and around the Hunter Valley (Quinn et al. 1995). This species occurs within the Hunter–Central Rivers, Central West, Namoi, Northern Rivers and Border Rivers–Gwydir (NSW) and Border Rivers Maranoa–Balonne and Condamine (Queensland) Natural Resource Management Regions (Threatened Species Scientific Committee 2008e).

Bothriochloa biloba is fairly tolerant of grazing and other disturbance. The plant has and been found in locations that are regularly mown, slashed, grazed, cultivated for five years or more, and areas where grazing is restricted (Threatened Species Scientific Committee 2008e). The plant prefers heavier-textured soils such as brown or black clay soils and grows in partially cleared eucalypt forests and grassland derived from the clearing of such forests (Threatened Species Scientific Committee 2008e).

b. Record details within the Project Boundary

There are 21 Atlas of NSW Wildlife database records of the species within the Gunnedah LGA. This species was recorded within the Project Boundary, along Court Lane and The Dip Road (see **Figure 4.2**). Its distribution is patchy along these two roads and restricted to road verges, land between the road edge and neighbouring properties. This indicates that the species may be less tolerant to grazing as currently known or that disturbance thresholds are more complex than currently known. From field observation the species seems to favour impeded drainage, as the majority of individuals were observed within the drainage line immediate to the road. This pattern could also indicate possible translocation of seed banks during the construction of the road.

The species distribution within the Project Boundary ranges from 275m AHD to 337m AHD and crosses Poplar Box Woodland habitat and White Box Woodland habitat. Preference to heavy soils means the species is found to overlap Brigalow and Box Gum Woodland ecological communities, also found within the Project Boundary. Apart from the areas where the species was found, there is suitable habitat within the Project Boundary and the species is considered to have potential to occur within other areas of grassland and woodland. However the history of extensive grazing within the Project Boundary indicates that it is not likely to support large populations of this species. Large areas of similar habitat to that found within the Project Boundary occur surrounding the site, which also has the potential to support this species.

c. Regional distribution and abundance of suitable and potential habitat

There are 157 Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is known to be associated with 20 vegetation types that occur within the CMA, including Brigalow, Box Gum Woodland community variants, and grassland communities. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

ii. *Dichanthium setosum*

a. Species Description

Dichanthium setosum (Bluegrass) is listed as Vulnerable under the EPBC Act. *Dichanthium setosum* is associated with the black, heavy basaltic soils on the New England Tablelands, the North West Slopes and Plains and the Central Western Slopes of New South Wales (DEC (NSW) 2005a). Locally the species is commonly found as scattered clumps in populations. Often, *Dichanthium setosum* is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture derived from woodland containing *Eucalyptus albens*, *Eucalyptus melanophloia*, *Eucalyptus melliodora* and *Eucalyptus viminalis* (DEC (NSW) 2005a).

b. Record Details in the Project Boundary

There are nine Atlas of NSW Wildlife records of the species within the Gunnedah LGA. Of these, eight recent records (dated 2009) occur within the Project Boundary. However, despite targeted searches for the species at these database locations over multiple survey sessions, including summer and autumn when the species is identifiable, no individuals were identified during current surveys undertaken by Cumberland Ecology for this assessment.

The majority of habitats within the Project Boundary are disturbed; however, suitable habitat for the species was identified within the Project Boundary. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species. Nevertheless, due to the database records from within the Project Boundary and due to the presence of suitable habitat, it is considered to have potential to occur and has been assessed in this report.

c. Regional distribution and abundance of suitable and potential habitat

There are 19 Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is known to be associated with 19 vegetation types that occur within the CMA, including Box Gum Woodland community variants and highly disturbed areas such as road verges and paddocks. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

iii. *Digitaria porrecta*

a. Species Description

Digitaria porrecta, (Finger Panic Grass) is listed as Endangered under the EPBC Act. *Digitaria porrecta* occurs in four disjunct areas extending over 1,000 km (Threatened Species Scientific Committee 2008c). In New South Wales it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran (DEC (NSW) 2005c). This grass species is generally found in native grassland, woodlands or open forest with a grassy understorey, on richer soils. Usually found along roadsides and travelling stock with native grassland, woodlands or open forest with a grassy understorey, on richer soils routes where there is light grazing and occasional fire (DEC (NSW) 2005c).

b. Record Details in the Project Boundary

There are eight Atlas of NSW Wildlife records of *Digitaria porrecta* within the Gunnedah LGA. This species was not detected during previous (GHD 2009) or current targeted searches within the Project Boundary. Notwithstanding this, there is suitable habitat (preferred soil and vegetation type) within the Project Boundary, and therefore *D. porrecta* is considered to have potential to occur. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species.

c. Regional distribution and abundance of suitable and potential habitat

There are 25 Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is frequently associated with White Box, and is known to be associated with 18 vegetation types that occur within the CMA, including Brigalow, Box Gum Woodland community variants and grassland communities. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

iv. *Cadellia pentastylis*

a. Species Description

Cadellia pentastylis, (Ooline) is listed as Vulnerable under the EPBC Act. *Cadellia pentastylis* occurs on the western edge of the NSW north-west slopes, from Mt Black Jack

near Gunnadah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Threatened Species Scientific Committee 2008a). Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent (Threatened Species Scientific Committee 2008a) and its distribution is known to overlap Box Gum Woodland and Brigalow, which occur within the Project Boundary.

b. Record Details in the Project Boundary

There are two Atlas of NSW Wildlife records of *Cadellia pentastylis* known within the Gunnedah LGA. However, no plants were detected during previous (GHD 2009) or current targeted searches by Cumberland Ecology within the Project Boundary. Despite this, there is suitable habitat within areas of Whitewood Woodland and other woodland remnants within the Project Boundary, and therefore Ooline is considered to have potential to occur. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species.

c. Regional distribution and abundance of suitable and potential habitat

There are 67 Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is only known to occur in the rainforest vegetation type 'Ooline closed forest (dry rainforest) on sandstone and conglomerate rises and hills in the Brigalow Belt South Bioregion', of which its current extent is 779 ha within the CMA.

v. *Swainsona murrayana*

a. Species Description

Swainsona murrayana (Slender Darling-pea) is a small forb (non-grassy understorey species) listed as Vulnerable under the EPBC Act. *Swainsona murrayana* is found in grassland, herbland, and open Black-box woodland, often in depressions. This species grows in heavy grey or brown clay, loam, or red cracking clays and is often associated with low chenopod shrubs (*Maireana* spp.), wallaby-grass (*Austrodanthonia* spp.), and spear grass (*Austrostipa* spp.). The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated (Threatened Species Scientific Committee 2008d).

b. Record Details in the Project Boundary

There are no Atlas of NSW Wildlife records of *Swainsona murrayana* for the Gunnedah LGA and no individuals were detected during spring surveys for this assessment. Nevertheless the species is considered to have potential to occur within some areas of the Project Boundary due to the presence of suitable habitat. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species.

c. Regional distribution and abundance of suitable and potential habitat

There is one Atlas of NSW Wildlife record for this species within the Namoi CMA. The species is known to be associated with 28 vegetation types that occur within the CMA. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

vi. *Tylophora linearis*

a. Species Description

Tylophora linearis is a small twiner that is listed as Endangered under the EPBC Act. It occurs in dry scrub and open forest, and has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii* (EIS 2011). *Tylophora linearis* has rarely been collected and is known from eight localities in the Dubbo area and Mt Crow near Barraba in New South Wales, and “Myall Park” near Glenmorgan in Queensland.

b. Record Details in the Project Boundary

There are records for this species in the Gunnedah LGA from the Atlas of NSW Wildlife and the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. Potential habitat for *Tylophora linearis* does occur within the Project Boundary; however, this species has not been recorded from the Project Boundary during spring and summer targeted surveys and it is situated beyond known populations. Accordingly, it is considered to be unlikely to occur.

c. Regional distribution and abundance of suitable and potential habitat

There are four Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is known to be associated with 20 vegetation types that occur within the CMA, including dry sclerophyll forests and grassy woodland communities. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

vii. *Thesium australe*

a. Species Description

Thesium australe (Austral toadflax) is a small straggling herb that is listed as Vulnerable under the EPBC Act. It occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo Grass (*Themeda australis*). It is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass.

b. Record Details in the Project Boundary

The Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality, and some potential habitat occurs within the Project Boundary. However, there are no records for *Thesium australe* in the Gunnedah LGA from the Atlas of NSW Wildlife and it has not been recorded from the Project Boundary during targeted surveys. Accordingly, it is considered to be unlikely to occur.

c. Regional distribution and abundance of suitable and potential habitat

There are five Atlas of NSW Wildlife records for this species within the Namoi CMA. The species is known to be associated with 45 vegetation types that occur within the CMA, including dry and wet sclerophyll forests, grassy woodlands and grassland communities. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

viii. *Pterostylis cobarensis*

a. Species Description

Pterostylis cobarensis (Greenhood orchid) is a small terrestrial orchid that is listed as Vulnerable under the EPBC Act. It occurs in eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes above streams in skeletal sandy-loam soils, chiefly from Nyngan to Bourke district (White 2004).

b. Record Details in the Project Boundary

The Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. There are no Atlas of NSW Wildlife records for *Pterostylis cobarensis* in the Gunnedah LGA, and it has not been recorded from the Project Boundary during spring targeted surveys. No suitable habitat occurs within the Project Boundary and it is considered unlikely to occur.

c. Regional distribution and abundance of suitable and potential habitat

There is only one Atlas of NSW Wildlife record for this species within the Namoi CMA. The species is known to be associated with 18 vegetation types that occur within the CMA, including dry sclerophyll forests and grassy woodlands. The current extent of such communities within the CMA indicates that there are extensive areas of known and potential suitable habitat present for this species in the region.

ix. *Prasophyllum* sp. Wybong (C. Phelps ORG 5269)

a. Species Description

Prasophyllum sp. Wybong is a perennial orchid endemic to NSW that is listed as Critically Endangered under the EPBC Act. It is known from seven populations in eastern NSW near

Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. *Prasophyllum* sp. Wybong is known to occur in open eucalypt woodland and grassland.

b. Record Details in the Project Boundary

There are no Atlas of NSW Wildlife records for this species in the Gunnedah LGA. The Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality and potential habitat for this species does occur within the Project Boundary. However, *Prasophyllum* sp. Wybong has not been recorded from the Project Boundary during targeted surveys and it is considered unlikely to occur as this species is known from a closely defined range and the Project Boundary falls outside of this range. It is therefore also considered unlikely to occur in the surrounding area.

c. Regional distribution and abundance of suitable and potential habitat

There are no Atlas of NSW Wildlife records for this species within the Namoi CMA. It is unclear as to the current extent of potential suitable habitat present for this species.

Chapter 5

Fauna Results

The majority of the Project Boundary has been cleared of its pre-existing vegetation, and is now dominated by grassland, with some small areas of woodland. The majority of threatened fauna species detected during surveys undertaken as part of this assessment are associated with the larger patches of woodland within the Project Boundary. Many of the threatened fauna species recorded within the Project Boundary were also recorded in the adjacent Breeza State Forest. The smaller patches of woodland habitats remaining within the Project Boundary also provide habitats for a range of flora and fauna species, albeit to a lesser extent than for the more intact woodland habitats in the larger patches within the Project Boundary and in the adjacent Breeza State Forest.

This chapter presents the results of the fauna field surveys with particular focus on species listed under the EPBC Act. The Koala was listed under the EPBC Act after the determination of the Project as a controlled action; however details of the field surveys relating to the Koala are included here. Comprehensive lists of fauna species recorded within the Project Boundary during the survey are provided in **Appendix G**.

5.1 Terrestrial Fauna Habitat Assessment

Vegetation within the Project Boundary provides potential habitat for a range of native vertebrate fauna species, including amphibians, reptiles, birds, microbats and arboreal and terrestrial mammals. Key habitat features present include:

- Wetland and riparian environments suitable for fauna species dependent on these habitats such as wetland birds, some frogs and reptiles;
- Ground cover, leaf litter, coarse woody debris and rocky outcrops suitable as shelter for small terrestrial fauna species;
- Tree hollows suitable as shelter and breeding habitat for a range of hollow-dependent fauna;
- Blossom-producing trees suitable as forage for a range of nectarivores;
- Koala feed tree species; and
- Caves, culverts and other suitable shelter or breeding habitat for a range of cave-dependent fauna.

These features are discussed in more detail in subsequent subsections below.

5.1.1 Wetland and Riparian Environments

Naturally occurring wetlands and permanent streams are absent within the Project Boundary, however several farm dams are present which provide permanent water sources, and drinking habitat for birds and mammals. The dams do not support significant amounts of aquatic or riparian vegetation and are therefore unlikely to provide suitable habitat for most wetland-dependent species. The dams do however provide suitable habitat for common amphibian species.

The Project Boundary is located within the Namoi Catchment and the Mooki River is a major aquatic habitat within the locality. It is characterised by a meandering channel and a variety of habitats, including deep channels and pools, wetlands, gravel beds and floodplain areas. These aquatic and semi-aquatic habitats play an important role in the life cycles of plants, terrestrial vertebrates, fish and aquatic invertebrates. The stretch of the Mooki River that is adjacent to the Project Boundary is highly degraded and riparian vegetation is completely absent. Cropping extends to the edge of the river banks and weed invasion is prevalent.

Lake Goran lies in the catchment of the Mooki River, upstream and to the west of the Project Boundary. When surface water is present this ephemeral water body provides an important refuge for wetland species, particularly birds.

5.1.2 Rocky Outcrops and Coarse Woody Debris

Rocky outcrops and coarse woody debris provide significant habitat features for a range of terrestrial vertebrates and woodland birds. Rocky outcrops and fallen logs provide shelter and breeding habitat for many reptiles and ground-dwelling mammals.

Fallen branches provide foraging perches and calling locations for small woodland birds. Significant rocky outcrops are located on the hilltops and talus slopes within the Project Boundary, with a similar distribution and abundance as is found throughout the locality. The structural integrity of woodland habitats including the presence of rocky outcrops and coarse woody debris is a key factor in determining habitat suitability for a range of forest and woodland-dependent fauna.

5.1.3 Tree Hollows

Tree hollows were counted at 31 of the Koala SAT survey sites. Tree hollow observations and recorded data is summarised in **Table 5.1** below. The data is based upon average values from the 31 Koala SAT sites.

Approximately 96.8 hollows per hectare were found to occur in the woodland communities within the Project Boundary. White Box and Inland Grey Box woodland communities within the Project Boundary provide the greatest abundance and diversity of tree hollows for fauna species that are dependent on this resource as shelter and breeding habitat. In comparison, the Blakely's Red Gum communities within the Project Boundary support relatively few hollow-bearing trees. Throughout all communities where they occur, White Box and Inland

Grey Box provide the majority of tree hollows available for wildlife. Dead stags are also an important resource for hollow-dependent fauna within the Project Boundary.

Tree hollows were mostly small in size and the removal and regrowth of trees that has occurred within the Project Boundary in the past.

Table 5.1 Size and Abundance of Tree Hollows Within the Project Boundary, Averaged from 31 Sample Plots			
Hollow Size Class	Tree Species	Total number of hollows within 31 Sample Plots	Average number of hollows per hectare
<5cm	<i>E. albens</i>	71	22.90
	Stag	38	12.26
	<i>E. conica</i>	5	1.61
	<i>E. microcarpa</i>	11	3.55
	<i>E. blakelyi</i>	2	0.65
	<i>E. melliodora</i>	19	6.13
	<i>Callitris glaucophylla</i>	1	0.32
5-10cm	<i>E. albens</i>	41	13.23
	<i>E. blakelyi</i>	2	0.65
	Stag	30	9.68
	<i>E. conica</i>	7	2.26
	<i>E. microcarpa</i>	7	2.26
	<i>E. melliodora</i>	6	1.94
11-15cm	<i>E. albens</i>	16	5.16
	Stag	7	2.26
	<i>E. blakelyi</i>	4	1.29
	<i>E. conica</i>	2	0.65
	<i>E. microcarpa</i>	4	1.29
	<i>E. melliodora</i>	4	1.29
16-20cm	<i>E. albens</i>	5	1.61
	Stag	4	1.29
	<i>E. microcarpa</i>	5	1.61
21-25cm	<i>E. albens</i>	2	0.65
	<i>E. microcarpa</i>	2	0.65
26-30cm	Stag	1	0.32
	<i>E. microcarpa</i>	2	0.65
>30cm	Stag	2	0.65

5.1.4 Koala Habitat Assessment

The Koala (*Phascolarctos cinereus*) is known to occur within the Project Boundary and in the wider locality. This species was frequently recorded during surveys, and Koala SAT surveys were conducted to determine the extent of suitable habitat for Koalas.

The primary food tree species in the locality is *Eucalyptus camaldulensis* (River Red Gum), which commonly occurs along creeks and waterways, including some sections of the Mooki River. This species was identified within the Project Boundary as well as a number of secondary food trees for Koalas, including *Eucalyptus albens* (White Box), *E. blakelyi* (Blakely's Red Gum), *E. populnea* (Poplar Box), *E. melliodora* (Yellow Box), *E. conica* (Fuzzy Box), *E. microcarpa* (Inland Grey Box), *E. pilligaensis* (Narrow-leaved Grey Box), *E. blakelyi* (Blakely's Red Gum) and *E. dealbata* (Tumbledown Red Gum). Koala activity within the Project Boundary shows a strong association with feed trees growing on the more fertile slopes and plains.

Although the results of Koala SAT surveys indicate a variation in the levels of Koala activity throughout the Project Boundary, it is apparent that Koalas occur in all of the woodland communities present within the Project Boundary. Woodland communities dominated by non-feed trees such as *Callitris* spp. also showed signs of occupation by Koalas, albeit at low activity levels, therefore it is considered likely that all of the woodland communities within the Project Boundary could provide suitable habitat for Koalas.

In addition, it is likely that scattered trees throughout the Project Boundary are used as "stepping stones", facilitating Koala movement between adjacent patches of woodland vegetation.

5.1.5 Wildlife Corridors

Patches of woodland vegetation within the Project Boundary are mostly small and isolated, with the nearest large area of intact woodland vegetation occurring in the adjacent Breeza State Forest.

Historical disturbance and surrounding agricultural development have resulted in the relative isolation of the small patches of woodland vegetation within the Project Boundary from other similar forest or woodland habitats. As a result, the vegetation within the Project Boundary does not provide continuous connectivity with nearby vegetation, but rather provides "stepping stone" corridors for a range of highly mobile species, particularly birds and microbats. Narrow strips of woodland vegetation along property boundaries and roads within the Project Boundary may also provide some additional movement corridors for wildlife, particularly for Koalas and other arboreal mammals.

5.1.6 Caves

Caves are an important component of fauna habitat for some species of microbats that depend on caves to roost and breed. The Project Boundary contains very few areas of cave habitat. Small caves within the Project Boundary are largely restricted to the upper sections of Mt Watermark and Smokey Point, however due to their small size, they are unlikely to

provide habitat for large colonies of cave-dependant microbats. These areas do however provide potential habitat for small numbers or individuals of cave-dependent microbats.

5.1.7 Regional Distribution and Abundance of Fauna Habitat

The Namoi CMA encompasses 42,060 km² and supports a diverse range of vegetation, ranging from rainforests and wet sclerophyll forest, to dry sclerophyll forests, woodlands, shrublands and grasslands. These various vegetation types provide extensive areas of varied habitat, some of which is protected in formal conservation reserves, and is known to support a number of threatened flora and fauna species that have been recorded or have potential to occur within the Project Boundary. Key habitat features discussed above are also found elsewhere in the region and provide habitat for threatened species.

Conservation areas and forest reserves adjacent to the Project Boundary and in the wider locality can influence the distribution and dispersal of flora and fauna into the wider locality, and as many are formally conserved, will continue to provide important areas of good quality habitat for locally occurring species. Such surrounding reserves include:

- Breeza State Forest;
- Doona State Forest;
- Spring Ridge State Forest;
- Goran State Forest;
- Wondoba State Conservation Area;
- Trinkey State Conservation Area;
- Melville Range Nature Reserve; and
- Somerton National Park.

Figure 5.1 shows the extent of woodland and grassland habitat within a 50km radius of the Project Boundary as mapped by across the Namoi CMA by EcoLogical (2009). With the absence of detailed surveys in these areas it is impossible to map the fauna habitat features present at a finer scale, however the major determinant of higher quality habitat in this area is the presence of woodland trees, and the extent of woodland has been used as a proxy for fauna habitat. All the threatened species recorded from the Project Boundary or considered to have potential to inhabit woodland environments (see **Section 5.2**). Although some also occur in derived grasslands, the clearing of trees indicates that these areas are more likely to be degraded and have higher levels of stock grazing, which would render them less suitable as habitats for native species.

As can be seen on **Figure 5.1**, there are substantial areas of woodland habitat in the locality, particularly in large patches to the south-east of the Project Boundary. Approximately 204,234 ha of woodland habitat and 260,353 ha of grassland habitat occurs in a 50 km

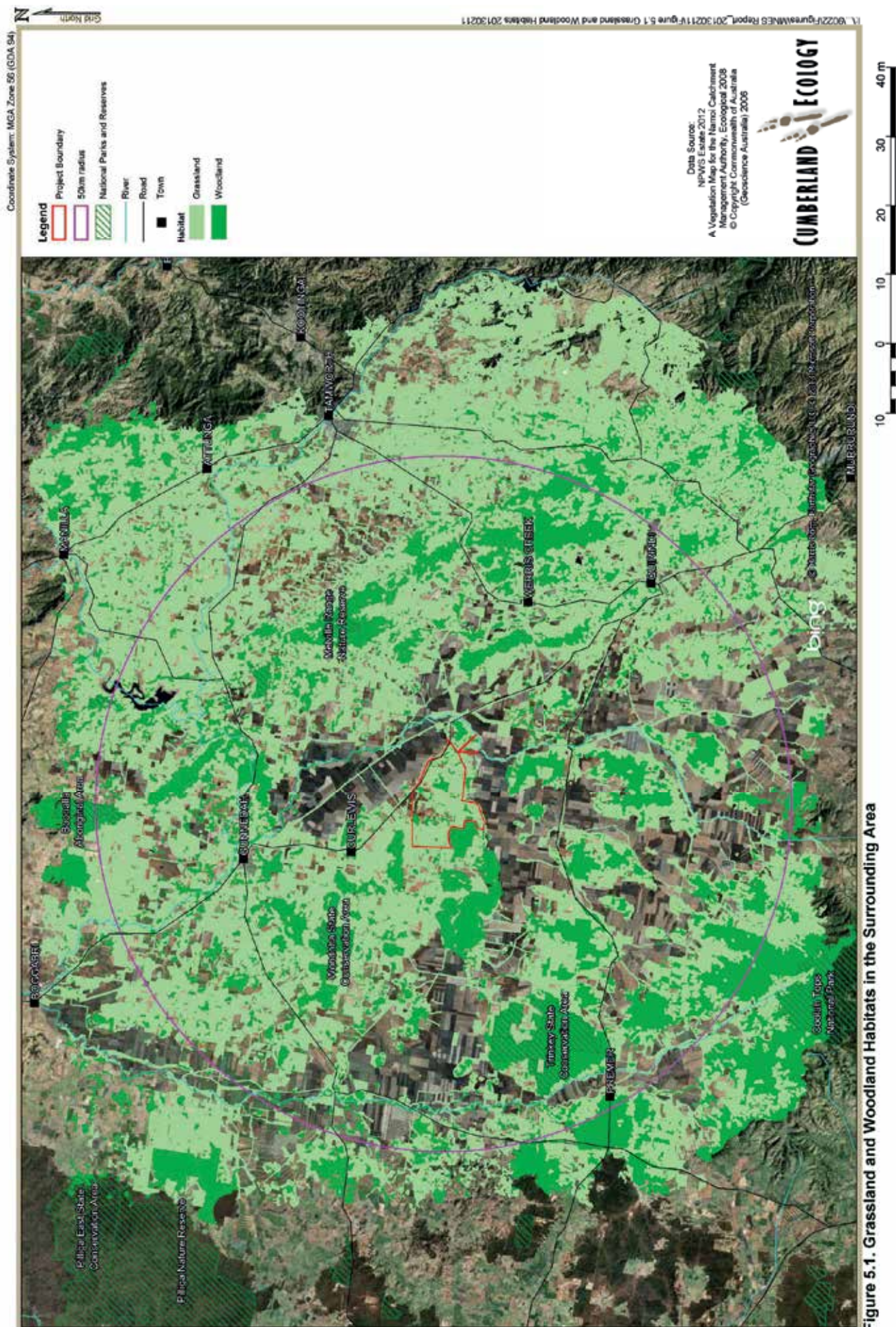
radius of the Project (see **Figure 5.1**). These areas are likely to support similar assemblages of threatened flora and fauna species that have been recorded or have potential to occur within the Project Boundary.

5.2 Fauna Species

The matrix of woodland and grassland communities within the Project Boundary and in the surrounding locality provides extensive forage, breeding and shelter habitat for a range of fauna species. The dominant fauna group is the birds, with 100 species recorded, followed by mammals with a total of 25 mammal species recorded within the Project Boundary. This included 13 terrestrial species, three arboreal species and nine bat species. A total of 17 reptiles were recorded and five frog species. Several feral animals have been recorded including foxes, cats, hares, rabbits and pigs.

One mammal species listed as Vulnerable under the EPBC Act has been recorded from the Project Boundary; the Koala (*Phascolarctos cinerea*), and one Migratory bird species; the White-bellied Sea-eagle (*Haliaeetus leucogaster*) (see **Figure 5.2**). Additionally, database records indicate that several threatened fauna species listed under the EPBC Act have been recorded from the Gunnedah LGA. Several EPBC Act listed threatened species have been recorded from the area surrounding the Project Boundary, and those that have been recorded within a 50 km radius of the Project Boundary are shown in **Figure 4.4**

An analysis of the likelihood of occurrence within the Project Boundary of threatened fauna species known, or predicted to occur within the Gunnedah LGA is presented in **Appendix H**. Based on this analysis, those considered to have potential to occur within the Project Boundary due to the presence of suitable habitat, or that are required to be assessed by SEWPaC are discussed in more detail in subsequent subsections below. These include threatened and migratory birds such as the Swift Parrot and the Honeyeater; mammals such as the Spotted-tailed Quoll, microbats, reptiles and amphibians.



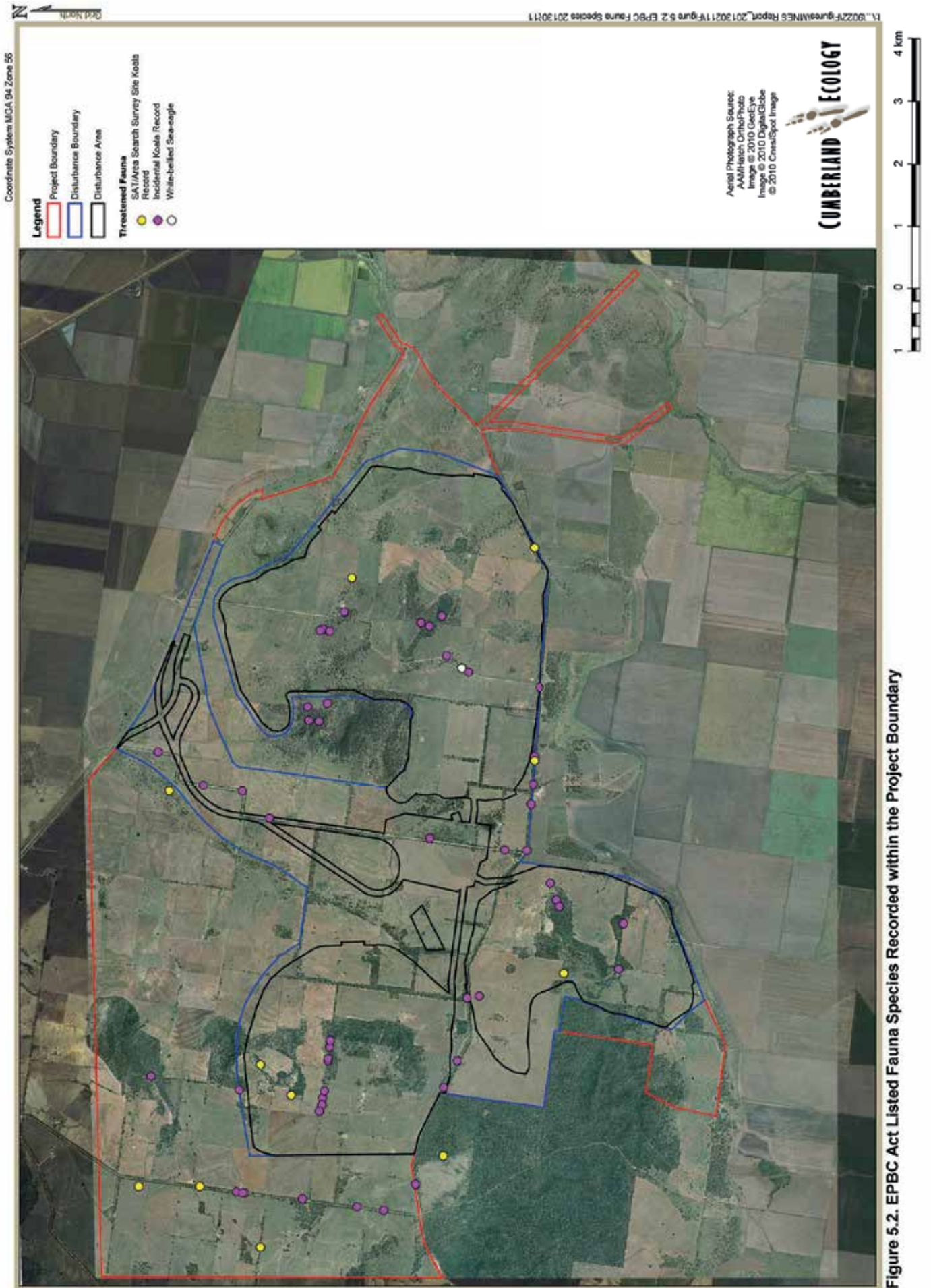


Figure 5.2. EPBC Act Listed Fauna Species Recorded within the Project Boundary

5.2.1 Birds

The woodland communities of the Project Boundary support a high diversity of avifauna, and numerous bird species have been detected within the Project Boundary and immediate surrounds during recent surveys by Cumberland Ecology and GHD (2009). A complete list of bird species recorded during recent surveys undertaken for this assessment is provided in **Appendix G**.

One bird species listed as Migratory under the EPBC Act was recorded within the Project Boundary and adjacent areas during the current surveys. This was the White-bellied Sea-eagle (*Haliaeetus leucogaster*). No additional Migratory species have been recorded within the Project Boundary.

No other bird species listed under the EPBC Act have been recorded within the Project Boundary; however, several bird species listed under the EPBC Act have the potential to occur due to the presence of suitable habitat. These include several birds listed under the EPBC Act under either a threat category (Endangered or Vulnerable) or as Migratory. All bird species listed under the EPBC Act that have either been recorded from the Project Boundary or are considered to have potential habitat within the Project Boundary are considered in more detail in subsections below.

i. Swift Parrot and Regent Honeyeater

Two blossom-dependent birds listed as Endangered under the EPBC Act; the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*) are considered to have potential to occur, although they were not recorded from the Project Boundary. The Swift Parrot is also listed as a Marine species, and the Regent Honeyeater is also listed as a Migratory species under the EPBC Act. These birds are both blossom feeding species and have a strong reliance upon suitable flowering feed trees. **Table 5.2** indicates that summer, autumn, winter and spring flowering trees can be found in the forest and woodland communities identified within the Project Boundary. These tree species would provide some sources of forage for blossom-dependent birds at most times of the year.

Table 5.2 Flowering Periods For Dominant Tree Species												
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Eucalyptus melliodora</i>	✓	✓							✓	✓	✓	✓
<i>Eucalyptus populnea</i>		✓	✓									
<i>Eucalyptus microcarpa</i>		✓	✓	✓	✓	✓	✓	✓				
<i>Eucalyptus albens</i>			✓	✓	✓	✓						
<i>Eucalyptus dealbata</i>					✓	✓	✓	✓	✓	✓		
<i>Eucalyptus conica</i>						✓	✓	✓	✓			
<i>Eucalyptus blakelyi</i>								✓	✓	✓	✓	✓

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

Regent Honeyeaters mostly occur in dry box-ironbark eucalypt woodland and dry sclerophyll forest associations (SEWPaC 2012a). The Regent Honeyeater is a generalist forager and key eucalypt feed trees 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) 2005f). Nests are usually built in rough-barked trees, which are 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 (SEWPaC 2012a). This species has been frequently recorded from the district and there are 141 records from the Namoi CMA.

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 (SEWPaC 2012a). The species are known to forage in Box Gum Woodland dominated by *E. albens*, *E. melliodora*, and *E. blakelyi*, all of which have been recorded within the Project Boundary. Six records of this species have been made in the Namoi CMA.

Both the Regent Honeyeater and the Swift Parrot are known to occur in the wider locality of the Project Boundary. Although they have not been recorded within the Project Boundary, these species are migratory and have low abundance and wide ranges, and are therefore difficult to observe. Approximately 1,997 ha of suitable woodland habitat for these species occurs within the Project Boundary, and therefore it is assumed that these species occur within the Project Boundary, although they are likely to occur infrequently. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support these species.

ii. *Superb Parrot*

Although not recorded during field surveys, Atlas of NSW Wildlife records indicate that the Superb Parrot (*Polytelis swainsonii*), listed as Vulnerable under the EPBC Act has been recorded from the Gunnedah LGA, and there are six records from the Namoi CMA. The nearest recent Atlas of NSW Wildlife records for this species are approximately 70 km to the west of the Project Boundary near Purlawaugh and at Pilliga State Forest. Nevertheless, due to the presence of suitable habitat within the Project Boundary, this species is considered to have potential to occur. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species. Over 204,000 ha of woodland habitat similar to that in the Project Boundary has been recorded from a 50 km radius of the Project Boundary that is likely to provide similar quality habitat for this species.

The Superb Parrot is a non-breeding winter migrant to the upper Namoi River (DEC (NSW) 2005i). The Superb Parrot mainly inhabits forests and woodlands dominated by eucalypts, especially River Red Gums (*Eucalyptus camaldulensis*) and box eucalypts such as Yellow Box (*Eucalyptus melliodora*) or Grey Box (*E. microcarpa*). The species also seasonally occurs in box-pine (*Callitris*) and Boree (*Acacia pendula*) woodlands (SEWPaC 2012h). During the winter months, this species is known to occupy a variety of woodland habitats, including most of the woodland communities occurring within the Project Boundary. In particular, Inland Grey Box woodland is thought to be important habitat for wintering birds

(Schrader, 1980). Superb Parrots feed on a range of plant species, mostly on the ground, but also in trees.

The Project Boundary provides approximately 1,997 ha of foraging habitat for this species, consisting of woodland vegetation. Breeding habitat does not occur as this species is known to breed in three main areas outside of the Project Boundary: along the Murray and Edward Rivers, along the Murrumbidgee River; and in a triangle bounded by Molong, Yass and Young (SEWPaC 2012h). The quality of the habitat in the study area is relatively poor for this species, due to the long history of grazing. Although this species forages in woodlands, they feed on a variety of plant species other than the canopy eucalypts, such as grasses and acacia shrubs. The understorey of the woodlands in the Project Boundary have been grazed for many years which has resulted in a reduction in the diversity of grasses and shrubs relative to what would be expected in less disturbed remnants.

The habitat in the Project Boundary is loosely connected to Breeza State Forest, through a stepping stone corridor of remnant vegetation patches.

iii. *Migratory Species*

One bird species listed as Migratory under the EPBC Act was recorded within the Project Boundary and adjacent areas during the current surveys. This was the White-bellied Sea Eagle (*Haliaeetus leucogaster*). No additional Migratory species have been recorded within the Project Boundary.

In addition to the Regent Honeyeater (discussed above in **Section 5.2.1.i**), six other species listed as Migratory under the EPBC Act have been recorded from the Gunnedah LGA, although they have not been recorded from the Project Boundary. These are:

- White-throated Needletail (*Hirundapus caudacutus*);
- Fork-tailed Swift (*Apus pacificus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Cattle Egret (*Bubulcus ibis*);
- Great Egret (*Ardea alba*); and
- Australian Painted Snipe (*Rostrulata australis*).

Of these, the Australian Painted Snipe (*Rostrulata australis*) is also listed as Vulnerable under the EPBC Act.

The White-throated Needletail (*Hirundapus caudacutus*) and Fork-tailed Swift (*Apus pacificus*) are both insectivorous species. They are non-breeding summer migrants to the region that forage for small flying insects over the canopy of forest and woodland communities. These are wide-ranging species, and large areas of habitat exist in the locality, particularly the Breeza State Forest.

The Rainbow Bee-eater (*Merops ornatus*) is a widespread and common species that migrates to the region in summer to breed in burrows constructed in sand or earth river banks. This species forages in open woodland and grassland habitats. The Rainbow Bee-eater was not recorded within the Project Boundary during the recent surveys. However, it is highly likely that the Rainbow Bee-eater would forage over and within suitable woodland communities within the Project Boundary particularly in the summer months.

The Cattle Egret and the Great Egret are two species of heron that are widely distributed throughout the world. These species forage in wetland and waterways and flooded grasslands. They adapt well to human habitation and can be readily seen near wetlands and bodies of water in urban, suburban and agricultural areas. The Cattle Egret and the Great Egret species were not recorded within the Project Boundary during the recent surveys; however the small dams within the Project Boundary may potentially provide some foraging habitat for these species.

The White-bellied Sea-eagle occurs from India and Sri Lanka, through south-east Asia to Australia on coasts and major waterways (SEWPaC 2012f). This species breeds and hunts near water, and fish form around half of its diet. It is opportunistic and consumes carrion and a wide variety of animals. This species was not recorded within the Project Boundary during the recent surveys, however it may fly over it to access suitable aquatic habitat. The small dams within the Project Boundary may potentially provide some highly limited foraging habitat for this species.

The Australian Painted Snipe (*Rostrulata australis*) generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. This species is widespread and has been recorded at wetlands in all states of Australia. The Australian Painted Snipe has not been recorded from the Project Boundary or the Gunnedah LGA; however the Protected Matters Search Tool indicates that this species may have potential habitat in the locality. Little wetland habitat is present within the Project Boundary, consisting of degraded farm dams. This species may utilise these from time to time, however this is considered to be unlikely and these dams do not provide important habitat for this species.

5.2.2 Mammals

The matrix of woodland and grassland communities within the Project Boundary and in the surrounding locality provides extensive forage, breeding and shelter habitat for a range of terrestrial and arboreal mammals. However survey results indicate that the Project Boundary generally supports a relatively low abundance and diversity of mammal species. This is likely to be the result of historical disturbance and relative isolation from more extensive forest/woodland areas. As a result the Project Boundary now supports mostly highly mobile mammals or those that are resilient to disturbance and isolation. The majority of mammals recorded within the Project Boundary were large macropods, microbats or exotic animals (foxes, cats, hares, rabbits and pigs). A complete list of mammal species recorded from the Project Boundary during surveys is provided in **Appendix G**.

One mammal species listed under the EPBC Act, was recorded within the Project Boundary; the Koala (*Phascolarctos cinerea*). In addition, Commonwealth and NSW database searches indicate that several threatened mammal species listed under the EPBC Act have been recorded in the locality or considered to have potential habitat within the Project Boundary despite the absence of records during field surveys. The threatened mammal species recorded from the Project Boundary or with potential to occur are discussed below.

i. Koala

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the EPBC Act. The Atlas of NSW Wildlife holds 720 records of Koalas within the Gunnedah LGA, and Koalas have been recorded on numerous occasions during past and current surveys throughout the Project Boundary (**Figure 5.2**).

The dominant trees across a high proportion of the woodland and open forest within the Project Boundary 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. conica* (Fuzzy Box), *E. microcarpa* (Inland Grey Box), *E. blakelyi* (Blakely's Red Gum) and *E. dealbata* (Tumbledown Red Gum). Although in lower numbers, important primary food tree species do occur, most importantly *Eucalyptus camaldulensis*.

The results of the SAT surveys (see **Figure 5.3**) indicate that Koala density is generally high within the Project Boundary. Areas of "High" Koala activity are assumed to represent the core of the Koala population within the Project Boundary, whereas area of "Low" activity indicate historical or occasional presence of Koalas.

Approximately 1,883 ha of preferred Koala habitat is present in the Project Boundary (of which only 847 ha will be disturbed over the 30 year life of the Project), comprised of remnant eucalypt woodland patches that contain suitable forage trees. This habitat is connected to Breeza State Forest through patches of remnant woodland, and Koalas are expected to be able to migrate between Breeza State Forest and the Project Boundary as they are also known to cross areas of open land between habitat patches. The quality of the habitat for Koalas in the Project Boundary is considered to be moderate to high, due to the presence of suitable feed trees and the demonstrated high levels of Koala activity. This habitat is expected to provide suitable breeding habitat for the Koala, particularly in areas that support Primary feed tree species. That notwithstanding, far higher quality habitat occurs in Breeza State Forest, where the impacts of clearing and cattle grazing have not occurred. In addition, large areas of similar habitat for the Koala occurs in the surrounding areas. Numerous records have been made of Koalas in surrounding areas (see **Figure 4.4**) and over 204,000 ha of similar woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**).

The Commonwealth listing advice gives a best estimate of the NSW population at 21,000 individuals (SEWPaC 2012g); however there is lack of certainty regarding a number of the regional population estimates that comprise this estimate. Key populations of the Koala occur west of the Great Dividing Range within the Pilliga and Gunnedah regions (SEWPaC

2012g). Population estimates for the Gunnedah region and the Disturbance Area are provided within the KPoM (Appendix L of the EIS).

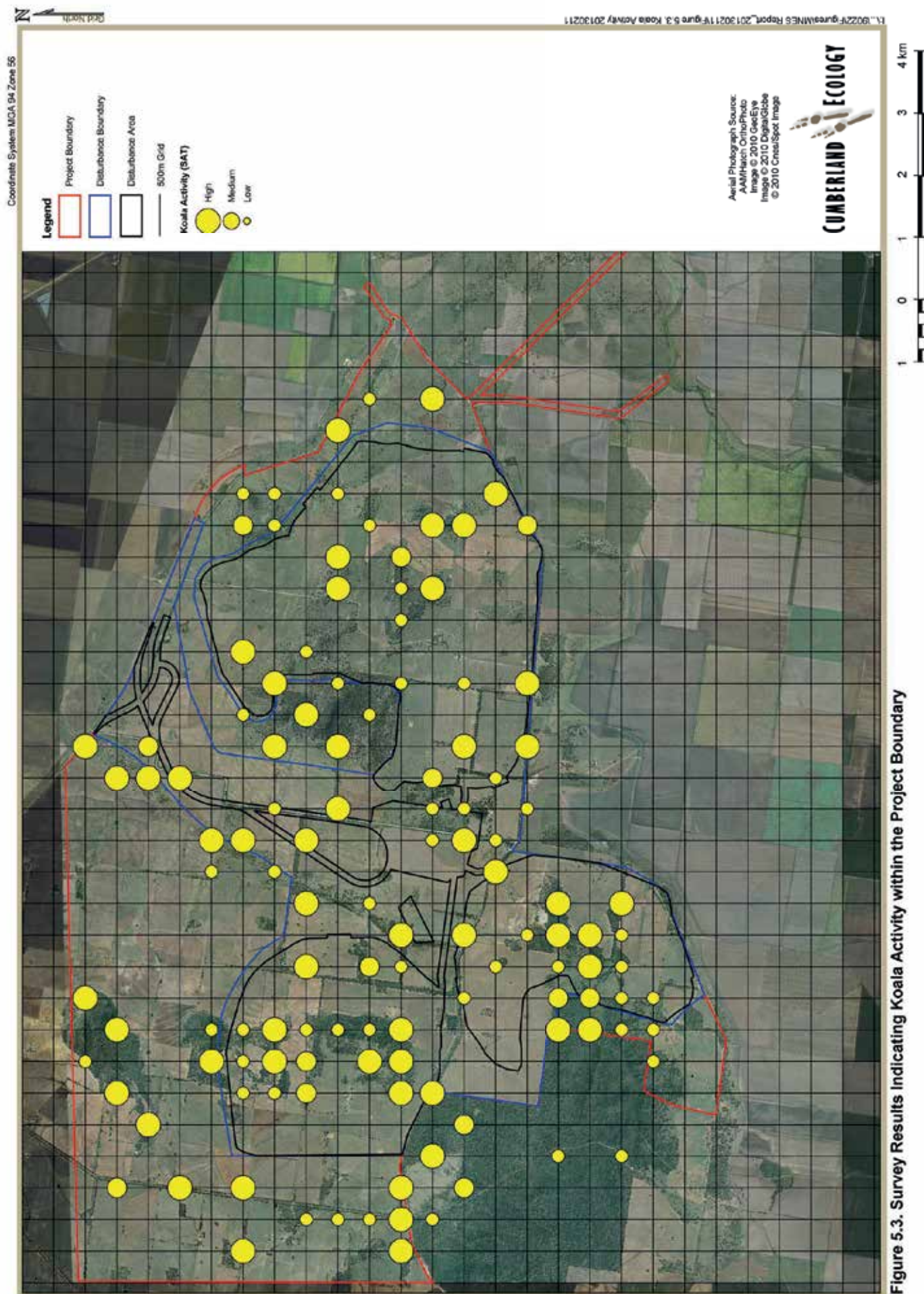


Figure 5.3. Survey Results Indicating Koala Activity within the Project Boundary

ii. *Spotted-tailed Quoll*

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act. This species has been recorded in the locality; however it was not identified within the Project Boundary during the current surveys, despite targeted searches. It is known from the locality however, and a total of 81 records of this species have been made in the Namoi CMA.

Although the species has not been recorded within the Project Boundary, rocky overhangs and crevasses, and woodland communities provide suitable forage, den and breeding habitat for the Spotted-tailed Quoll. It is therefore considered that the Spotted-tailed Quoll has the potential to occur within the Project Boundary, albeit in very low density. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species.

The Project Boundary contains approximately 1,997 ha of potential habitat for the Spotted-tailed Quoll, including potential breeding habitat. This habitat is largely located in woodland areas, and within the rocky slopes of Mt Watermark. Suitable habitat also occurs in nearby Breeza State Forest, and this habitat connects to habitat in the Project Boundary through remnant patches of woodland. The quality of the habitat in Breeza State Forest is likely to be relatively high as it has had limited disturbance. In contrast, the quality of the habitat in the Project Boundary is generally likely to be relatively low for this species due to the long history of clearing and cattle grazing. Understorey complexity in the Project Boundary is relatively low, which would result in low densities of prey species for the Spotted tail Quoll, such as rodents, bandicoots and possums. Preferred habitat is likely to be located on the rocky slopes of Mt Watermark.

Large areas of similar habitat for the Spotted-tailed Quoll occurs in the surrounding areas, and over 204,000 ha of similar woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**).

iii. *Brush-tailed Rock Wallaby*

The Brush-tailed Rock Wallaby (*Petrogale penicillata*) is listed as Vulnerable under the EPBC Act. This species has not been recorded from the Gunnedah LGA, however there are 28 records from the Namoi CMA, and the Protected Matters Search Tool indicates that this species may have habitat within the locality.

This species occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. They browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees. The rocky habitats associated with Mt Watermark provide suitable habitat for this species, however the Brush-tailed Rock Wallaby is a relatively conspicuous species and it has not been recorded. Furthermore, Mt Watermark exists as a relatively small island of rocky habitat in the middle of extensively cleared grasslands and remnant woodland patches. Due to its small size and isolation, this indicates that the potential habitat on Mt Watermark is unlikely to be of high value to this species. There are no large areas of rocky

habitat nearby that connects to this area, and it is highly unlikely that a single small population of this species persists in Mt Watermark, or in surrounding areas.

iv. *New Holland Mouse*

The New Holland Mouse (*Pseudomys novaehollandiae*) is listed as Vulnerable under the EPBC Act. In NSW, the New Holland Mouse is known from: Royal National Park and the Kangaroo Valley, Kuringai Chase National Park, and Port Stephens to Evans Head near the Queensland border. Across the species' range, the New Holland Mouse is known to inhabit open heathland, open woodland with a heathland understorey and vegetated sand dunes. Coastal heath vegetation undergoing early to mid-successional regeneration, as a result of habitat disturbances (e.g. fire, mining, clearing), appears to be the preferred habitat for this species in many areas.

The Project Boundary is located outside of this species known distribution, and the vegetation present is not considered to be this species preferred habitat. No heath, or sand dunes are present, and no coastal heaths are present. The Project Boundary is not considered to provide habitat for this species. No records of this species are present in the Gunnedah LGA, the Protected Matters Search Tool does not indicate that this species has potential to occur in the locality and it has not been recorded from the Project Boundary. Accordingly, it is considered unlikely that this species occurs within the Project Boundary or in surrounding areas.

v. *Grey-headed Flying Fox*

The Grey-headed Flying Fox (*Pteropus poliocephalis*) is listed as Vulnerable under the EPBC Act. This species occurs in a wide range of habitats including subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. They roost in large camps, which are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.

This species has not been recorded from the Gunnedah LGA, and only three records have been made in the Namoi CMA. Furthermore, the Protected Matters Search Tool does not indicate that this species has potential to occur in the locality. That notwithstanding, potential foraging habitat for this species occurs in the Project Boundary, however this species does not breed within the Project Boundary as evidenced by the lack of camps. Potential foraging habitat is present in the wooded areas of the Project Boundary where flowering trees are seasonally available. However, due to the lack of nearby camps, the habitat in the Project Boundary is considered to provide low quality habitat for the Grey-headed Flying Fox. Other potential habitat occurs in the nearby Breeza State Forest, which is likely to provide more foraging resources due to the higher quality of the woodland in this area, however in common with the Project Boundary it is not considered to provide high quality habitat due to the lack of camps in the locality and the long distances animals would have to fly to reach this area. Large areas of similar habitat occurs in the surrounding areas, and over 204,000 ha of similar woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**).

The Grey-headed Flying Fox has not been recorded from the Project Boundary and is not considered likely to occur. It is possible that this species may occasionally use the Project Boundary to forage in; however this is expected to be unlikely due to the lack of records from the locality and distance from known roosting sites.

vi. *Microchiropteran Bats*

No microbats listed under the EPBC Act have been recorded from the Project, however, two threatened microbat species listed as Vulnerable under the EPBC Act are known to occur in the locality and considered to have potential to occur within the Project Boundary; the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*).

Neither the Large-eared Pied Bat nor the South-eastern Long-eared Bat were recorded during the recent surveys, however Atlas of NSW Wildlife records indicate that the Large-eared Pied Bat has been recorded from Kelvin State Forest to the north of the Project Boundary, and near Werris Creek to the south. The Atlas of NSW Wildlife records indicate that the South-eastern Long-eared Bat has been recorded at Wondoba State Forest and near Gunnedah to the north of the Project. In addition, this species was recorded recently by Cumberland Ecology from a property to the west of Gunnedah. Despite the absence of records, the Project Boundary is considered to provide suitable forage, shelter and breeding habitat for both species. These habitats are considered to be relatively high quality and include woodland communities (that provide forage habitat for both species), tree hollows (roosting and breeding habitat for South-eastern Long-eared Bat) and small caves and crevices in the higher rocky outcrops within the Project Boundary (e.g. Mt Watermark) (suitable roosting and breeding habitat for the Large-eared Pied Bat). Both of these microbat species are therefore considered to have potential to occur within the Project Boundary, despite the absence of survey recordings of either species. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support these species. Over 204,000 ha of similar woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**). Areas of high quality habitat for both these species also occur in Breeza State Forest. This area has not experienced the same degradation as the Project Boundary, and is likely to provide high quality foraging and breeding habitat. The Project Boundary is connected to Breeza State Forest through a network of remnant woodland patches that form stepping stone corridors in the landscape.

5.2.3 Reptiles

A total of 17 reptile species were recorded from within the Project Boundary including snakes, geckos, monitors, dragons and skinks. It is likely that a number of additional common species occur throughout the Project Boundary, as the vegetation within the Project Boundary provides suitable forest and woodland habitat for reptiles known to occupy these habitats. Reptile diversity within the Project Boundary is considered to be low when compared to similar sized areas of intact woodland vegetation, most likely due to a history of disturbance and the isolation of remnant woodland patches. A complete list of reptile species recorded during surveys is provided in **Appendix G**.

No threatened reptile species listed under the EPBC Act were recorded during the recent surveys despite targeted searches for these species. Commonwealth and NSW database searches indicate the occurrence of three reptiles listed as Vulnerable under the EPBC Act from the locality of the Project Boundary, and habitat assessment confirms the potential for these species to occur within the Project Boundary where suitable habitat occurs. These are:

- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*);
- Pink-tailed Legless Lizard (*Aprasia parapulchella*); and
- Five-clawed Worm-skink (*Anomalopus mackayi*).

i. Border Thick-tailed Gecko

The Border Thick-tailed Gecko occurs in dry sclerophyll open forest and woodland associated with outcrops of basalt, sandstone and metamorphic rocks, in particular granite (SEWPaC 2012j). It favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Known populations of this species occur in Gunnedah, within the locality of the Project Boundary, and the Atlas of NSW Wildlife holds 41 records of this species in the Namoi CMA.

This species has not been recorded from the Project Boundary, however potential habitat for this species does occur, mostly restricted to the woodland patches (fallen timber and leaf litter) and the rocky outcrops associated with Mt Watermark. Approximately 2,069 ha of potential woodland habitat is present in the Project Boundary for this species. This is likely to provide foraging and breeding habitat for this species.

Suitable woodland habitat for this species occurs in the locality, in particular in Breeza State Forest, which supports a high quality patch of remnant vegetation that is likely to contain habitat features suitable for this species. This area has not experienced the same degradation as the Project Boundary, and is likely to provide high quality foraging and breeding habitat. The Project Boundary is connected to Breeza State Forest through a network of remnant woodland patches that form stepping stone corridors in the landscape. Approximately 204,234 ha of similar woodland habitat to that in the Project Boundary occurs in a 50 km radius of the Project Boundary.

ii. Pink-tailed Legless Lizard

The Pink-tailed Legless Lizard is a fossorial species that forages and shelters beneath leaf litter. It inhabits sloping, open woodland areas with predominantly native grassy ground layers, particularly those dominated by Kangaroo Grass (*Themeda australis*). It is known to occur in primary and secondary grassland, grassy woodland and woodland communities dominated by box and ironbark eucalypts (SEWPaC 2011b). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. It is commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks.

This species has not been recorded from the Project Boundary; however two records of this species have been made within the Namoi CMA. Most of the Project Boundary is likely to provide potential habitat for this species, including areas of remnant woodland vegetation and derived native grasslands. Approximately 2,069 ha of woodland and native grassland habitat for this species occurs in the Project Boundary. This is likely to comprise relatively high quality breeding and foraging habitat as it contains all the microhabitat features required by this species.

High quality habitat for this species is present in nearby Breeza State Forest. This area has not experienced the same degradation as the Project Boundary, and is likely to provide high quality foraging and breeding habitat. The Project Boundary is connected to Breeza State Forest through a network of remnant woodland patches that form stepping stone corridors in the landscape. In addition, large areas of similar habitat occurs in the surrounding areas, and over 464,000 ha of similar grassland and woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**).

iii. *Five-clawed Worm-skink*

The Atlas of NSW Wildlife does not indicate any records for the Five-clawed Worm-skink within the Gunnedah LGA. The nearest records for this species are to the north of the Project, at Culgoola and between Narrabri and Moree. However, this is a cryptic fossorial species and may easily avoid detection, and therefore due to the presence of suitable habitat, this species is presumed to have potential to occur.

The species shelters at the soil surface where moisture is sufficiently retained under decaying leaf litter, coarse woody debris or artificial debris. The species also lives in cavities in rotting tree bases, logs and in tussock bases. It is known to dig permanent tunnel-like burrows in loose, friable, humic soils in woodland (SEWPaC 2011a). The Five-clawed Worm-skink occurs in grasslands and grassy, open woodlands on heavy black and grey, alluvial cracking clay soils. Associated tree species include River Red Gum (*Eucalyptus camaldulensis*), box eucalypts, ironbarks and *Acacia pendula* (Weeping Myall). It has been found occurring in burrows in open paddocks with few trees, cropped grass and moist black soil.

Although this species was not recorded from the Project Boundary; two records of this species have been made within the Namoi CMA. Potential habitat for this species was identified within the Project Boundary and it is therefore considered that it has the potential to occur. The majority of the Project Boundary provides relatively high quality foraging and breeding habitat for the Five-clawed Worm-skink. Approximately 2,069 ha of woodland and derived native grassland habitat are present in the Project Boundary. Large areas of similar habitat to that found within the Project Boundary also occur in surrounding areas, which also have the potential to support this species. Over 204,000 ha of similar woodland habitat to the Project Boundary has been mapped within a 50 km radius (see **Figure 5.1**). Breeza State Forest is located adjacent to the Project Boundary and this is likely to provide an area of particularly high quality habitat for this species as it is relatively less disturbed than the Project Boundary. The Project Boundary is connected to Breeza State Forest through a network of remnant woodland patches that form stepping stone corridors in the landscape.

5.2.4 *Amphibians*

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 common amphibian species during heavy rainfall periods.

A total of five frog species were detected within the Project Boundary during recent surveys by Cumberland Ecology and GHD (2009). 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 within the Project Boundary due to the lack of suitable aquatic habitat. A complete list of the amphibian species recorded during surveys is provided in **Appendix G**.

Chapter **6**

Aquatic Ecology Results

Aquatic assessments were conducted at 13 sites in and around the Project Boundary to gain a comprehensive overview of the condition of aquatic habitat and water quality within the Project Boundary. This included farm dams, the Mooki River, Native Dog Gully, and Lake Goran.

Results from the aquatic surveys indicate all 13 sites are highly disturbed as a result of human activities and ecological function is significantly to severely impaired.

AusRivAS and SIGNAL assessments indicate water quality and habitat availability is low and that the water bodies do not support abundant or diverse community assemblages. These findings are discussed in more detail below.

6.1 Aquatic Habitat Assessment

6.1.1 *Farm Dams*

The farm dams within the Project Boundary are small and shallow, with evidence of occasional drying out. They are constructed on mounds higher than the surrounding open grass and cropland. Apart from occasional livestock access and providing some habitat for water birds such as ducks, the farm dams offer little habitat for native terrestrial fauna, mostly due to the lack of fringing vegetation and connectivity within open, highly disturbed land. As with the Mooki River, the dams offer marginal habitat with little or no in-stream vegetation, rocks or snags, making it difficult for aquatic macroinvertebrates to colonise (see **Photographs 6.1 to 6.3**).

Future monitoring of dams would be unnecessary as these man made waterbodies are unlikely to ever have a 'natural' aquatic state and are ephemeral, which means they are likely to have different aquatic communities to permanent, and flowing, water bodies.



Photograph 6.1 **Aquatic Survey Location - SWM15**



Photograph 6.2 **Aquatic Survey Location - SWM12**



Photograph 6.3 Aquatic Survey Location - FD07

6.1.2 *Waterways*

Two waterways were sampled in the south-east of the Project Boundary, Mooki River and Native Dog Gully, which is a tributary of Mooki River (see **Figure 3.3**). These are two ephemeral waterways that only flow following sufficient rainfall. The Mooki is a tributary of the Namoi River, which in turn is a tributary of the Darling River.

Aquatic habitat along the Mooki River and Native Dog Gully is highly degraded. Native riparian and floodplain vegetation has been historically cleared for agriculture and now it is practically non-existent, with the exception of a few scattered paddock trees.

The floodplain is intensively cropped, and cultivated land extends to within 2 to 10m of the bank edge at many sites. The noxious weed Bathurst Burr (*Xanthium spinosum*) now dominates the area from the river bank to the edge of cropping land. Prior to clearing and cultivation, the Mooki River channel would likely have been incised and meandering, due to variable flow regimes and the highly erodible nature of the soil. However, this has been exacerbated by the removal of vegetated ground cover, which has resulted in severe erosion of the steeper river banks, and the formation of channels that have formed as a result of heavy rainfall and run-off. Erosion has caused sedimentation of the river, resulting in a turbid water column and soft substratum (refer to **Photograph 6.1** and **Photograph 6.2**).

The Mooki River and Native Dog Gully provide highly simplified aquatic habitat with little or no in-stream vegetation, or rocks and snags required for aquatic macroinvertebrate habitation. Few macroinvertebrates can colonise and survive on bare substrates, even if

water quality is suitable (Chessman 2003). Both water courses provide sub-optimal habitat for aquatic fauna, but are likely to be used by birds and possibly amphibians at some locations. The sections surveyed are unlikely to support significant freshwater fish communities due to the presence of barriers and road crossings across the channel (e.g. Pipe1, SWM15); a lack of both woody debris and macrophyte coverage for shelter and spawning; generally low levels and flow; and intermittently dry nature of the watercourses.

6.1.3 Lake Goran

Lake Goran is an extensive but shallow lake located outside of and to the west of the Project (see **Figure 3.3**). The land surrounding the lake is generally used for agriculture and cleared of trees and shrubs. The lake is subject to intermittent drying periods in which the lake edges and occasionally the deepest section of the lake bed dries out. When this occurs, Lake Goran is often sown with crops.

The lake provides habitat for a number of water birds, including ducks and a large flock of pelicans. As the lake is periodically cropped and the bed is fine mud, it is unlikely that it offers suitable habitat for benthic macroinvertebrates as the mud is abrasive and could potentially clog the gills of invertebrates (refer to **Photograph 6.4**).

Table 6.1 presents the results of a visual habitat assessment of several surface water monitoring locations for the Project (SWM01, SWM02, SWM11, SWM12, SWM14. And SWM15) and proposed pipeline locations (Pipe1 and Pipe 2), including a ranking of disturbance levels from human activities. This table indicates that habitat quality is generally low quality across all surface water monitoring locations.

Table 6.1 Aquatic Habitat Assessment									
Survey Site	Surrounding land use	Substrate	Rocks/snags	Riparian vegetation - trees	Riparian vegetation - mid & groundcover	Macrophytes	AusRivAS visual assessment of human disturbance		
							Water quality	In-stream Vegetation	Riparian Vegetation
Pipe1	Agriculture (cropping)	Silt - Cobbles	Bank stabilisation	Absent	Absent	Present	3	4	4
Pipe2	Agriculture (cropping)	Silt - Gravel	Absent	Present - limited	Exotic Grass	Absent	2	2	4
SWM01	Agriculture (cropping)	Sand - Cobbles	Absent	Present - limited	Exotic Grass	Absent	2	2	3
SWM02	Agriculture (cropping)	Silt - Gravel	Absent	Absent	Exotic Grass	Present	3	2	4
SWM11	Agriculture (cropping)	Silt - Cobbles	Snags	Absent	Exotic Grass	Present	2	2	3
SWM12	Agriculture (cropping)	Clay - Silt	Absent	Absent	Exotic Grass	Present	2	3	3
SWM14	Agriculture (cropping)	Silt	Absent	Present - limited	Exotic Grass	Absent	2	3	3
SWM15	Agriculture (cropping)	Clay - Pebbles	Present - channel barriers	Absent	Exotic Grass	Present	3	4	3

AusRivAS visual assessment ranking: 0 = no evidence of human disturbance 1 = little disturbance 2 = moderate disturbance 3 = high disturbance 4 = extreme disturbance



Photograph 6.4 **Aquatic Survey Location - Lake Goran**

6.2 Threatened Aquatic Species

No surveys were conducted for vertebrate species due to low water levels at the time of aquatic sampling in the Mooki River and Native Dog Gully, surrounding land use and lack of aquatic habitat. Farm dams were not surveyed for fish as they are artificial waterbodies not connected to river systems that would allow natural fish movement. No threatened aquatic species are considered likely to occur due to the highly disturbed nature and poor quality (stock trampling, fouling and overgrazing; weeds; loss of native plants; and loss of snags, logs and pools in waterways (Murray-Darling Basin Authority 2008)) of the aquatic habitat at the sampling sites.

Literature reviewed indicates that several threatened species of fish are known from the Namoi catchment, which drains into the Murray-Darling Basin. This includes the Murray Cod (*Maccullochella peellii peellii*) (Murray-Darling Basin Authority 2008), which is listed as Vulnerable under the EPBC Act, and is subject to re-stocking measures in the catchment. This fish species is not considered likely to occur within the Project Boundary due to the poor condition of watercourses in the locality.

6.3 Site Condition and Water Quality

Water parameters were measured in-situ at selected locations during the aquatic field surveys using a calibrated TPS 90FLMV multimeter. The parameters recorded included alkalinity, electrical conductivity (EC), dissolved oxygen (DO), pH, temperature and turbidity. In addition, flow rate and water level were visually assessed at each location and the

average annual rainfall was determined from the Australian Bureau of Meteorology (BOM 2011).

Water quality parameters were compared to the lowland rivers in south-eastern Australia trigger values published in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000a) to provide an indication of the relative water quality of the survey sites. The ANZECC trigger values are concentrations (or loads) of the key performance indicators, below which there is a low risk that adverse biological effects will occur. These may have direct or indirect, toxic or non-toxic effects on the ecosystem or biota (von der Ohe and Liess 2004)

Table 6.2 shows the physical and chemical data collected that was used to determine the overall condition of each survey site. A brief explanation of the impact of these stressors in relation to ANZECC trigger values is listed below (ANZECC 2000a, Turak and Waddell 2001b).

Alkalinity – Alkalinity levels at all sites were very high, ranging from 140 to 440ppm, which is likely to be a result of the underlying geology. Levels of at least 20ppm are considered the minimum required to protect aquatic organisms against any changes in pH.

EC ($\mu\text{S}/\text{cm}$): Conductivity levels in the survey sites were highly variable, and are expected to fluctuate greatly depending on the amount of water flowing at each site. ANZECC guideline ranges are from 100-5,000 $\mu\text{S}/\text{cm}$. Variability of inorganic ions (salts) in the water at the sample sites is likely to be the result of a combination of factors such as flow regime, evaporation, runoff and the minerals within underlying geology and soil.

DO (ppm): levels at all sites were generally well above the ANZECC minimum criteria values, indicating levels of oxygen sufficient to support life. However, DO levels can fluctuate daily and long term monitoring of surface water is recommended to confirm these conditions. DO concentrations <6ppm were measured at some sites during the March 2011 sampling event, which is unsuitable for many aquatic organisms. DO can vary depending on factors such as time of day, temperature, photosynthetic activity, amount of decaying organic matter, aeration and stream flow and animal and human activities. Low levels of DO can starve organisms of oxygen, thereby inhibiting the suitability of waterways to support aquatic life.

pH: pH levels were fairly similar across all sample sites however all were above the ANZECC upper limit trigger values, indicating that the levels of pH were well above the limit for healthy waterways. Higher pH levels can damage metabolic function or directly kill aquatic organisms. It may also increase the toxicity of substances such as ammonia.

Turbidity (NTU): The sample sites all have high levels of suspended particulate matter and turbidity was well over the range specified by ANZECC guidelines, indicating that they are highly turbid and degraded. A lack of macrophyte and riparian vegetation along the banks allows fine clay and silt sediment to erode into the watercourses. The sediment was observed to be easily disturbed and remained suspended in the water column for a long time before settling to the substrate. High levels of turbidity result in reduced levels of light which

can severely impact on photosynthetic capabilities of aquatic plants, smother benthic and filter-feeding organisms and influence predator-prey interactions.

Table 6.2 Physical and Chemical Data Recorded at 2011 Aquatic Survey Sampling Locations

	Units	ANZECC trigger values for South-east Australia	Lake Goran	Pipe1	Pipe2	SWM01	SWM02	SWM11	SWM12	SWM14	SWM15	FD03	FD04	FD06	FD07
LOCATION ATTRIBUTES															
Altitude			293	296	292	282	280	286	292	301	299	334	320	322	336
Latitude			-31.27	-31.29	-31.28	-31.26	-31.22	-31.27	-31.31	-31.15	-31.28	-31.21	-31.25	-31.26	-31.23
Longitude			150.2	150.42	150.45	150.47	150.47	150.46	150.41	150.42	150.4	150.33	150.41	150.34	150.32
CHEMICAL ATTRIBUTES															
Alkalinity	ppm		280	370	350	380	320	320	266	440	340	-	270	140	-
EC	(µS/cm)	30-350	1,438	-	1,919	1,621	1,301*	1,692	1,546	1,045	1,093	-	495	1,992	234
DO	ppm	>6	12.61	10.24	9.64	9.98	13.48	10.23	8.2	8	13.26	10.21	12.43	6.51	8.12
pH		6.5-8	8.9	9.08	8.04	8.15	8.81	6.98	8.6	8.49	9.18	8.45	8.97	8.7	8.54
PHYSICAL ATTRIBUTES															
Flow rate			No flow	Slow	Slow	Slow	Slow	Slow	Slow	Slow	Slow	N/A	N/A	N/A	N/A
Water level			Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Moderate	N/A	N/A	N/A	N/A
Turbidity	(NTU)	1-20 for lakes; 2-25 for rivers	-	29.8	75	42	40	22.9	-	60	89.2	117.2	108.6	20.6	-
Rainfall (average/yr)	(mm)		650	650	650	650	650	650	650	650	650	650	650	650	650
Temperature	(°C)		16.9	17.6	17.2	13.9	14	15.8	10.1	14.2	19.3	14.3	13.9	15.4	16.6

Table 6.2 Physical and Chemical Data Recorded at 2011 Aquatic Survey Sampling Locations															
	Units	ANZECC trigger values for South-east Australia	Lake Goran	Pipe1	Pipe2	SWM01	SWM02	SWM11	SWM12	SWM14	SWM15	FD03	FD04	FD06	FD07
CONDITION RANKINGS															
(AusRivAS Ecological Integrity Bands			C	C	C	C	B	B	C	C	C	C	C	B	C
SIGNAL score			5.2	2.7	2.7	5.9	2.4	2.2	2.6	0.9	1.6	6.9	3.7	4.1	7.9

* = Trigger values refer to south-east Australia guideline levels of chemical and physical stressors for slightly disturbed ecosystems that are used to assess risk of adverse effects due to nutrients, biodegradable organic matter and pH in various ecosystem types.

6.4 Macro-invertebrate Results

Aquatic macro-invertebrates are used as biological indicators of freshwater ecosystem health due to their sensitivity to changes in water quality, flow regime and general habitat condition (von der Ohe and Liess 2004). The presence or absence of particular species, diversity, composition and abundance of communities provide general measures of health which can be used to assess impacts on aquatic systems (Maher and Norris 1990). The condition and degree of ecological integrity of the aquatic survey sites was determined by inputting survey data into the AusRivAS macroinvertebrate predictive model (Turak and Waddell 2001b) and the SIGNAL macroinvertebrate scoring system (Chessman 2003) (see **Section 6.4.1** and **Section 6.4.2**).

To gain an appreciation of how similar the survey sites were in terms of invertebrate assemblages, invertebrate abundance and community composition data for each site was run through the PRIMER statistical program, which creates a Multi-Dimensional Scaling (MDS) plot (see **Figure 6.1**). The MDS plot shows how similar invertebrate communities at each site are in comparison to other aquatic invertebrate communities within the Project Boundary; the closer the symbols, the more similar the assemblage in terms of aquatic invertebrate abundance and community composition. For example, sites which recorded low diversity (numbers of species) and abundance of invertebrates would be closer to each other on the plot than sites which recorded high diversity and abundance. 'Stress' is an indication of confidence in the data and output patterns; stress of less than 0.2 is considered acceptable. In this analysis, a stress of 0.11 was recorded, which indicates that the output is considered to be robust.

The MDS plot shown in **Figure 6.1** shows a clear divide between the abundance of taxa collected at stream sites and dams/lake. Sites located along waterways form a group to the right of the plot; sites located at dams fall in a group in the middle, and the site at Lake Goran form a group to the far left. Note that the two types of standing water bodies (i.e. dams and lake) group closest to each other. These results show clearly that there is a clear distinction between the macroinvertebrate assemblages in the farm dams, the waterways and in Lake Goran. This is likely to be due to the different flow regime in the different waterways – the lake and the farm dams are bodies of water that experience no flow regime, while the waterways experience variable flow rates for at least some of the year. These different habitat types support different macroinvertebrate assemblages as reflected in **Figure 6.1**.

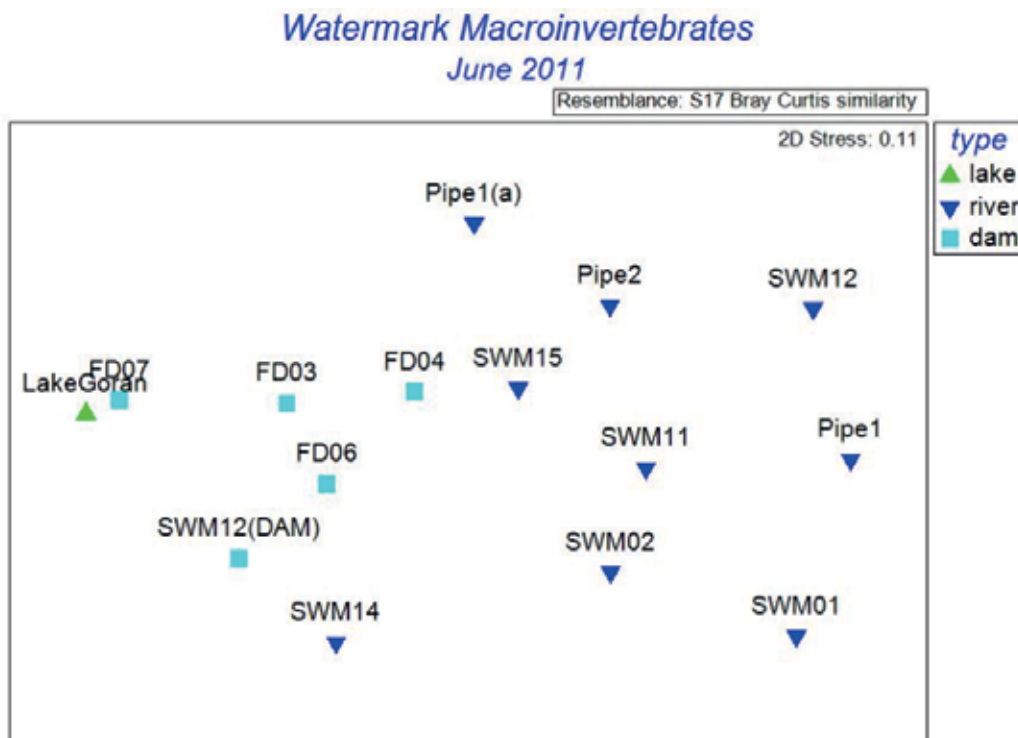


Figure 6.1 MDS Plot of Invertebrate Abundance

6.4.1 AusRivAS Analysis

To assess the aquatic health of the sampling sites using the AusRivAS models, the abundance and diversity of macroinvertebrates at each sampling location was compared with published reference sites used to allocate each sampling site into bands representing different levels of biological condition. When testing the aquatic health of a stream, the model predicts the reference condition for this stream based on the invertebrate community. The model then compares this expected condition with the observed condition and calculates a score, which is called the observed to expected ratio (OE50). An OE50 score around 1 means that the observed invertebrate community is similar to the expected one and therefore equivalent to that of a reference or undisturbed stream. A score lower than 1 means that less invertebrates were observed than expected and that the community is in poorer ecological condition when compared to a reference site. To enable easier reading of OE50 scores, a banding system is used where the Band A is given to OE50 scores around 1, whilst Bands B, C and D are given to respectively lower OE50 scores.

The AusRivAS bands are as follows:

X = sample site invertebrate abundance is more diverse than reference site;

R = is the reference site;

A = sample site invertebrate abundance is equal to the reference site;

B = sample site invertebrate abundance is significantly impaired in comparison to the reference site;

C = sample site invertebrate abundance is severely impaired in comparison to the reference site; and

D = sample site invertebrate abundance is extremely impaired in comparison to the reference site

A description of the interpretation guidelines for all the AusRivAS bands is provided in **Table 6.3**.

Based on the diversity and abundance of invertebrates, all aquatic survey locations were classified as Band B (significantly impaired) or Band C (severely impaired) under the AusRivAS Ecological Integrity Bands classification system (see **Table 6.4**). Sites that are classified as Band B do not contain several macroinvertebrate families that would be found in healthy waterways and water quality and/or habitat condition is significantly impaired. Sites in Band B have a reduction in up to nearly 50% of the expected macroinvertebrate biodiversity (compared to the reference site). Band C sites are further degraded, where up to 75% of expected biodiversity has been lost and habitat condition is severely impaired (see **Table 6.4**).

This analysis shows that all sites are significantly altered or affected by surrounding land practices and do not support a diverse assemblage of aquatic invertebrate fauna.

Table 6.3 AusRivAS Ecological Integrity Bands			
AusRivAS Band	Description	Macroinvertebrate Biodiversity Status	Interpretation Guide
X	More biologically diverse than reference sites	Over 112% more biodiversity than reference sites	More macroinvertebrate families found than expected. Potential biodiversity 'hot spot'. Possible mild nutrient enrichment.
R	Reference Site	Natural or near-natural levels of biodiversity	Presumed to be in a reference condition
A	Reference condition	Similar levels of biodiversity to reference sites	Most or all of the expected families were found at the sample site. Water quality and/or habitat condition roughly equivalent to reference sites.
B	Significantly impaired	Approximately 16-45% of macroinvertebrate biodiversity has been lost	Several expected families not found. Water quality and/or habitat condition significantly impaired. Significant loss of macroinvertebrate biodiversity.
C	Severely impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
D	Extremely impaired	Approximately 76-100% of macroinvertebrate biodiversity has been lost	Extremely few of the expected families found. Extremely poor water quality and/or habitat condition. Extreme loss of macroinvertebrate biodiversity. Highly degraded
?	Beyond the capacity of current AusRivAS models	Could not be assessed using current AusRivAS models	Could not be assessed using current AusRivAS models

Table 6.4 Ecological Integrity of 2011 Aquatic Survey Sampling Locations

Survey Location	AusRivAS Band	Description	Macroinvertebrate Biodiversity Status	Interpretation Guide
Pipe1	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
Pipe2	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
SWM01	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
SWM02	B	Significantly Impaired	Approximately 16-45% of macroinvertebrate biodiversity has been lost	Several expected invertebrate families not found. Water quality and/or habitat condition significantly impaired. Significant loss of macroinvertebrate biodiversity.
SWM11	B	Significantly Impaired	Approximately 16-45% of macroinvertebrate biodiversity has been lost	Several expected invertebrate families not found. Water quality and/or habitat condition significantly impaired. Significant loss of macroinvertebrate biodiversity.
SWM12	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
SWM14	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.
SWM15	C	Severely Impaired	Approximately 46-75% of macroinvertebrate biodiversity has been lost	Many expected invertebrate families not found. Water quality and/or habitat condition severely impaired. Severe loss of macroinvertebrate biodiversity.

6.4.2 *SIGNAL Analysis*

SIGNAL analysis involves categorising the aquatic health of waterways based on the environmental tolerance of the macroinvertebrates recorded. Relatively pristine sites would be expected to have high macroinvertebrate diversity, including taxa that are sensitive to pollution. These sites would have a high SIGNAL score. Sites that are highly degraded are expected to support a lower diversity of macroinvertebrate species, and these are expected to be pollution tolerant species. These sites would have a low SIGNAL score.

The most common taxa recorded in the survey sites were fly, bug, damselfly and caddis fly larvae, and beetles; generally those with low SIGNAL grades indicating their tolerance of a range of environmental conditions, including poor water quality and common forms of water pollution, such as toxic chemicals, turbidity, salinity, and nutrient concentrations. Site SWM14 had the highest macroinvertebrate diversity, with 14 taxa collected. The farm dams generally had a lower number of taxa, most likely due to a lack of flowing water and limited habitat availability.

SIGNAL scores have been plotted in a basic quadrant diagram, displayed in **Figure 6.2**. The scores represent general environmental conditions based on the abundance and diversity of taxa collected at each site, where sites that fall within Quadrant 1 are considered to be in the highest ecological condition and sites in Quadrant 4 are in the lowest ecological condition. **Figure 6.2** shows that the majority of survey sites fall in Quadrant 4 and are affected by one or more human impacts, which are typically from urban, industrial or agricultural pollution, or downstream effects of dams. Only one survey site fell into Quadrant 1, which represents the least modified habitat. These results are likely to be because all sites are located within a highly degraded region in which native vegetation has been removed, intensive cropping occurs, and watercourses are not protected or fenced off. All sites had high abundances of Cladocera (water fleas), which are indicators of nutrient enrichment.

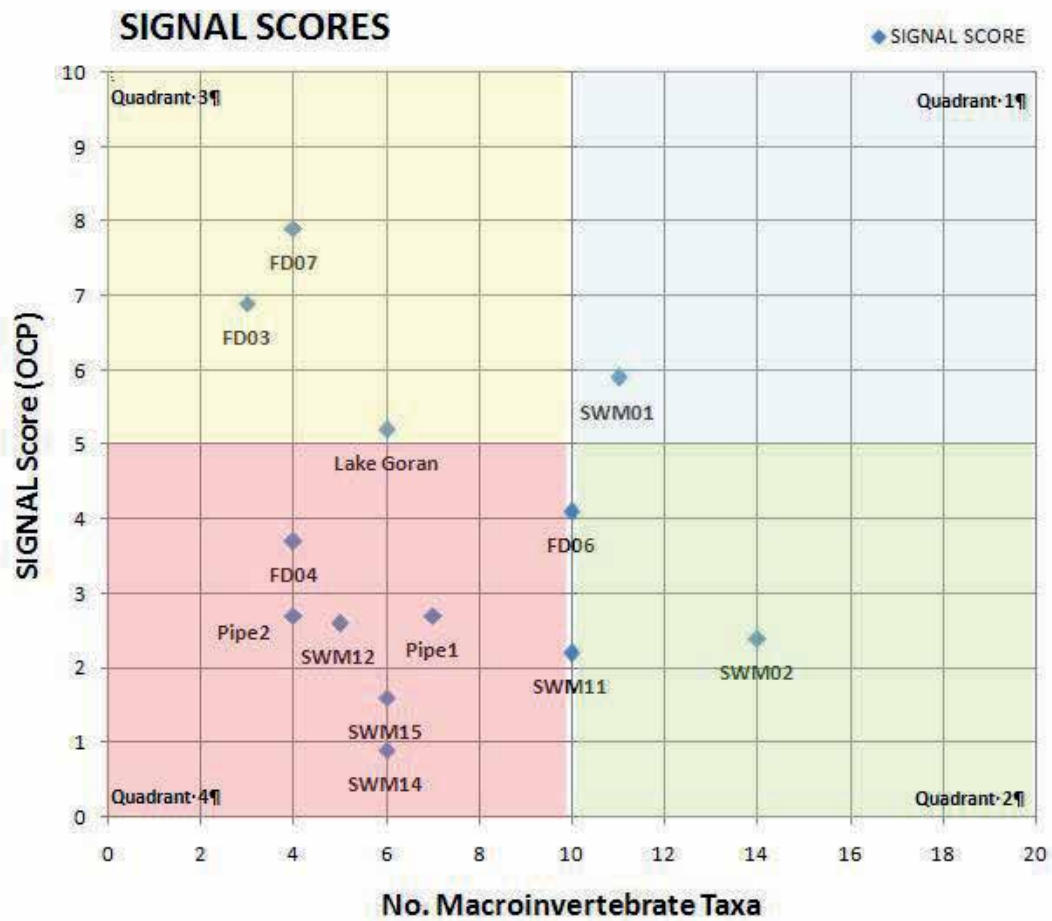


Figure 6.2 Quadrant Diagram of Signal Scores

Chapter 7

Information Relating to Water

This section presents a discussion on overall water impacts of the Project. As noted in **Section 6.2**, no EPBC Act listed aquatic species are not considered likely to occur within the Project Boundary due to the poor quality of the aquatic habitat at the sampling sites. Some aquatic MNES such as Murray Cod (*Maccullochella peelii*) are known to occur in the Namoi River, of which the Mooki River is a tributary. The Project may result in reduced flows in the Mooki River due to extraction and as a result of reduced catchment area, which will result in lower flows in the Namoi River. The scale of the reduction in flows is so small, that is not expected to impact the Murray Cod. Therefore, any impacts to water as a result of the Project are not considered to impact on MNES.

The broader impacts of the Project on groundwater and surface water sources have been addressed through separate assessments, including:

- A Groundwater Impact Assessment undertaken by Australasian Groundwater and Environmental Consultants Pty Ltd (2012) (see Appendix S of the EIS). The purpose of the assessment was to characterise the existing groundwater system, predict inflows into the mining areas throughout the life of the Project and assess the impacts of the Project on groundwater sources; and
- A Surface Water Impact Assessment undertaken by WRM Water and Environment (see Appendix R of the EIS). The purpose of the assessment was to characterise existing catchments, develop a water balance with consideration of the proposed water management system and assess the impacts to surface water sources as a result of the Project.

7.1 Regulatory Framework

The following legislation, plans, policies and regulations are relevant to the Project for surface water and groundwater management:

- *Water Act 1912*;
- *Water Management Act 2000* (WM Act) and associated water sharing plans;
- *Dams Safety Act 1978*;
- *NSW State Groundwater Policy* (DEWHA 2008b);

- *NSW Groundwater Quality Protection Policy* (DEWHA 2008a);
- *NSW Groundwater Dependent Ecosystems Policy* (DLWC (NSW) 2002);
- *NSW Groundwater Quantity Management Policy* (Lunt et al. 2007);
- *Aquifer Interference Policy* (NSW NPWS 2008);
- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (ANZECC 2000b);
- *ANZECC Guidelines and Water Quality Objectives in NSW* (OEH 2012b);
- *Managing Urban Stormwater Soils and Construction – Volume 2E Mines and Quarries* (Debus 2012); and
- *Managing Urban Stormwater, Soils and Construction* (Landcom 2004).

The Project Boundary lies within the Namoi River Catchment and the Murray-Darling Basin. The following water sharing plans (see **Figure 7.1**) are relevant to the Project and will regulate water sources within the Project Boundary or potentially relevant to the water effects related to the conduct of the Project:

- *Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011*, as developed under the WM Act;
- *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*, as developed under the WM Act, particularly with regard to the following groundwater sources:
 - Upper Namoi Zone 3, Mooki Valley (Breeza to Gunnedah) Groundwater Source;
 - Upper Namoi Zone 7, Yarraman Creek (East of Lake Goran to Mooki River) Groundwater Source;
 - Upper Namoi Zone 8, Mooki Valley (Quirindi – Pine Ridge Road to Breeza) Groundwater Source; and
 - All water contained in the “unconsolidated alluvial sediment aquifers associated with the Namoi River and its tributaries” (but excludes the underlying Great Artesian Basin).
- *Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources 2003*.

There is currently a draft *Water Sharing Plan for the Namoi Unregulated and Alluvial Water Sources*, which is expected to commence in the second half of 2012.

I:\19022\Figures\W\NES Report_20130211\Figure 7.1. Water Uses and Management Zones

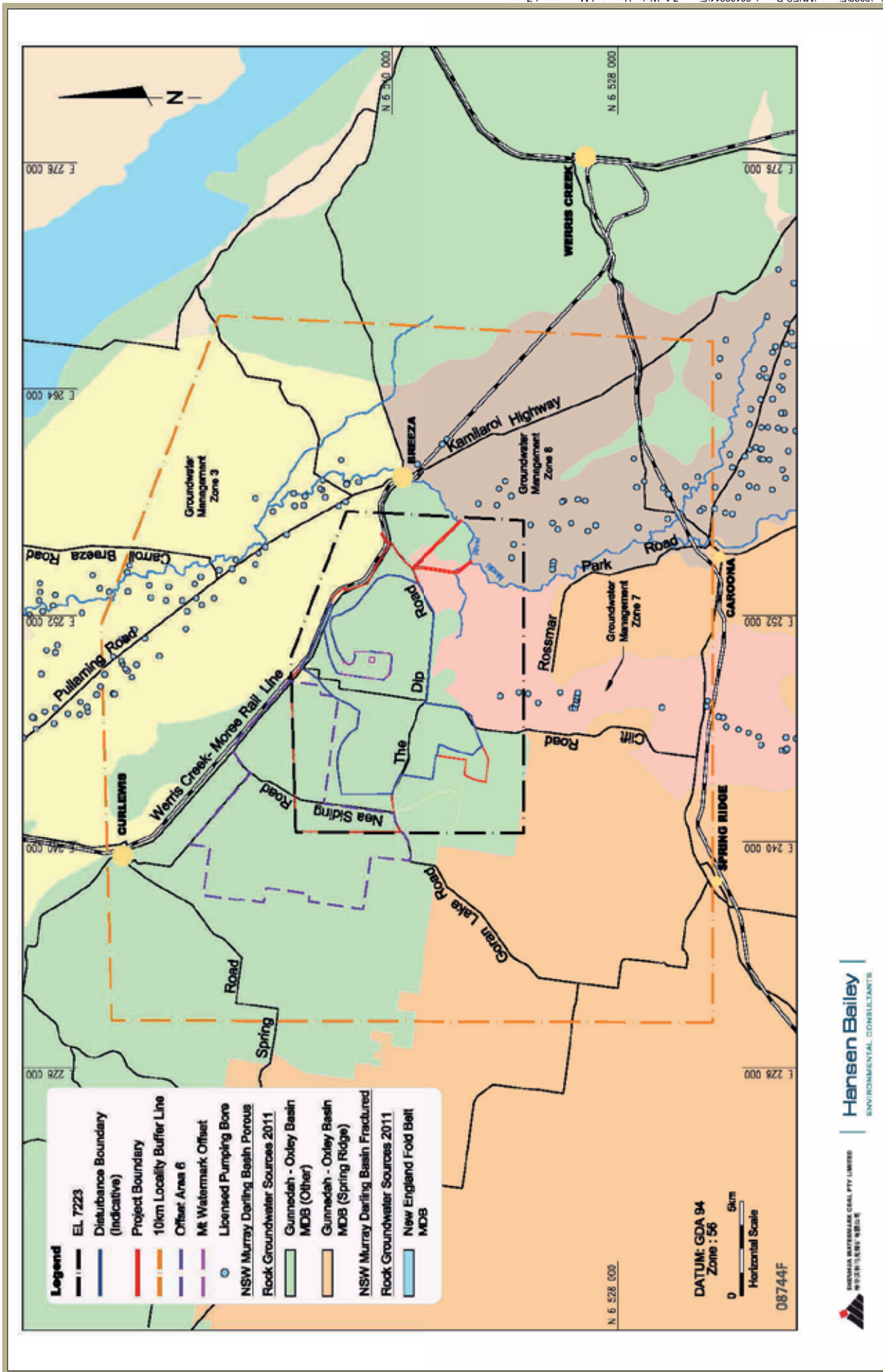


Figure 7.1. Water Uses and Management Zones

7.2 Baseline Data on Water Resources in the Project Boundary

7.2.1 Groundwater

i. Previous Groundwater Investigations

Numerous hydrogeological investigations have previously been completed within the region surrounding the Project Boundary. These investigations predominately focused on determining the characteristics and behaviour of the Upper Namoi alluvium system and defining the regional groundwater systems within the Mooki River catchment.

Previous investigations were reviewed to develop a conceptual site model and subsequent mathematical groundwater model for the Project.

ii. Field Investigation Program

Due to the lack of site specific data within EL 7223, Shenhua Watermark commenced an extensive hydrogeological investigation program in 2009, including:

- An extensive hydrogeological investigation program, including the installation of a network of 103 groundwater monitoring sites and monitoring of water levels, water quality, hydraulic conductivity and porosity, radiocarbon and tritium age dating;
- Site survey for groundwater fed springs and soaks throughout the Project Boundary;
- Installation of 16 additional monitoring bores to characterise the hydrogeological properties of the buffer zone between the mining areas and the aquifers underlying the black soil plains; and
 - Quaternary alluvium delineation study by GHD (2012) using geology and soils mapping, digital terrain data, airborne radiometrics, borehole logs and site inspections.
- Transient Electromagnetic Geophysical Survey within EL 7223 (Eby and Lunney 2002) to define the extent of Upper Namoi alluvium and any other potential conduits or barriers for groundwater flow into the mining areas.

iii. Existing Groundwater System

Within EL 7223, groundwater occurs within the following two main systems:

- The Quaternary / Tertiary alluvial systems of the Upper Namoi alluvium; and
- The older, deeper and poorer quality bedrock that contains localised aquifers within weathered rock, porous sandstones, fractured zones, volcanics and coal seams of the Gunnedah Basin (Permian Formations).

A conceptual cross section of the aquifer systems and how they are anticipated to interact is shown on **Figure 7.2**. Each system is further discussed below in relation to the Project Boundary.

Within the Project Boundary, groundwater predominately occurs within low yielding fractured rock aquifers within Permian aged sandstones and Tertiary aged volcanic rocks.

The Upper Namoi alluvium comprises of two major formations, the Narrabri Formation and the Gunnedah Formation. The Narrabri Formation is a typical brown clay dominated aquitard overlying the Gunnedah Formation, which is a porous sand and gravel aquifer. The Gunnedah Formation has high permeability and yield and is commonly referred to as the primary aquifer system in the region.

The limit of the Narrabri Formation is generally represented by the quaternary alluvium soil boundary (Banks 1995). Accordingly, the Eastern and Southern Mining Areas are set back by a minimum of 150 m from the Narrabri Formation. The Gunnedah Formation does not exist within the Project Boundary. The closest occurrence of this aquifer is 900 m from the north-eastern corner of the Eastern Mining Area and more than 1.3 km to the south of the Project Boundary.

The average yield from the Narrabri Formation is approximately 50 litres per second (L/s). Groundwater in the Narrabri Formation to the south of the Project Boundary is brackish to saline, with Total Dissolved Solids (TDS) concentrations greater than 10,000 milligrams per litre (mg/L).

Water quality in the underlying Gunnedah Formation is significantly better and typically fresh to slightly brackish. Water quality records from NSW Office of Water indicate groundwater within the Gunnedah Formation to the west of the Mooki River (i.e. towards the Project Boundary) is typically slightly brackish at between 1,200 mg/L to 3,000 mg/L TDS. To the east of the Mooki River, groundwater is much fresher with TDS less than 500 mg/L.

Given the existing water quality of the Narrabri and Gunnedah Formations, both water sources meet the environmental value of '*Agricultural water use*' under the National Water Quality Management Strategy and *Australian Water Quality Guidelines for Fresh and Marine Waters*.

The Permian coal measures throughout the Project Boundary form a low yielding localised fractured rock groundwater system. Recharge to the Permian formations within the Project Boundary occurs via rainfall infiltration into weathered sandstone outcrops and fractured zones within elevated areas. There is some evidence within the Project Boundary of shallow groundwater levels increasing in response to rainfall whilst the deeper monitoring bores show a stable to steady decline in groundwater level. This trend indicates a limited vertical hydraulic connection between the shallow and deeper groundwater systems within the Project Boundary (GHD 2011, Umwelt (Australia) Pty Limited 2012a).

Groundwater quality is variable in the Permian Formations with generally saline groundwater found in the deeper sediments (Umwelt (Australia) Pty Limited 2012b). Data from the groundwater monitoring program for the Project shows that around ridgelines within the

Project Boundary, groundwater salinity in the Permian formations is less than 3,000 mg/L TDS. However, down gradient from the ridgelines, the groundwater becomes more saline (5,000 to 10,000 mg/L TDS). Away from the elevated terrain and toward the alluvial plains, Permian Formation bores with shallow groundwater levels (less than 3 m below ground surface) typically yield highly saline groundwater (10,000 to 20,000 mg/L TDS) (GHD 2011, Umwelt (Australia) Pty Limited 2012a).

Given the existing water quality of the Permian Formations, this water sources meet the environmental value of '*Industrial water use*' under the National Water Quality Management Strategy and *Australian Water Quality Guidelines for Fresh and Marine Waters*.

iv. *Groundwater Dependent Ecosystems*

As discussed in **Section 4.2**, typical GDE communities such as wetlands and riparian vegetation do not occur within the Project Boundary, and there are no obvious areas of heavy groundwater dependence. There are no permanently flowing rivers with a baseflow rate maintained by groundwater, no limestone or karst environments and no wetlands that are seasonally waterlogged within the Project Boundary or surrounds. Analyses of groundwater depth and site inspections have indicated that none of the vegetation communities within the Project Boundary are GDEs that are completely dependent on groundwater. Additionally, large areas of the groundwater within the Project Boundary are highly saline and this would preclude reliance upon it by native vegetation (AGE Consultants 2012).

Box Gum Woodland is not assessed to conform to a GDE and therefore any impacts to water as a result of the Project will not impact on this MNES.

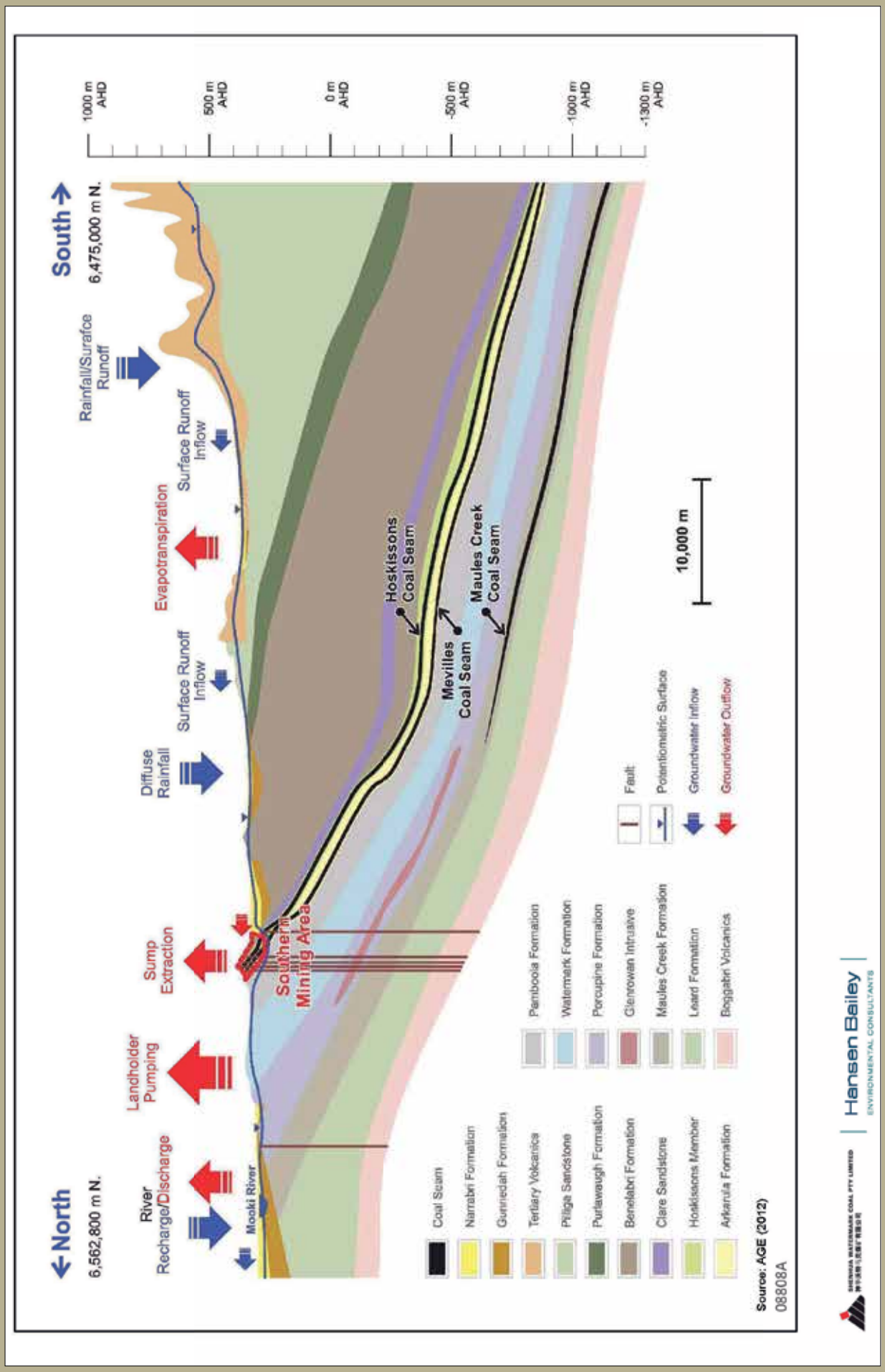


Figure 7.2. Conceptual Groundwater Section

7.2.2 Surface Water

i. Existing Catchments

The Project Boundary is located within the catchment of the Mooki River, a tributary of the Namoi River. Surface runoff drains in one of three general directions; north to the Mooki River floodplain via Watermark Gully or other smaller unnamed flow paths, south to Native Dog Gully or west towards Lake Goran.

ii. Existing Water Quality

Shenhua Watermark has an established surface water monitoring network, comprising of 12 sites within and adjacent to EL 7223. Routine surface water monitoring across the network commenced in October 2009 and is ongoing. The network records on a monthly basis salinity, pH, temperature, TDS, total suspended solids (TSS) and a number of metals and organic compounds.

Surface water quality data from the Shenhua Watermark monitoring network provides an indication of the state of the watercourses within and adjacent to the Project Boundary, including the Mooki River, Watermark Gully and Native Dog Gully.

The Mooki River is characterised by alkalinity (pH ranging from 6 to 12.2) and fresh to brackish waters (electrical conductivities ranging from 89 to 2,200 microsiemens per centimetre ($\mu\text{S}/\text{cm}$)). Generally major ions and trace elements are within the ANZECC trigger values for ecosystem protection and recreation and livestock purposes with the exception of elevated levels of phosphorous, chromium, copper and iron.

Watermark Gully is characterised by alkalinity (pH ranging from 6.3 to 8.8) and fresh waters (electrical conductivities ranging from 14 to 266 $\mu\text{S}/\text{cm}$). Generally major ions and trace elements are within the ANZECC trigger values for ecosystem protection and recreation and livestock purposes with the exception of elevated levels of phosphorous, chromium, copper, lead, zinc and iron. Additionally the level of turbidity in the system far exceeds the range for ecosystem protection.

Native Dog Gully is characterised by alkalinity (pH ranging from 7.7 to 9.7) and fresh to brackish waters (electrical conductivities ranging from 3 to 48,200 $\mu\text{S}/\text{cm}$). Generally major ions and trace elements are within the ANZECC trigger values for ecosystem protection and recreation and livestock purposes with the exception of elevated levels of sulphate, phosphorous, chromium, copper, zinc and iron. Additionally the level of turbidity and TDS in the system far exceeds the range for ecosystem protection and recreational and livestock purposes, respectively.

The higher levels of nutrients, such as phosphorus, observed in the watercourses within and adjacent to the Project Boundary reflect dominant agricultural practices in the area.

Given the existing water quality of the Mooki River, Watermark Gully and Native Dog Gully, these water sources meet the environmental value of '*Agricultural water use*' under the

National Water Quality Management Strategy and *Australian Water Quality Guidelines for Fresh and Marine Waters*.

7.3 Methodology

7.3.1 Groundwater

i. Predictive Groundwater Model

A three-dimensional groundwater flow model (MODFLOW SURFACT) was used to simulate the Project's impacts on the groundwater regime over time. The model was developed using hydrology, hydrogeology and geological structure data and previous groundwater assessments undertaken within the region. It includes the current understanding of the interactions between the aquifers within the Project Boundary and the regional groundwater system.

Two separate models were constructed for the Project, a calibration model and a predictive model. The groundwater model was calibrated via two processes; a steady state calibration and a transient calibration. The aim of the calibration process was to adjust aquifer parameters and stresses to produce the best match between the observed and simulated water levels and fluxes.

ii. Seepage Water Quality Assessment

A Seepage Water Quality Impact Assessment was undertaken by Terrenus Earth Sciences and is provided as an appendix to Appendix S within the EIS. The assessment predicted the water quality associated with seepage from the three mining areas of the Project to:

- Understand the likely water quality characteristics associated with run-off and seepage from the OEA (mining areas) after mining ceases and post-closure;
- Discuss the potential impacts to surface water and groundwater resulting from run-off and seepage from mining areas; and
- Assist with the management of potential surface water and groundwater impacts from these mining areas.

7.3.2 Surface Water

i. Water Balance

A computer-based simulation model (OPSIM) was used to assess the dynamics of the water balance (both volume and salt loads) under varying rainfall and catchment conditions. The model was then configured to dynamically simulate the operation of the water management system proposed for the Project.

To assess the effects of varying climatic conditions, the model was run for 92 realisations with each realisation corresponding to the 30 year Project life. A different rainfall input

sequence is applied to each realisation. The first realisation adopts climatic data from 1889 to 1919, the second from 1890 to 1920 and so on through the 122 years of historical climatic data. A statistical analysis of the resultant 92 realisations was then be undertaken to assess the behaviour of the various storages over extended dry and wet periods.

ii. Final Void Water Balance

The OPSIM model was used to assess the likely long term water level behaviour and salt balance of the final void. A salinity of 800 mg/L for runoff from the rehabilitated catchment area draining to the final void and a salinity of 3,000 mg/L for groundwater inflows were adopted.

iii. Surface Runoff Salinity Assessment

The OPSIM model was used to undertake an assessment of the likely impact of the Project on the salt load released to receiving waters as surface flow. Representative salinities (expressed as TDS) were assigned to runoff from various catchment types, as well as groundwater inflows to mining areas and raw water imported to the mine site. The adopted salinities for the different sources of water were based on an assessment of seepage water quality undertaken by Terrenus Earth Sciences (2012).

To assess the impacts of the Project on the receiving water salt balance, the OPSIM model was run as a static simulation. For the static simulation, each stage of mine development was modelled separately from the other stages, over the full historical climatic data set (1889 to 2010).

iv. Proposed Surface Water Management Infrastructure

The key objective of the water management system will be to keep fresh water separate from poorer quality mine water. Further, the poorer quality water will be prioritised for use over extracting water from external sources. The main components of water-related infrastructure for the Project include:

- Sediment dams to collect and treat runoff from the OEAs;
- Dirty water drains to divert sediment-laden runoff from the OEAs to sediment dams;
- Clean water drains to divert runoff from undisturbed catchments around areas disturbed by mining;
- A dirty water storage system to store water pumped out of the mining areas and to collect runoff from the CHPP and coal stockpile area. The mine water dams will be the first priority water source for road watering and CHPP water demands; and
- Raw water storage (the Main Dam) from the water supply pipeline.

7.4 Impacts to Water Related Issues

7.4.1 Groundwater

i. Mining Area Inflows

The groundwater seepage into the mining areas average 0.5 Mega litres per day (ML/day) (or 182 Mega litres per year (ML/yr)) over the life of the Project. The peak annual average seepage into the mining areas is estimated at 2.2 ML/day (760 ML/yr) in Year 23 as mining advances through higher permeability material. The predicted cumulative inflow of groundwater over the life of Project is approximately 5,500 ML, which represents less than 0.1% of the extraction limits set for the Gunnedah–Oxley Basin Murray Darling Basin Zone (Other) as prescribed under the *Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources*.

ii. Changes in Potentiometric Surface / Water Table Levels

The depressurisation induced by operations in the Eastern Mining Area extends to a maximum of 1.8 km in Year 21. Groundwater levels are predicted to reduce to 3 m or less in the Permian underlying the Narrabri Formation, laterally extending up to 0.7 km, and 1 m or less in the Permian underlying the Gunnedah Formation.

The depressurisation induced by operations in the Southern Mining Area is more extensive and extends to a maximum of 3.2 km in Year 25. The model predicts a drawdown of 25 m or less in the Permian underlying the Narrabri Formation. The depressurisation in the Permian extends to the south where the overlying Gunnedah Formation is present. At this distance, drawdown is predicted to be less than 2 m.

The depressurisation induced by operations in the Western Mining Area is less significant than the Eastern and Southern Mining Areas as it is located in an elevated area where groundwater levels are deeper and the operating life is short. The zone of depressurisation extends to a maximum of 1 km in Year 30, however, does not extend in the Permian under the alluvial aquifers.

The mining areas do not directly intersect the Narrabri and Gunnedah Formations. Depressurisation in the underlying Permian strata may induce downward vertical flow from the overlying alluvial aquifers identified under the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003*. The change in upward flow from the Permian to the alluvium due to mining is negligible beyond the immediately adjacent Zone 7. Zones 3 and Zone 8 report only a very small change. No change in flow rates is predicted for Zones 1, 6 and 10, which are relatively distant from the Project.

iii. Impacts on Existing Groundwater Users

There are a number of land users that utilise the groundwater systems within and adjacent to the Project Boundary, in particular the Gunnedah Formation, for irrigation, stock, domestic and industrial purposes. Within 10 km of the Project Boundary, 35 bores are predicted to experience maximum groundwater level reductions of greater than or equal to 0.1 metres.

Of these, four bores adjacent to the Southern Mining Area have a maximum predicted drawdown greater than 1 metre. At completion of the Southern Mining Area and Eastern Mining Area, groundwater levels are predicted to recover rapidly within approximately five years.

iv. Changes to Water Quality

The Seepage Water Quality Impact Assessment undertaken by Terrenus Earth Sciences (2012) (see appendix of Appendix S of the EIS) confirmed that existing groundwater aquifers within and adjacent to the Project Boundary have salinity concentrations equal to or significantly greater (up to 10 times greater) than the seepage predicted to be produced from overburden and interburden. The average salt load for each mining area ranges between less than 1 kg to 3.4 kg per hectare of seepage zone per day.

Groundwater in all aquifers within the Project Boundary currently has a salt concentration of equal to or significantly greater (in some aquifers over 10 times greater) than the salinity potentially produced from overburden seepage / leachate. Therefore overburden seepage / leachate is expected to have a low to negligible impact on local groundwater resources.

Terrenus Earth Sciences (2012) indicates that environmental values and beneficial use categories will not change due to the Project.

The Geochemical Assessment of Overburden/Interburden and Coal Reject Materials undertaken for the Project (Namoi Catchment Management Authority) (see Appendix V of the EIS) determined that the runoff and seepage generated by overburden, interburden and coal rejects are anticipated to have concentrations of dissolved trace metals below that of applied water quality guideline criteria. These concentrations are unlikely to present any significant impacts to groundwater quality.

A small proportion of the interburden and coal rejects derived from the Lower Hoskissons seam (roof and floor) has potential acid forming capacity. Most overburden and interburden material has significant excess buffering capacity that will be available to more than adequately buffer the negligible amount of acid that could theoretically be produced. Mitigation and management measures will be implemented to avoid the potential for acid generation when handling of the Lower Hoskissons seam, such as capping of potential acid forming material with non-acid forming material. These measures will limit the opportunity for runoff or seepage and consequently the receiving environment to be impacted by potential acid generating material.

Potentially hazardous materials, including hydrocarbons, hydrocarbon derivatives and Polycyclic Aromatic Hydrocarbons, will be stored within the fuel delivery, storage and refill area of the Dangerous Goods Store in designated self-bunded area. This will prevent any hazardous materials from impacting runoff or seepage and consequently the receiving environment.

v. *Post Mining Recovery of Groundwater Levels*

Groundwater levels will begin to recover after the back-filling of the Eastern Mining Area and Southern Mining Area eventually exceeding pre-mining levels. This is due to a higher recharge rate on the overburden material than the pre-mining condition. The higher recharge rate and rehabilitated landform mean that a zone of seepage occurs at spill points, which are topographic low points at the base of Overburden Emplacement Areas.

The predicted groundwater levels within the Western Mining Area final void will slowly recover and reach equilibrium at approximately 319 m AHD after approximately 1,400 years post mining. Groundwater levels will rise above pre-mining groundwater levels after approximately 300 years. Prior to this point, groundwater flow is into the void, and beyond 300 years the flow will reverse and will be from the void into the surrounding aquifers.

vi. *Groundwater Dependent Ecosystems*

If Groundwater dependent ecosystems (GDE) were present in the Project Boundary, the drawdown of groundwater would have potential to affect these systems by lowering the groundwater beyond the reach of their roots. As these ecosystems are reliant at least in part on groundwater, this would likely affect their viability. However, no GDEs have been recorded from the Project Boundary and it is unlikely that any occur. Consequently, the Project is considered unlikely to impact any GDE. No MNES that are dependent on groundwater have been recorded from the Project Boundary, and the impacts of the Project on groundwater are considered unlikely to affect any MNES. The potential impacts of the Project on GDEs are discussed further in **Section 8.6**.

vii. *Cumulative Impacts*

Other proposed mining and gas projects within the Liverpool Plains area may also result in the depressurisation of the Permian. If the zones of depressurisation due to open cut and underground coal mining, as well as groundwater extraction for coal seam gas mining occur concurrently there will be enhanced drawdown in these zones.

The Namoi Water Study Model (Schumberger Water Services Australia 2012) has assessed the potential cumulative impacts associated with proposed mining and coal seam gas projects within the Namoi catchment, including the Project. The Namoi Water Study Model indicated the zone of depressurisation extends slightly further than that of the Project with the 1 m drawdown contour increasing to 5 km from the Southern Mining Area. The more extensive zone of depressurisation is presumably due to the cumulative impact of the adjacent conceptual Caroon Coal Project and the Project.

viii. *Mitigation and Management*

The current groundwater monitoring network will continue to be implemented through the life of the Project along with a revision of the current Water Management Plan, which will be guided by the National Water Quality Management Strategy. The plan will include provisions for:

- Identification and description of all potential water quality hazards;
- Consideration of water quality risks should be considered and, where possible, quantified;
- Consideration of cumulative effects, including environmental impacts;
- Threshold trigger and/or guideline values that protect MNES such as Box Gum Woodland and Derived Native Grassland and EPBC Act listed threatened species should be considered;
- Biological as well as chemical monitoring and assessment;
- Statistical analysis such as data averages, standard deviation and number of samples;
- Test and reference site locations;
- Sampling and analytical methods; and
- Quality control and quality assurance data.

Additional monitoring bores will be installed within the predicted zone of depressurisation to assess the extent and rate of depressurisation against model predictions. Shenhua Watermark manually monitors groundwater levels on a fortnightly basis through the current groundwater monitoring network. This system will be converted to electronic water level loggers with water levels recorded at six-hourly intervals for the life of the Project.

Trigger levels for water quality parameters will be developed as part of the Water Management Plan for the Project. A unique trigger for each bore will be required due to the variability in the groundwater quality of the aquifers within and adjacent to the Project Boundary.

As discussed previously, no GDEs are present in the Project Boundary, and no MNES are considered likely to be dependent on groundwater. Nevertheless, the monitoring of groundwater will provide a valuable baseline of information on changes in the groundwater in the Project Boundary.

Shenhua Watermark has secured the relevant water licences under the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003* to allow the take of water for the Project. As there are insufficient licences available for porous rock on the market under the *Water Sharing Plan for the Murray-Darling Basin Porous Rock Groundwater Sources* a Controlled Allocation process will be sought from the Minister for Water.

7.4.2 Surface Water

i. External Water Requirements

Under the proposed water management system, annual volumes of water required for the Project vary depending on the effects of fluctuating climatic conditions. During wet years, it may be possible to obtain all water requirements for mining operations from local runoff and groundwater inflows. However, during average and dry years it is predicted that annual volumes up to 600 ML will be required to supplement the mine water supplies to ensure a reliable source of water for operational demands.

Based on the configuration and capacity of the proposed water management system, there will be no requirement for controlled discharges.

ii. Uncontrolled Spills

Based on the configuration and capacity of the proposed water management system, there will be no uncontrolled offsite spills from mine water storages.

iii. Loss of Catchment Area

During and after the life of the Project, there is a potential for the reduction of catchment flows to surrounding waterways, including the Mooki River, Watermark Gully, Native Dog Gully and Lake Goran. At the completion of mining, the conceptual final landform will influence the local catchment area and drainage regimes. An area of approximately 108 hectares, which originally drained to Lake Goran, will continue to drain to the final void of the Western Mining Area. The final landform will also result in an increase in catchment area draining north via Watermark Gully and to the Mooki River floodplain and a loss in catchment area draining south to Native Dog Gully and the Mooki River floodplain.

iv. Water Quality and Salinity

In order to minimise the volume of water collected in onsite storages and the need for discharge from the water management system, runoff from undisturbed areas will be redirected around the Project using diversion drains. Sediment-laden runoff from areas disturbed for mining purposes (as opposed to mine water) will be collected and treated in sediment dams. The maximum total average salt load associated with this runoff is predicted to reach 66.2 tonnes per day at Year 30 of the Project, which represents an increase in the pre-mine salt load of approximately 2%. Runoff water will only be released from site if its water quality is acceptable and during a rainfall event that exceeds the design capacity of the sediment dam. This configuration ensures that the Project does not significantly impact on downstream catchments and water quality.

The Geochemical Assessment of Overburden/Interburden and Coal Reject Materials undertaken for the Project (Namoi Catchment Management Authority) (see Appendix V of the EIS) determined that the runoff and seepage generated by overburden, interburden and coal rejects are anticipated to have concentrations of dissolved trace metals below that of

applied water quality guideline criteria. These concentrations are unlikely to present any significant impacts to surface water quality.

A small proportion of the interburden and coal rejects derived from the Lower Hoskissons seam (roof and floor) has potential acid forming capacity. Most overburden and interburden material has significant excess buffering capacity that will be available to more than adequately buffer the negligible amount of acid that could theoretically be produced. Mitigation and management measures will be implemented to avoid the potential for acid generation when handling of the Lower Hoskissons seam, such as capping of potential acid forming material with non-acid forming material. These measures will limit the opportunity for runoff and consequently the receiving environment to be impacted by potential acid generating material.

Potentially hazardous materials, including hydrocarbons, hydrocarbon derivatives and Polycyclic Aromatic Hydrocarbons, will be stored within the fuel delivery, storage and refill area the Dangerous Goods Store in designated self-bunded area. This will prevent any hazardous materials from impacting runoff and consequently the receiving environment.

Given the nature of the operation and the already elevated levels of phosphorus observed in the watercourses within and adjacent to the Project Boundary, the Project is unlikely to significantly impact the water quality of receiving catchments through nutrient enrichment.

v. *Final Void*

The final void in the Western Mining Area will reach an equilibrium water level of approximately 280 to 290 m AHD, which is approximately 20 to 30 m below the overflow level. The final void lake will take approximately 100 years to reach the equilibrium level. The salinity of runoff inflows is expected to decrease over time.

vi. *Geomorphic Condition*

The Geomorphology Impact Assessment undertaken for the Project (GSS Environmental 2011) (see Appendix W of the EIS) determined that due to historical disturbances associated with agricultural practices, the watercourses within EL 7223 generally have a poor to moderate geomorphic condition with the exception of the downstream extent of Watermark Gully, which is in good geomorphic condition.

As each mining area advances over the life of the Project, there will be minor losses to the catchments draining Watermark Gully, Native Dog Gully and the Mooki River. This will result in minor changes to the flow regime and the capacity for sediment transportation. As the predicted reduction in catchment area is minimal when compared to the overall catchment area of each watercourse, the impact on associated geomorphic processes will be negligible. However, the eastern extent of the Western Mining Area encroaches on a section of Watermark Gully. This is predicted to alter or impede the existing flow regime of Watermark Gully potentially causing erosion along the channel and increased sediment deposition downstream. Following the cessation of mining, catchment areas and geomorphic processes will largely be restored.

A pump station may be constructed on the Mooki River to supply water to the Project. The banks of the Mooki River are composed of alluvial silt materials and highly prone to bank erosion. Without appropriate bank stabilisation measures, construction of the pump station will exacerbate existing erosion issues within the localised area without causing any significant change in stream form and functioning. The Project will also require temporary or permanent waterway vehicle crossings for access purposes. The construction of these crossings has the potential to exacerbate bed and bank instability in localised areas along the relevant watercourses if not carefully designed.

vii. Impacts of Surface Water Changes on MNES

No MNES recorded from the Project Boundary are expected to be impacted by changes in the surface water regime. No aquatic MNES were recorded, or are considered likely to occur. Although the vegetation on the Project Boundary consists of large areas of woodland that comprise MNES (e.g. Box Gum Woodland and Derived Native Grassland) and provide habitat for MNES such as the Koala, the slight changes to the surface water regime are not expected to significantly impact the vegetation that remains, or render it less viable. Changes in surface water are expected to be slight, and are not expected to impact on MNES. There will be a slight reduction in catchment area for surface water flowing into the Mooki River, and in some years there will be extraction of surface water. These changes are considered to be minor however, and are not expected to significantly affect levels of water downstream. As a proportion of the total catchment area being affected and the total amount of water extracted from the region annually, the reduction of surface water as a result of Project will be negligible. Some aquatic MNES such as Murray Cod (*Maccullochella peelii*) are known to occur in the Namoi River, of which the Mooki River is a tributary. The Project may result in some minor reduction in flows in the Mooki River due to extraction and as a result of reduced catchment area, which will result in lower flows in the Namoi River. The scale of the reduction in flows is so small, that is not expected to impact the Murray Cod. Accordingly, no impact is predicted to occur to MNES that may occur downstream outside of the Project Boundary such as the Murray Cod.

viii. Mitigation and Management

The current surface water monitoring network will continue to be implemented through the life of the Project along with a revision of the current Water Management Plan, which will be guided by the National Water Quality Management Strategy. The plan will include provisions for:

- Identification and description of all potential water quality hazards;
- Consideration of water quality risks and, where possible, quantified;
- Consideration of cumulative effects, including environmental impacts;
- Threshold trigger and/or guideline values that protect MNES such as Box Gum Woodland and EPBC Act listed threatened species ;
- Biological as well as chemical monitoring and assessment;

- Statistical analysis such as data averages, standard deviation and number of samples;
- Test and reference site locations;
- Sampling and analytical methods; and,
- Quality control and quality assurance data.

At commencement of operations, the surface water monitoring program will be expanded to include samples from key storages within the water management system, such as sediment dams and the primary mine water storages. The parameter suite and sampling frequency for surface water monitoring will be initially undertaken in accordance with the current monitoring program and then refined over time in accordance with the mine site's regulatory approved Water Management Plan.

A Sediment and Erosion Control Management Plan will also be prepared in accordance with *Managing Urban Stormwater, Soils and Construction* (Landcom 2004) and *Managing Urban Stormwater, Soils and Construction, Volume 2E Mine and Quarries* (Debus 2012). The design of sediment control measures will be based on the principle of ensuring that runoff from disturbed areas is separated from clean area runoff and collected in sediment dams for treatment. The Sediment and Erosion Control Management Plan will also outline controls to minimise impacts to stream geomorphology throughout the Project Boundary.

As discussed previously, no MNES recorded from the Project Boundary are considered likely to be impacted by changes in the surface water regime.

ix. Sewage Management

Sewage will be managed via an onsite sewerage treatment facility. The treated effluent will be utilised as irrigation water supply for rehabilitation in accordance with *Environmental Guideline for the Use of Effluent by Irrigation* (Xstrata 2012), reused within the mine water management system or pumped out regularly by a licensed contractor. Sewerage will be managed in accordance with the National Water Quality Management Strategy for sewerage systems.

Chapter 8

Ecological Impact Assessment

This chapter provides an assessment of the ecological impacts of the Project on the biodiversity values of the Project Boundary. The ecological impacts of the Project are largely related to direct habitat loss represented by the removal of native and semi-natural vegetation and future degradation of the remaining habitat.

The nature of the impacts on habitat for threatened species is 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 provides significant habitat for both native flora and fauna species. Although the original character of the vegetation within the Project Boundary has been greatly altered, some larger areas of forest and woodland remain relatively 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 on remaining areas of vegetation are also relevant to the Project and are discussed within this chapter. This chapter also discusses the cumulative impacts of the Project on the flora and fauna within the locality, the duration and timing of impacts, and the permanence and reversibility of impacts.

8.1 Impacts to Vegetation Communities

The largest direct impact of the Project is the removal of threatened woodland vegetation communities that also provide habitat for a wide range of flora and fauna species. 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 woodland vegetation.

A total of approximately 937 ha of native woodland and grassland habitat will be removed by the Project, comprising a suite of communities as shown in **Table 8.1**. The vegetation communities that would be most impacted by the Project include: White Box, Yellow Box, Blakely's Red Gum Woodland (Condition Class C), Derived Native Grassland (Condition Class B); Inland Grey Box Woodland (Category 3 Condition Threshold); Weeping Myall Woodland and other non-threatened woodland communities and grasslands (**Table 8.1**).

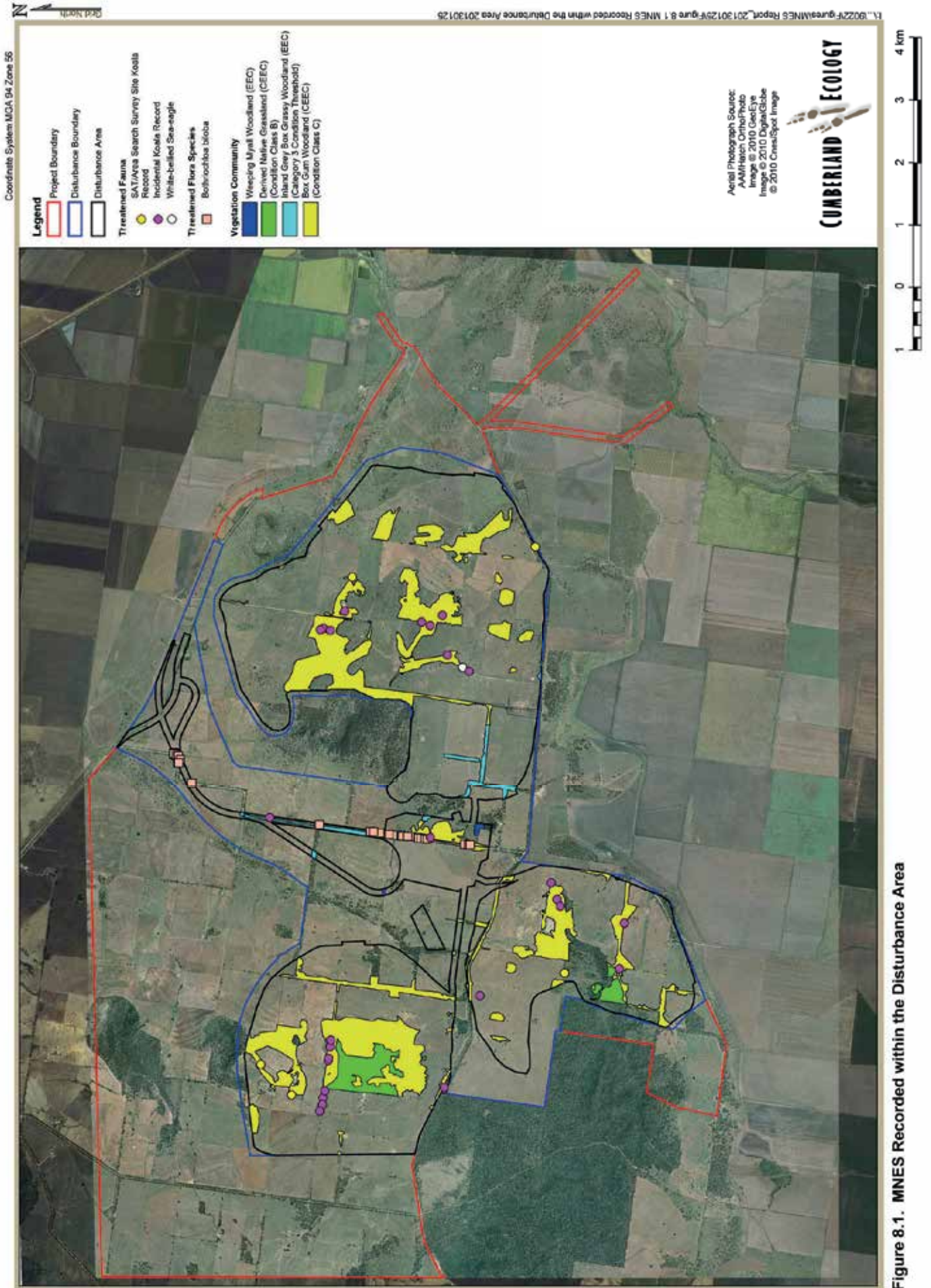
In addition to the direct removal of these vegetation communities, the Project will also indirectly impact vegetation that will remain by additional fragmentation and isolation.

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. Offset strategies have been developed to address and counter such predicted impacts. These are discussed in **Chapter 10**.

Table 8.1 Summary of Vegetation Clearance within the Project Boundary				
Vegetation Community	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
Box Gum Woodland	CEEC	1,192	665	56
Derived Native Grassland	CEEC	73	73	100
<i>Subtotal Box Gum Woodland and Derived Native Grassland (CEEC)</i>		1,265	738	58
Inland Grey Box Grassy Woodland	EEC	55	30	55
Weeping Myall Woodland	EEC	22	3	14
Semi-evergreen Vine Thicket	EEC	n/a*	0	0
Brigalow	EEC	9	0	0
<i>Subtotal Other C/EEC</i>		86	33	38
Fuzzy Box Woodland		36	18	50
Poplar Box Woodland		223	45	20
Belah Woodland		7	1	14
Whitewood Woodland		76	13	17
Tumbledown Red Gum Grassy Open Woodland		50	16	32
White Box Shrubby Woodland		234	24	10
Regenerating White Box Shrubby Woodland		72	43	60
Blakely's Red Gum Shrubby Woodland		6	6	100
Blakely's Red Gum Motherumbah Shrubby Woodland		15	0	0
<i>Subtotal Other Woodland</i>		719	166	23
Low Diversity Grassland, Planted & Exotic Pasture		7,290	3,084	42
Cleared Areas (roads, dams, buildings, etc.)		141	63	45
<i>Subtotal Other</i>		7,431	3,147	42
TOTAL EPBC ACT C/EEC		1,351	771	57

Table 8.1 Summary of Vegetation Clearance within the Project Boundary				
Vegetation Community	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
GRAND TOTAL		9,501	4,084	43

**Area of occurrence is <0.1ha and has therefore not been mapped*



8.1.1 Box Gum Woodland and Derived Native Grassland

The Project will result in the removal of approximately 665 ha of woodland (Condition Class C) and 73 ha of Derived Native Grassland (Condition Class B) conforming to the EPBC Act listed CEEC White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grassland. The actual direct impact on Box Gum Woodland is expected to be slightly lower than this figure as the Disturbance Area incorporates buffers around the open cut mining areas, the MIA and transport corridors (see **Section 8.2**).

These impacts on Box Gum Woodland are known and are predictable. Although a smaller area may be impacted, the disturbed area of Box Gum Woodland and Derived Native Grassland will not be larger than this estimate. A significant proportion of the impact area will be rehabilitated to native woodland communities, including Box Gum Woodland, and therefore the impacts to some of this area can be considered to be reversible in the long term. A long term management and monitoring program will be implemented in areas of rehabilitation, which will ensure that the rehabilitation objectives of establishing a viable, self-sustaining woodland community will be reached. Although it is difficult to predict the outcome of rehabilitation, it is expected that a high quality woodland community will be able to be established, which will provide higher quality habitat for flora and fauna than what is currently within the Project Boundary.

The short term impacts on this community will be the direct removal of approximately 738 ha of woodland and native grasslands. Longer term potential impacts to this community include weed invasion into areas outside of the Disturbance Area, edge effects and habitat fragmentation. These are discussed in more detail in **Section 8.2**.

The removal of this area of Box Gum Woodland and Derived Native Grassland will constitute a relatively large loss of the community from the locality. This impact is compounded by the fact that additional removal of Box Gum Woodland and Derived Native Grassland within the locality of the Project is highly likely, with various other mine extension proposals recently submitted for development approval. Box Gum Woodland and Derived Native Grassland has suffered a large decline in the past and remaining remnants (an estimated 405,000 ha) are under continued threat from further land clearing due to ongoing land use for agriculture, horticulture, urban expansion and public infrastructure (NSW DECCW, 2010). Due to these pressures, the Key Threatening Process "*Land Clearance*" is considered the most prevalent threats to this community (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 this community remains poorly represented in the national conservation reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants is critical to its recovery.

As a consequence of the decline of this community, many flora and fauna species that occur within it 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 Native Grassland is provided in **Appendix I**. Recovery of this community can be expected to directly benefit the recovery of these species.

A range of impact avoidance, mitigation and compensation measures have been developed to minimise the impacts of the Project on Box Gum Woodland, and these are presented in **Chapter 9** and **Chapter 10**. Impact avoidance and mitigation measures include minimising clearing of woodland, and protection and rehabilitation of some areas of vegetation within the Project Boundary. A key feature of the compensation measures is the implementation of a significant offset strategy that has been developed for the Project. This involves the protection and rehabilitation of extensive areas of Box Gum Woodland and Derived Native Grassland in the offset areas. A total of 6,366 ha will be retained, revegetated or rehabilitated as part of the offsets package. These areas of vegetation will be protected in perpetuity for conservation and will be managed to increase their ecological value over time. An Assessment of Significance has been prepared for this community according to the EPBC Act Significant Impact Criteria for Endangered Ecological Communities (**Appendix J**). This assessment indicates that with the implementation of the proposed avoidance, mitigation and compensation measures, no significant impact is predicted to occur to Box Gum Woodland as a result of the Project.

8.1.2 Inland Grey Box Woodland

The Project will result in the removal of approximately 30 ha of Category 3 Condition Threshold Inland Grey Box Woodland, which conforms to the EPBC Act listed EEC Grey Box (*Eucalyptus microcarpa*) Grassy Woodland and Derived Native Grassland. This is a conservative estimate and the actual direct impact on this community is expected to be lower than this figure.

These impacts on Inland Grey Box Woodland are known and are predictable. Although a smaller area may be impacted, the disturbed area of Grey Box Woodland will not be larger than this estimate. A significant proportion of the impact area will be rehabilitated to native woodland communities including Inland Grey Box, and therefore the impacts to some of this area can be considered to be reversible in the long term. A total of 21 ha will be retained, 640 ha will be revegetated and 46 ha will be rehabilitated as part of the offsets package. A long term management and monitoring program will be implemented in areas of rehabilitation, which will ensure that the rehabilitation objectives of establishing a viable, self-sustaining woodland community will be reached. Although it is difficult to predict the outcome of rehabilitation, it is expected that a high quality woodland community will be able to be established, which will provide higher quality habitat for flora and fauna than what is currently within the Project Boundary.

The short term impacts on this community will be the direct removal of approximately 30 ha of woodland. Longer term potential impacts to this community include weed invasion into areas outside of the Disturbance Area, edge effects and habitat fragmentation. These are discussed in more detail in **Section 8.2**.

Similarly to Box Gum Woodland and other grassy woodlands, Inland Grey Box Woodland is usually located on fertile soils that are sought after for agriculture, and therefore it has been extensively cleared. As remnant patches become fragmented and isolated, they become less resilient to outside pressures and indirect effects and require active management to counter the effects of continued degradation. Since this community remains poorly

represented in the national conservation reserve system (being situated largely on fertile, arable land), the conservation of remaining remnants are critical to its recovery.

A range of impact avoidance, mitigation and compensation measures have been developed to minimise the impacts of the Project on Inland Grey Box Woodland, and these are presented in **Chapter 9** and **Chapter 10**. Impact avoidance and mitigation measures include minimising clearing of woodland, and protection and rehabilitation of some areas of vegetation within the Project Boundary. A key feature of the compensation measures is the implementation of a significant offset strategy that has been developed for the Project. This involves the protection and rehabilitation of extensive areas of Inland Grey Box Woodland in the offset areas. A total of 707 ha will be retained, revegetated or rehabilitated as part of the offsets package. These areas of vegetation will be protected in perpetuity for conservation and will be managed to increase their ecological value over time. An Assessment of Significance has been prepared for this community according to the EPBC Act Significant Impact Criteria for Endangered Ecological Communities (**Appendix J**). This assessment indicates that with the implementation of the proposed avoidance, mitigation and compensation measures, no significant impact is predicted to occur to Inland Grey Box Woodland as a result of the Project.

8.1.3 Weeping Myall Woodland

The Project will result in the removal of approximately 3 ha of Weeping Myall Woodland, all of which conforms to the EPBC Act listed EEC Weeping Myall Woodlands. This is a conservative estimate and the actual direct impact on this community is expected to be lower than this figure.

Similarly to other grassy woodlands occupying flat fertile lands Weeping Myall Woodland was cleared extensively. 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 this EEC 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 EEC.

A range of impact avoidance, mitigation and compensation measures have been developed to minimise the impacts of the Project on Weeping Myall Woodland, and these are presented in **Chapter 9** and **Chapter 10**. Impact avoidance and mitigation measures include minimising clearing of woodland, and protection and rehabilitation of some areas of vegetation within the Project Boundary. A key feature of the compensation measures is the implementation of a significant offset strategy that has been developed for The Project. This involves the protection and rehabilitation of extensive areas of Weeping Myall Woodland in the offset areas. A total of 10 ha will be retained and 461 ha will be revegetated as part of the offset package. These areas of vegetation will be protected in perpetuity for conservation and will be managed to increase their ecological value over time. An Assessment of Significance has been prepared for this community according to the EPBC Act Significant Impact Criteria for Endangered Ecological Communities (**Appendix J**). This assessment indicates that with the implementation of the proposed avoidance, mitigation

and compensation measures, no significant impact is predicted to occur to Weeping Myall Woodland as a result of the Project.

8.1.4 *Brigalow*

The Project will not result in the removal of any woodland conforming to the EPBC Act listed EEC Brigalow (*Acacia harpophylla* dominant and co-dominant). It is not expected that the Project will result in any adverse effects to the occurrence of this community within the Project Boundary and no impact is expected to occur. That notwithstanding, over 340 ha will be revegetated in the offset areas.

8.1.5 *Semi-evergreen Vine Thicket*

The Project will not result in the removal of any vegetation conforming to the EPBC Act listed EEC Semi-evergreen Vine Thicket. It is not expected that the Project will result in any negative effects to the occurrence of this community within the Project Boundary and no impact is expected to occur.

8.2 Impacts on Remaining Vegetation and 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. However, the Project will also have indirect impacts on the ecological values of the Project Boundary, including fragmentation and edge effects, noise, dust, and erosion. These indirect impacts of the Project are considered in more detail below.

Whilst it is acknowledged that indirect impacts can potentially be significant for a variety of threatened species and EECs, such impacts cannot be mapped or accurately calculated in advance. As a precautionary measure, the Disturbance Area incorporates buffers around the open cut mining areas, MIA and transport corridors. The majority of the Disturbance Area includes a 50 m buffer around these areas, however there are a few locations where this is reduced to 20-30 m such as along the southern boundary of the Western Mining Area, to ensure the Disturbance Area is located wholly on land owned by Shenhua Watermark. Inclusion of this buffer around the open cut mining areas, MIA and transport corridors has allowed for assessment of some areas that may be indirectly impacted.

8.2.1 *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 (Primack 1993, Fahrig 2003, Lindenmayer and Fischer 2006). The resultant divided habitat is often artificial and inhospitable to the species remaining within the fragments (Bennett 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;
- Isolate 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 removed, while mobile animals (especially birds and mammals) retreat into other remnant patches of habitat (Lindenmayer and Fischer 2006). The displacement of mobile fauna can reduce the survivorship of species in the case where there are limited areas of sufficiently large habitat within dispersal distance to retreat to.

Indirect fragmentation can put stress on 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.

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 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 **Section 8.2.2**). 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 the primary determinant of the number of woodland species in a fragment, and small fragments of woodland can only support small populations or sub-populations of plants and animals that depend on this habitat. 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.

The Project will increase fragmentation through the clearing of areas of woodland, particularly within the Disturbance Area. This impact will be felt most strongly by the

threatened flora species and fauna species that are less able to move long distances in response to disturbance. This includes the lizard species that have potential to occur; the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*).

That notwithstanding, the threatened fauna species found within the Project Boundary or with potential to occur are mainly mobile species that can move in response to disturbance. Those most able to relocate to other areas of habitat include bird species including the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*) and bats such as the Grey-headed Flying Fox (*Pteropus poliocephalis*), the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*) which are able to easily move across disturbed areas. Notwithstanding this, it is thought that many threatened birds in agricultural landscapes of New South Wales are declining due to clearing for agriculture (Reid 1999).

Other threatened fauna species that have been recorded or have potential to occur are also mobile, although not to the same extent as the flying animals. The Koala (*Phascolarctos cinerea*), the Brush-tailed Rock Wallaby (*Petrogale penicillata*) and the Spotted-tailed Quoll (*Dasyurus maculatus*) are also able to move in response to disturbance, and can also cross disturbed areas to access remaining habitats relatively easily. That notwithstanding, Koalas are known to be adversely affected by habitat fragmentation (NRMM, 2009). Progressive rehabilitation of some mined areas back to woodland will help to address the impacts of fragmentation on native fauna.

8.2.2 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 woodland 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 and Fischer 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 woodland habitat may be unfavourable for species which require interior habitat.

The Project Boundary and surrounding locality has already been extensively cleared and modified such that the remaining woodland patches have large edge to area ratios. In other words edge effects have already occurred and are wide spread due to historic clearing for agriculture. Species that remain present within the Project Boundary today are therefore likely to be able to cope with edge effects, at least to a degree. The most obvious example of this is the Koala which commonly occurs within small patches of woodland trees in fields and within narrow strips of woodland along roadside corridors. The implication being that although the Project could increase edge effects, such impacts are unlikely to be great

relative to the edge effects that have already occurred. The subsequent discussion in this section should be viewed in this context.

The Project will result in some limited edge effects where woodland is cleared to make way for infrastructure or mining. Due to edge effects, the Disturbance Area extends beyond the areas that are being cleared and into areas of adjacent woodland that are being retained. The edge created between farmland and mining development is not considered likely to negatively affect the ecology within the Project Boundary, as farmland does not provide significant habitat. It is mainly where edges are created between mining development and areas of existing woodland that impacts will occur to the ecological value of the woodland that remains. Although some edge effects will occur, the majority of the Project Boundary has been extensively cleared and is already highly fragmented. The majority of the Disturbance Area connects to degraded grassland, which will result in limited edge effects.

The MNES that are most at risk of edge effects are the listed ecological communities of Box Gum Woodland and Derived Native Grassland, Inland Grey Box Woodland, Weeping Myall Woodland, and Brigalow. These areas may experience some reduction in quality of habitat along the edges of developed areas. Fauna species remaining in the patches of vegetation outside the Disturbance Area could also likely to experience negative edge effects. These are likely to be the less mobile species such as the Koala, and if present, the reptiles Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*). The Koala is known to occur around Mt Watermark, and these individuals will remain, although the quality of the habitat that remains may be reduced due to edge effects. The highly mobile species such as the flying animals (Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*), Regent Honeyeater (*Anthochaera phrygia*), Grey-headed Flying Fox (*Pteropus poliocephalis*), the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*)) may be likely to be less affected, as they will be able to access suitable habitat elsewhere and are less dependent on the habitat that remains. That notwithstanding, edge effects may result in a reduction in the area of potential habitat available to these species also.

Progressive rehabilitation of mined areas back to woodland will be an important mitigation measure for edge effects on native fauna.

8.2.3 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 generated by the Project, 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. Noise can be generated by large volumes of traffic, particularly large mining trucks, excavation machinery, explosions used during the mining phase, and generators and machinery used in the daily Project operation. Some 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 Project 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 woodlands 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. This is restricted to fauna species however, and other MNES such as threatened plant species and ecological communities will be unaffected. The species that are expected to be most disturbed by noise are those that have relatively good hearing, or that depend on sounds in their environment. These species are likely to include the threatened birds with potential to occur such as the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*), and mammals such as the Grey-headed Flying Fox (*Pteropus poliocephalis*), the Koala (*Phascolarctus cinerea*), and the Spotted-tailed Quoll (*Dasyurus maculatus*). These species use sounds to communicate with others of the same species, and persistent loud noise from the active coal mine has the potential to disrupt these sounds and reduce the areas of habitat available to these species.

Microchiropteran bats use echolocation calls to forage and to navigate, and they have been found to avoid noisy areas during foraging (Schaub et al. 2008). This indicates that areas subject to loud noise impacts are likely to be less suitable foraging habitat for the threatened microchiropteran bats with potential to occur in the Project Boundary; the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*).

Other threatened fauna species with potential to occur in the Project Boundary are less reliant on sounds to communicate, or do not communicate across large distances. These include the reptile species Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*).

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 are likely to only cause temporary disturbance to fauna. Furthermore, the impacts from noise emissions are likely to be localised close to the active mining areas (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.

8.2.4 Light

The Project has the potential to increase the level of artificial night 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 and Rich 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 during night-time;
- A disruption of seasonal day length cues which trigger critical behaviours (Longcore and Rich 2004, Saleh 2007, Longcore and Rich 2010);
- Disorientation and/or temporary blindness; and
- Interference with predator-prey relationships.

In common with the potential impacts of noise, the impacts from light are restricted to fauna species; ecological communities and plant species will not be affected. The diurnal fauna species are those that are least likely to be impacted by increased levels of night light, as they are not active during the night. This includes the threatened bird species with potential to occur; such as the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*). The threatened mammal species that have been recorded or which have potential to occur such as the Grey-headed Flying Fox (*Pteropus poliocephalis*), the Koala (*Phascolarctus cinerea*), the Spotted-tailed Quoll (*Dasyurus maculatus*), Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*) are all nocturnal and have potential to be impacted by increased levels of light in the night environment. The extent of these impacts is unclear, and there has been no targeted research on the response of these species to increased levels of night light.

While the construction and operational phases of the Project will have some effect on the surrounding woodland environment, the impacts from light pollution are likely to remain close to the disturbance associated with the open cut mining areas, with only limited glare into the surrounding natural vegetation. Although this may result in a reduction in the area of habitat available due to the increase in the disturbance area of the Project, It is likely that the threatened nocturnal fauna species listed above would habituate to the periodic disturbance and night light pollution from the Project is unlikely to have a significant or long-term impact on any fauna species.

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

8.2.5 Vehicle Strike

Vehicle strike can pose a significant risk to some wildlife, particularly but not exclusively ground dwelling species (Taylor and Goldingay 2010). This is likely to be particularly relevant for common species such as the Eastern Grey Kangaroo (*Macropus giganteus*) that occur in large numbers on farming land and are frequently struck by vehicles. Koalas are also particularly at risk from vehicle strike as they frequently cross roads and tracks while moving between individual trees or from one patch of habitat to another. While some mobile species, such as birds, have the potential to move away from the path of clearing, other species that are less mobile, including Koalas and hollow-dependent species, may have difficulty avoiding vehicles during clearing operations. Pre-clearance surveys and translocation of species are likely to reduce the risk of mortality during the clearing phase of the Project.

Other than the Koala, the threatened fauna species that are most at risk from vehicle strike in the Project Boundary are the ground-dwelling species such as the Spotted-tailed Quoll, and the Brush-tailed Rock Wallaby. If present however, the Spotted-tailed Quoll is in very low densities in the Project Boundary, and it is very unlikely that it would be struck by a vehicle. The Brush-tailed Rock Wallaby is unlikely to occur, as it is restricted to rocky outcrops, and if it does occur, it also is in extremely low densities. The threatened bird species which have potential to occur such as the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*) are extremely unlikely to be impacted by vehicle strike as they are very mobile and are able to easily avoid vehicles. Similarly, the microchiropteran bats; Large-eared Pied Bat (*Chalinolobus dwyeri*), South-eastern Long-eared Bat (*Nyctophilus corbeni*) and the Grey-headed Flying Fox (*Pteropus poliocephalis*) are also flying species that forage above the tree canopy and as such are not likely to be affected by vehicle strike.

The Project will result in the construction of some additional roads and tracks which means an increased length of road for animals to cross and navigate, as well as an increase in the number of vehicles operating within the Project Boundary. These changes are likely to increase the likelihood of vehicle strikes on native fauna, with an associated increase in mortality. In particular, the Project has the potential to result in an increase of Koala mortality resulting from vehicle strikes. This is likely to be most significant during the construction phase, when vegetation and habitats are being cleared. This may also occur during the operation of the Project as a result of collision with vehicles entering and leaving the open cut mining area as well as during the normal daily movements of workers and vehicles throughout the site.

Although some mortality of Koalas as a result of vehicle strike may occur, it is not expected to be significant. Limiting speeds along internal roads, appropriate signage and careful driving policies will increase the awareness of drivers and decrease the risk of vehicles striking fauna. The risk of vehicle strike will diminish as areas that are progressively rehabilitated will return to current levels following rehabilitation of the total mined area and cessation of mining.

8.2.6 Dust

Construction and mining activities have the ability to generate dust, which may impact on the ecology within the Project Boundary in a number of ways. Dust that settles can accumulate on leaf surfaces and reduce essential physiological processes including photosynthesis, respiration, and transpiration. It can also permit the penetration of phytotoxic gaseous pollutants into plants (Farmer 1993).

Dust can also produce physical effects on plants such as blockage and damage to stomata, shading, and abrasion of leaf surface or cuticle. This can result in cumulative effects such as drought stress on already stressed species. This can result in decreased plant health, and even death in extreme circumstances. Decreased growth and vigour of plants may mean that they are more susceptible to pathogens and other disturbance, and these plants are more likely to be subject to increased mortality. Such impacts to individual plants generally result in decreased productivity and can result in changes in vegetation and community structure (Farmer 1993).

The effect of dust deposition also affects animals that use plants, either as a source of food or habitat. Dust on the foliage and fruit may reduce palatability to animals and decreased health of trees and changed community structure results in a reduction in the amount of available habitat.

Similar to the impacts caused by noise, dust pollution can lead to a decrease in habitat quality which has the potential to extend the area of impact beyond the area directly disturbed by the Project.

With regard to the Project, dust generated by the Project could impact vegetation within woodland communities, reducing health of some species along the edge of mined areas. This may have potential impacts for threatened ecological communities such as Box Gum Woodland and Derived Native Grassland, Inland Grey Box Woodland, Brigalow and Weeping Myall Woodland. This may also impact on threatened flora species that have potential to occur including *Bothriochloa biloba*, *Dicantheum setosum*, and *Digitaria porrecta*.

It could also impact upon potential foraging resources for wildlife, including Koalas that consume leaves directly, and threatened nectarivorous birds such as the Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*), as well as the nectarivorous and frugivorous Grey-headed Flying Fox (*Pteropus poliocephalis*). The threatened microchiropteran bats such as the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*) do not feed directly on foliage, fruits or flowers as they are insectivores, however their insect prey may be affected negatively by elevated levels of dust in the environment. Species such as the Spotted-tailed Quoll (*Dasyurus maculatus*) are not expected to be affected by increased levels of dust in the environment, and neither is the Brush-tailed Rock Wallaby (*Petrogale penicillata*) (if it occurs).

However, standard dust minimisation strategies such as watering haul roads will be implemented to minimise the creation of dust, and significant levels of dust are not expected

to be deposited far away from the operating mine and the tracks. Dust generated by the Project would diminish within areas that are progressively rehabilitated and, in the long term, dust levels should return to normal following rehabilitation of the total mined area and cessation of mining.

8.2.7 Erosion

The Project has the potential to increase the amount of erosion occurring within the Project Boundary through the construction of roads, tracks, and infrastructure. Water erosion of soil can be classified into four categories, being sheet, rill, gully, and tunnel erosion (2001). Sheet erosion is the uniform removal of soil without the development of visible water channels and is the least apparent of the four erosion types. Rill erosion is soil removal through the cutting of many small, but conspicuous, channels. Gully erosion is the consequence of water that cuts down into the soil along the line of flow and this type of erosion develops more quickly in places like tracks and animal trails. Tunnel erosion may occur in soils with sub-surface layers that have a greater tendency to transport flowing water than does the surface layer.

The effects of erosion can already be seen in places within the Project Boundary, particularly along drainage lines, mostly consisting of gully erosion. This is the result of land clearing and many years of cattle grazing. Removal of trees and the stabilising effect of their roots on soil has facilitated erosion in the Project Boundary and this has been exacerbated by trampling from stock and the creation of trails. The Project would result in the creation of more roads and tracks throughout the Project Boundary, with an associated risk of increase in gully erosion. This has the potential to result in sedimentation and increased turbidity of streams and impacts to the aquatic environment.

There is an increased risk of sheet and rill erosion where large areas are cleared, particularly on hillsides. Where there is no obvious existing channel for the water to follow, it will form rills or flow overland.

Despite the potential for increased levels of erosion as a result of the Project, this is not considered likely to impact directly on any MNES that have been recorded from the Project Boundary or which have potential to occur. If very extensive erosion were to occur, it may have some negative effect on the threatened ecological communities recorded from the Project Boundary, including Box Gum Woodland and Derived Native Grassland, Inland Grey Box Woodland, Brigalow and Weeping Myall Woodland. Erosion is unlikely to be so severe as to affect the quality of remaining habitats in the Project Boundary, and therefore is unlikely to have an impact on the threatened fauna species that have been recorded from the Project Boundary or which have potential to occur.

The effects of erosion will be minimised by erosion and sediment controls implemented as part of a surface water management plan for the Project.

8.2.8 Weeds, Feral Animals and Overabundant Native Species

Alterations to habitat conditions often favour introduced and/or hardy native plant and animal species that can proliferate in disturbed conditions. Such species have potential to impact

upon the original local native plant and animal species. Weeds such as thistles and other introduced plants have potential to out-compete regenerating native plant species. MNES that are at risk from weeds are the threatened flora species recorded from the Project Boundary such as *Bothriochloa biloba*, *Dicantheum setosum*, and *Digitaria porrecta* and the threatened ecological communities such as Box Gum Woodland and Derived Native Grassland, Inland Grey Box Woodland, Brigalow and Weeping Myall Woodland. Fauna species in the Project Boundary are not directly at risk from weeds unless they cause their habitat to become degraded to a significant degree.

Feral animals such as foxes, rabbits and some species of birds can also breed in the more open areas following clearance of forest and woodland. They can impact native fauna species by preying upon them or by competing with them for food and resources. MNES relevant to the Project that are vulnerable to predation by feral animals include the reptiles; Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*) as they are terrestrial and slow moving. The other species such as the birds; Swift Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*) are vulnerable to a lesser extent, however juveniles or weak individuals will always be at risk. Similarly, the Koala and the Spotted-tailed Quoll are not likely to be at risk except for juveniles. The microchiropteran bats and the Grey-headed Flying fox are entirely arboreal and are unlikely to be at risk.

The presence of the foxes is likely to be a key factor in the low numbers and diversity of ground-dwelling fauna in the woodland communities within the Project Boundary. These introduced predators have long been recognised to be a major contributor to the decline of ground-nesting birds, small to medium mammals and reptiles (SEWPaC 2010). Feral pigs are also known to prey on frogs, reptiles, birds and small mammals (DEC (NSW) 2005e) as well as degrade habitat by:

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

Some native fauna such as the Eastern Grey Kangaroo can become prolific on mining developments as access by the public, including hunters, is denied. Overabundant native animals can cause overgrazing and other related problems. Aggressive birds such as the Noisy Miner would have a greater impact on smaller native birds as a result of increased edge effects and fragmentation of woodland habitat.

The Project is unlikely to exacerbate existing impacts from weeds, feral animals and overabundant native species. These issues are well known and understood and weed and feral animal control will be incorporated into the Biodiversity Management Plan that will be prepared for the Project (see **Section 9.4**). With the implementation of appropriate control strategies, these factors are unlikely to impact on MNES in the Project Boundary.

8.3 Impacts on Flora Species

One threatened flora species, *Bothriochloa biloba* (Lobed Blue Grass) (Vulnerable under the EPBC Act) has been recorded within the Project Boundary during surveys conducted by Cumberland Ecology. No other threatened flora species listed under the EPBC Act have been recorded within the Project Boundary during surveys conducted by GHD (2009) or surveys conducted by Cumberland Ecology.

There are several Atlas of NSW Wildlife records of *Dichanthium setosum* occurring within the Project Boundary, along Court Road and other threatened plants have been assessed as having potential to occur within parts of the Project Boundary. This section provides an assessment of the potential impacts of the Project on the flora species listed under the EPBC Act that are known to occur or have been recorded in the locality of the Project Boundary and have potential to occur. A summary of the potential impacts to these species as a result of the Project is provided in **Table 8.2** and formal Assessments of Significance are provided in **Appendix J**.

8.3.1 *Bothriochloa biloba*

Bothriochloa biloba (Lobed Blue Grass) is listed as Vulnerable under the EPBC Act. The species occurs within the Project Boundary in a patchy distribution along Court Lane and The Dip Road. Based on the combination of suitable habitat and known records in wider locality, the species is considered to have potential to occur in other areas of the Project Boundary.

The quality of habitat within the Project Boundary for *Bothriochloa biloba* is limited due to the degree of degradation of the vegetation through grazing. *Bothriochloa biloba* is tolerant of light levels of grazing, however, heavy grazing and overstocking impact the species and it is more prevalent in areas that are seldom grazed e.g. on roadsides and travelling stock routes. This is consistent with investigations undertaken for the Project, as the species was recorded only from alongside Court Lane and The Dip Road, with no records from the remainder of the Project Boundary. This is likely to be because the majority of the Project Boundary has been heavily grazed, and accordingly, it is considered unlikely to more widely distributed throughout the Project Boundary. The conservation value of the habitat within the Project Boundary for this species is therefore considered to be relatively low.

From a regional perspective, *Bothriochloa biloba* has a wide distribution and the Project Boundary is not located at the limits of its distribution. The quality of the habitat within the Project Boundary is considered to be very similar to the remainder of the habitat available for this species throughout its range. Over 464,000 ha of similar grassland and woodland habitat to that which occurs in the Project Boundary has been recorded within a 50 km radius. These areas are considered likely to provide similar levels of habitat for this species as habitats within the Project Boundary. For these reasons, the importance of the population present within the Project Boundary is considered to be low.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of

grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Bothriochloa biloba*.

8.3.2 *Dichanthium setosum*

Dichanthium setosum is listed as Vulnerable under the EPBC Act. Although no individuals were detected during surveys for this assessment, there are nine Atlas of NSW Wildlife records for this species in the Gunnedah LGA and due to the presence of suitable habitat within the Project Boundary including disturbed habitats, *Dichanthium setosum* is considered to have potential to occur. No known individuals will be removed by the Project, although potentially suitable habitat will be removed.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Dichanthium setosum*.

8.3.3 *Digitaria porrecta*

Digitaria porrecta is listed as Endangered under the EPBC Act. There are seven records of *Digitaria porrecta* within the Gunnedah LGA. *Digitaria porrecta* appears to be distributed along roadsides to the north-west and south-west of the Project Boundary. In NSW, the most frequently recorded associated tree species are *Eucalyptus albens* and *Acacia pendula* (DEC (NSW) 2005c). Although not found during targeted searches, there is potential habitat for this species within the Project Boundary in areas of secondary grassland and grassy woodlands, especially White Box Woodland and Weeping Myall Woodland, however other grassy woodlands with *Acacia pendula* present such as Grey Box Woodland and Poplar Box Woodland are also potential habitats for *Digitaria porrecta*. Although no records have been found within the Project Boundary, suitable habitat for this species will be cleared for the Project.

Known populations of this species exist in degraded habitat along roadsides and stock routes which are continuously disturbed by livestock trampling and grazing, and clearing for agriculture (Threatened Species Scientific Committee, 2008d). *Digitaria porrecta* also persists in persist in fallow paddocks, but its capability to maintain a viable population is unknown (Halford, 1995; SEWPAC, 2011b).

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of

grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Endangered Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Digitaria porrecta*.

8.3.4 *Cadellia pentastylis*

Cadellia pentastylis is listed as Vulnerable under the EPBC Act. There are two records of *Cadellia pentastylis* recorded in the Atlas of NSW Wildlife close to Gunnedah, approximately 20km from the Project Boundary. Although no individuals were detected during surveys for this assessment, the species is considered to potentially occur within some areas of the Project Boundary from a combination of suitable habitat and known Atlas of NSW Wildlife records in the Gunnedah LGA. No known individuals will be removed by the Project, although potentially suitable habitat will be cleared.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Cadellia pentastylis*.

8.3.5 *Swainsona murrayana*

Swainsona murrayana is listed as Vulnerable under the EPBC Act. There are no records of *Swainsona murrayana* in the Atlas of NSW Wildlife for the Gunnedah LGA and no individuals were detected during surveys for this assessment. Nevertheless the species is considered to have potential to occur within some areas of the Project Boundary due to the presence of suitable habitat. No known individuals will be removed by the Project, although potential habitat will be cleared.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Swainsona murrayana*.

8.3.6 *Tylophora linearis*

Tylophora linearis is a small twiner that is listed as Endangered under the EPBC Act. It occurs in dry scrub and open forest, and has been recorded from low-altitude sedimentary

flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii*. This species has been recorded from the Gunnedah LGA and the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Tylophora linearis* has not been recorded from the Project Boundary, although potential habitat for this species does occur and will be removed by the Project.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Endangered Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Tylophora linearis*.

8.3.7 *Thesium australe*

Thesium australe (Austral toadflax) is a small straggling herb that is listed as Vulnerable under the EPBC Act. It occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo Grass (*Themeda australis*). It is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Thesium australe* has not been recorded from the Project Boundary, although potential habitat for this species does occur.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Thesium australe*.

8.3.8 *Pterostylis cobarensis*

Pterostylis cobarensis (Greenhood orchid) is a small terrestrial orchid that is listed as Vulnerable under the EPBC Act. It occurs in eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes in skeletal sandy-loam soils. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Pterostylis cobarensis* has not been recorded from the Project Boundary, although potential habitat for this species does occur.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Vulnerable Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Pterostylis cobarensis*.

8.3.9 *Prasophyllum* sp. Wybong (C. Phelps ORG 5269)

Prasophyllum sp. Wybong is a perennial orchid endemic to NSW that is listed as Critically Endangered under the EPBC Act. It is known from seven populations in eastern NSW near Ilford, Premier, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Prasophyllum* sp. Wybong has not been recorded from the Project Boundary, although potential habitat for this species does occur. It is considered unlikely to occur however as this species is known from a closely defined range and the Project Boundary falls outside of this range.

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. Over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. An Assessment of Significance for this species has been conducted according to the EPBC Act Significant Impact Criteria for Critically Endangered Species and is presented in **Appendix J**. This indicates that the Project is considered unlikely to result in a significant impact to *Prasophyllum* sp. Wybong.

8.4 Impacts on Fauna Species

A number of threatened fauna species have been recorded within the Project Boundary, and others have the potential to occur within the Project Boundary, given the proximity of recent database records and the presence of suitable habitat for these species. A summary of the potential impacts to these species as a result of the Project is provided in **Table 8.2** and is discussed in the following sections. Formal Assessments of Significance for all threatened species recorded or with potential to occur are provided in **Appendix J**. The Assessments of Significance provide a further discussion of impacts on the following for each species or fauna group:

- Population of the species at the site;
- Area of occupancy of the species;
- Habitat critical to the survival of the species;
- Breeding cycle of the population; and

- Availability of quality of habitat for the species.

8.4.1 Birds

i. Swift Parrot and Regent Honeyeater

The Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*) have not been recorded during surveys of the Project Boundary. No targeted winter bird surveys were undertaken; however the species were not observed incidentally during other surveys of the Project Boundary. Both species are considered to have potential to occur as suitable forest and woodland habitat, containing forage resources such as mistletoe and winter-flowering box and ironbark trees occur in the woodland habitats of the Project Boundary. These species may forage in the region in low numbers during migratory movements.

Regent Honeyeaters have been recorded from near Quipolly and Goonoo Goonoo to the south-east and east of the Project, near Coolah Tops to the south and from Kelvin State Forest to the north (OEH 2012a). Regent Honeyeaters have been reliably detected in the Bundarra-Barraba area and Warrumbungle National Park from 1994 to 1997 (Oliver D. L. 1998, 2000). Swift Parrots breed in Tasmania but rely on foraging resources on the mainland during winter. Swift Parrots have been recorded from near Gunnedah to the north of the Project and from Wallabaddah Nature Reserve to the south-east (OEH 2012a).

Both the Regent Honeyeater and Swift Parrot are predominantly nectarivorous, although psyllid lerps and invertebrates form a significant proportion of the diet of both species, especially during poor flowering seasons (Oliver D. L. 2000, Kennedy and Tzaros 2005). Both species are reliant on box/ironbark woodlands for foraging and birds are strongly associated with flowering and lerp bearing *Eucalyptus* spp. (Saunders and Heinsohn 2008).

The woodland and scattered paddock trees within the Project Boundary support mature and/or old regenerating *Eucalyptus* spp. that produce nectar and support psyllid lerps. Regent Honeyeaters, in particular, forage in the canopy tops of taller trees and thus mature trees are an important component of the forest and woodland matrix (Oliver D. L. 2000). Interestingly, the species has been observed to roost in saplings of a variety of tree species and rarely use roost trees for feed trees (Oliver D. L. 1998). This suggests that the area of habitat required by the Regent Honeyeater could be more extensive than for some other similar species.

Both species are blossom feeding species and rely on an abundance of blossoms during the appropriate months, and the Swift Parrot is particularly reliant on mass flowering events to fuel its migration to the next resource patch. Drought periods and poor flowering seasons can increase the significance of remaining patches of intact woodland and forest. The flowering resources provided by the woodlands the Project Boundary and the adjacent Breeza State Forest are likely to be locally significant because the vegetation in these areas represent islands of foraging habitat in a largely cleared agricultural district.

The Project would clear approximately 864 ha of woodland that provides potential forage habitat for the Swift Parrot and Regent Honeyeater. However, over 204,000 ha of similar woodland habitat occurs in a 50 km radius of the Project Boundary that is expected to

provide similar levels of habitat for these species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas. An offset strategy has been developed for the Project that will result in the protection of 13,015 ha of land for conservation that provides habitat for these species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the Project will result in a significant impact to the Swift Parrot and Regent Honeyeater.

ii. *Superb Parrot*

The Superb Parrot (*Polytelis swainsonii*) has not been recorded during surveys of the Project Boundary; however, it is considered to have potential to occur, particularly as there are major river systems in the region. This species is known to inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest, which occur in the locality. They nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or woodland, or in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box.

In common with other woodland birds, the Superb Parrot is dependent on tree hollows for nesting. Such holes take many decades to develop, with the largest hollows taking over 150 years on average to form (Mackowski 1984). Many of the larger trees in woodland communities of the Project Boundary contain tree hollows. These are likely to represent a significant nesting resource for local woodland birds, including the Superb Parrot.

The Project will remove 864 ha of potential woodland habitat for the Superb Parrot. However, over 204,000 ha of similar woodland habitat occurs in a 50 km radius of the Project Boundary that is expected to provide similar levels of habitat for this species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas, and the rehabilitation of mined lands within the Project Boundary will ensure that foraging habitat is maintained or increased for the Superb Parrot in the long term. Planted trees will ultimately attain large size and will develop hollows, thus replenishing this resource throughout the landscape in the long term. An offset strategy has been developed for the Project that will result in the protection of extensive areas of land for conservation that provides habitat for this species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to the Superb Parrot.

iii. *Migratory Birds*

One migratory species listed under the EPBC Act have been recorded from the Project Boundary; the White-bellied Sea Eagle (*Haliaeetus leucogaster*). Although not recorded, the

following migratory species (in addition to the Regent Honeyeater that is discussed in **Section 8.4.1.i**) have the potential to occur within the Project Boundary due to the presence of suitable forage resources, or fly over the area:

- White-throated Needletail (*Hirundapus caudacutus*);
- Fork-tailed Swift (*Apus pacificus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Cattle Egret (*Bubulcus ibis*); and
- Great Egret (*Ardea alba*)

The White-throated Needletail and the Fork-tailed Swift were not recorded during field surveys, however the Project Boundary provides suitable forage habitat for these species and they are considered to have potential to occur, particularly during the summer months. Both the White-throated Needletail and Fork-tailed Swift are common non-breeding summer migrants to Australia. These species are exclusively aerial hunters and forage over the canopy of forest and woodland communities for insects.

Although not recorded during recent field surveys, the Project Boundary provides suitable foraging and breeding habitat for the Rainbow Bee-eater, and this species has potential to occur within the Project Boundary, particularly during the summer months. The Rainbow Bee-eater is known to be a summer breeding migrant to the locality of the Project Boundary.

The Project will remove approximately 864 ha of woodland habitat and 3,157 ha of grassland habitat that provides potential forage and breeding habitat for these species. However, over 204,000 ha of woodland and 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for these species. Given the wide range of these species, the abundance of suitable foraging habitat in the locality and the presence of more suitable habitat outside of the Project Boundary, it is unlikely that the Project will result in any significant impacts on these species.

8.4.2 Mammals

Cumberland Ecology surveys did not record any additional EPBC Act listed threatened fauna species within the Project Boundary. Despite the absence of survey records, habitat assessment combined with database searches indicates that a number of EPBC Act threatened fauna species have the potential to occur within the Project Boundary, and these are discussed below. A summary of the potential impacts to these species as a result of the Project is provided in **Table 8.2**. Assessments of Significance are provided in **Appendix J**.

i. Koala

Koalas were detected during the site surveys and the data collected from the SAT surveys indicates that this species makes substantial use of most woodland communities within the

Project Boundary. The dominant trees across a high proportion of the woodland and open forest within the Project Boundary include species that are regarded as important secondary feed species such as White Box (*Eucalyptus albens*). The primary feed species for Koalas in the locality is the River Red Gum (*Eucalyptus camaldulensis*) which also occurs within the Project Boundary, albeit at lower densities.

The Project would clear approximately 847 ha of preferred eucalypt-dominated habitat, resulting in a sizeable loss of foraging resources for Koalas in the locality. In particular the Project will result in the removal of secondary tree species (particularly White Box) that have obtained the required age for these species to become more palatable and less toxic to Koalas.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. A Project specific Koala Plan of Management has also been prepared and is presented as part of the EIS. This includes protocols for minimising clearing of woodland, pre-clearance surveys to relocate individuals, rehabilitation of vegetation within the Project Boundary, along with public education, research and finding strategies.

Short term loss of potential forage resources for Koalas will be addressed with the retention of suitable forage habitat in offset areas located both within and outside the Project Boundary. Strategies to rehabilitate mined lands within the Project Boundary will ensure that Koala feed trees are present in the long-term. An offset strategy has been developed for the Project that will result in the protection of extensive areas of land for conservation that provides habitat for the Koala. Approximately 8,104 ha of Koala habitat (eucalypt-dominated woodland) will be provided within the Onsite Offset Areas. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to the Koala.

ii. *Spotted-tailed Quoll*

The Spotted-tailed Quoll was not recorded within the Project Boundary during recent surveys, despite targeted searches. Atlas of NSW Wildlife database searches indicate that the Spotted-tailed Quoll has been recorded recently from Curlewis to the north of the Project, Caroonna to the south and Trinkey State Conservation Area to the west. There are also a number of records from near Gunnedah. Habitat assessment indicates that the Project Boundary provides suitable forage, den and breeding habitat for this species. All of the woodland vegetation within the Project Boundary provides potential habitat for the Spotted-tailed Quoll.

The Project will clear approximately 864 ha of potential woodland habitat for this species, resulting in the loss of potential foraging and shelter habitat for the Spotted-tailed Quoll. However, over 204,000 ha of woodland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance

surveys and rehabilitation of vegetation within the Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas. An offset strategy has been developed for the Project that will result in the protection of 13,015 ha of land for conservation that provides habitat for this species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to the Spotted-tailed Quoll.

iii. *Brush-tailed Rock Wallaby*

The Brush-tailed Rock Wallaby (*Petrogale penicillata*) is considered unlikely to occur within the Project Boundary as only limited potential habitat is present in the rocky areas associated with Mt Watermark, and it has not been recorded from the Gunnedah LGA or the Project Boundary.

The rocky habitats associated with Mt Watermark will not be cleared as a result of the Project and no significant impact is predicted to occur to this species.

iv. *New Holland Mouse*

The New Holland Mouse (*Pseudomys novaehollandiae*) is not considered likely to occur within the Project Boundary as it is located outside of this species known distribution, and the vegetation present is not considered to be this species preferred habitat. No records of this species are present in the Gunnedah LGA. The Protected Matters Search Tool does not indicate that this species has potential to occur in the locality and it has not been recorded from the Project Boundary.

Accordingly, no significant impact is expected to occur to the New Holland Mouse as a result of the Project.

v. *Grey-headed Flying Fox*

The Grey-headed Flying Fox (*Pteropus poliocephalis*) has some low potential to occur within the Project Boundary due to the presence of suitable habitat, but it has not been recorded from the Gunnedah LGA, and the Protected Matters Search Tool does not indicate that this species has potential to occur in the locality. This species does not breed within the Project Boundary as evidenced by the lack of camps.

The Project will clear approximately 864 ha of potential woodland habitat for this species, although no breeding habitat will be lost. However, over 204,000 ha of woodland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for this species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas. An offset strategy has been developed for the Project that will result in the protection of 13,015 ha of land for

conservation that provides habitat for this species. No significant impact is predicted to occur to the Grey-headed Flying Fox as a result of the Project.

vi. *Microchiropteran Bats*

The Large-eared Pied Bat (*Chalinolobus dwyeri*) and the South-eastern Long-eared Bat (*Nyctophilus corbeni*) have not been recorded from the Project Boundary, although they have been recorded from the Gunnedah LGA.

The Project is likely to remove approximately 864 ha of potential woodland forage habitat for these microbat species. In addition, the removal of tree hollows will remove roosting and breeding habitat for the South-eastern Long-eared Bat. The Project is likely to impact on the Large-eared Pied Bat to a lesser extent, as this species roosts in rocky outcrops, and the only significant rocky outcrops within the Project Boundary that are likely to provide suitable shelter habitat for this species (e.g. Mt Watermark) will not be impacted by the Project.

However, over 204,000 ha of woodland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for these species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas. An offset strategy has been developed for the Project that will result in the protection of 13,015 ha of land for conservation that provides habitat for these species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to microbat species.

8.4.3 Reptiles

No threatened reptile species were recorded within the Project Boundary, however potential habitat is present for three species; the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*).

The Project will remove approximately 864 ha of woodland habitat and 3,157 ha of grassland habitat that provides potential habitat for the Pink-tailed Legless Lizard and Five-clawed Worm-skink. The Border Thick-tailed Gecko lives under rocks and the rocky outcrops of the Project (e.g. Mt Watermark) may provide suitable forage and shelter habitat for this species, although this habitat is unlikely to be impacted by the Project.

However, over 204,000 ha of woodland habitat and over 260,000 ha of grassland habitat similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that will continue to provide potential habitat for these species. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the

Project Boundary. Short term loss of potential forage resources will be addressed with the retention of suitable forage habitat in on-site and off-site offset areas. An offset strategy has been developed for the Project that will result in the protection of 13,015 ha of land for conservation that provides habitat for these species. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to these reptile species.

8.4.4 Summary of Impacts on Threatened Species

The following tables present a summary of the potential impacts on threatened species and ecological communities listed under the EPBC Act (**Table 8.2**) based on the potential impacts to species and communities' habitat.

Table 8.2 Summary of Project Impacts on EPBC Act Listed Ecological Communities and Threatened Species

Ecological Communities and Threatened Species	EPBC Act Status	LGA Count#	Occurrence within Project Boundary	Preferred Habitat within Project Boundary^	Total Area of Habitat in Project Boundary (ha)	Area of Habitat Cleared within the Project Boundary (ha)	Area of Habitat Remaining within the Project Boundary (ha)
ECOLOGICAL COMMUNITIES							
Box Gum Woodland and Derived Native Grassland	CEEC		Known		1,265	738	527
Inland Grey Box Woodland	EEC		Known		55	30	25
Weeping Myall Woodland	EEC		Known		22	3	19
Brigalow	EEC		Known		9	0	9
Semi-evergreen Vine Thicket	EEC		Known		n/a*	0	0
PLANTS							
Bothriochloa biloba	Vulnerable	21	Known	W,G	9,360	4,021	5,339
Dichanthium setosum	Vulnerable	9	Potential	W,G	9,360	4,021	5,339
Digitaria porrecta	Endangered	8	Potential	W,G	9,360	4,021	5,339
Cadellia pentastylis	Vulnerable	2	Potential	W	1,997	864	1,133
Swainsona murrayana	Vulnerable	0	Potential	W,G	9,360	4,021	5,339
BIRDS							

Table 8.2 Summary of Project Impacts on EPBC Act Listed Ecological Communities and Threatened Species							
Ecological Communities and Threatened Species	EPBC Act Status	LGA Count#	Occurrence within Project Boundary	Preferred Habitat within Project Boundary^	Total Area of Habitat in Project Boundary (ha)	Area of Habitat Cleared within the Project Boundary (ha)	Area of Habitat Remaining within the Project Boundary (ha)
White-bellied Sea Eagle	Migratory	2	Known	G	7,362	3,157	4,206
Regent Honeyeater	Endangered, Migratory	1	Potential	W	1,997	864	1,133
Swift Parrot	Endangered	1	Potential	W	1,997	864	1,133
Superb Parrot	Vulnerable	0	Potential	W	1,997	864	1,133
White-throated Needletail	Migratory	9	Potential	W,G	9,360	4,021	5,339
Fork-tailed Swift	Migratory	1	Potential	W,G	9,360	4,021	5,339
Rainbow Bee-eater	Migratory	12	Potential	W,G	9,360	4,021	5,339
Cattle Egret	Migratory	0	Potential	G	7,363	3,157	4,206
Great Egret	Migratory	0	Potential	G	7,363	3,157	4,206
MAMMALS							
Koala	Vulnerable	720	Known	W	1,997	847	1,036
Spotted-tailed Quoll	Endangered	11	Potential	W	1,997	864	1,133
Large-eared Pied Bat	Vulnerable	6	Potential	W	1,997	864	1,133
South-eastern Long-eared Bat	Vulnerable	2	Potential	W	1,997	864	1,133

Table 8.2 Summary of Project Impacts on EPBC Act Listed Ecological Communities and Threatened Species

Ecological Communities and Threatened Species	EPBC Act Status	LGA Count#	Occurrence within Project Boundary	Preferred Habitat within Project Boundary [^]	Total Area of Habitat in Project Boundary (ha)	Area of Habitat Cleared within the Project Boundary (ha)	Area of Habitat Remaining within the Project Boundary (ha)
REPTILES							
Border Thick-tailed Gecko	Vulnerable	2	Potential	W	1,997	864	1,133
Five-clawed Worm-skink	Vulnerable	0	Potential	W, G	9,360	4,021	5,339
Pink-tailed Legless Lizard	Vulnerable	1	Potential	W, G	9,360	4,021	5,339

[#]Data obtained from Atlas of NSW Wildlife (Gunnedah LGA)

[^]Preferred Habitat: W = woodland, G = grassland,

*Area of occurrence is <0.1ha and has therefore not been mapped

8.5 Impacts to the Aquatic Environment

The Project has very low potential to impact on the aquatic environment as the majority of the Project will not occur in the vicinity of any aquatic ecosystem, with the exception of several degraded farm dams and ephemeral waterways. The Project is seeking approval for the construction of two pipelines from the Mooki River to the Project Boundary (see **Figure 2.2**). The potential ecological impacts of water extraction from this river are discussed below.

8.5.1 Pipeline and Pump Construction and Management

The construction of the proposed pipeline and the pump station will not entail tree clearance as it will be located in areas covered mainly by exotic grasses and herbaceous plants on the floodplain. There will be no disturbance to fish habitats such as billabongs and no clearance of threatened species habitat. The Mooki River and the riparian zone at this location are highly degraded by existing land uses and the additional disturbance that will result from the installation and maintenance of the pipeline and pump station is minimal. No significant impact is predicted to occur threatened flora and fauna or the aquatic environment.

8.5.2 Impacts of Water Extraction and Loss of Catchment Area

Water extraction from the Mooki River may occur periodically as a result of the Project, and as described in **Section 7.4.2**, some reduction in the catchment area of the Mooki River will occur. This will reduce the amount of water available in the Mooki River and will contribute to the cumulative aquatic impact upon fish, macro-invertebrates, water birds, water plants and riparian plants associated with downstream areas of the Mooki River. This will be caused solely by reducing the amount of water in the river that would otherwise be available to river life, and will contribute to the impacts upon the ecology of the Mooki River that result from other water extractions.

Water use in the Mooki River is subject to the NSW Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources (DIPNR 2005). This includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the plan area. The provisions in the Plan provide water for the environmental needs of the river and its ecological processes and direct how water available for extraction is to be shared. The Water Sharing Plan also establishes rules for the management of access licences, water allocation accounts, the trading of or dealings in licences and water allocations, the extraction of water, the operation of dams and the management of water flows. The vision of the Plan is to have a sustainable, healthy river system that provides equitable water access for all users through flow management.

The impacts of water allocations within the Mooki River are therefore already being considered by the Government and the collective impacts of the Water Sharing Plan are being monitored. No significant ecological impacts are predicted to occur in the aquatic environment as a result of the proposed extraction of waters from the Mooki River.

There is minor potential for fish to be impacted by the suction from the pump, however this part of the Mooki River is highly ephemeral and it does not have a resident population of fish, as the waterway periodically dries out. During times of river flow, water may be extracted and some invertebrates may get sucked into the intake; however no threatened invertebrates were recorded in the aquatic surveys of the Mooki River. Further, Shenhua Watermark will install the necessary pump filters to ensure threatened invertebrates are not sucked into the intake. Therefore it is not expected that any are likely to be significantly impacted by this process.

Some MNES such as the Murray Cod (*Maccullochella peelii*) occur in the Namoi River, of which the Mooki River is a tributary. The Project will result in a very minor reduction in the amount of water entering the Namoi via the Mooki River.

8.6 Impacts to Groundwater Dependent Ecosystems

No obvious GDEs occur within the Project Boundary such as swamps, riparian forest or woodland or other such vegetation communities likely to be dependent on base river flow. Some vegetation within the Project Boundary has the potential to utilise groundwater, however based on analysis of groundwater depth, salinity and site inspections, none of the vegetation communities are considered to be GDEs that are likely to be completely dependent on groundwater.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimising clearing of woodland and rehabilitation of vegetation within the Project Boundary. An offset strategy has been developed for this Project that will result in the protection of extensive areas of land for conservation including likely occurrences of GDEs. With the implementation of the proposed avoidance, mitigation, and offset measures, it is expected that the Project will not result in a significant impact to GDEs.

8.7 Cumulative Impacts to MNES

Cumulative impacts result when many small-scale alterations to the environment combine to cause an overall greater level of impact. In a mining environment, cumulative impacts can arise from the compounding activities of a single operation, or multiple mining and processing operations in the same area, as well as the interaction of mining impacts with other past, current and future activities that may not be related to mining (Franks et al. 2008). Cumulative impacts can arise from either persistent losses of one resource, or the compounding effects of two or more impacts (Lindenmayer, 2006). Direct and indirect impacts that may be insignificant on their own may be significant when considered together with other actions being undertaken as part of the same Project, or with other similar projects in the locality.

Modern mining is a temporary land use that almost inevitably entails rehabilitation of native vegetation and offsetting. So although open cut mining entails the clearance of vegetation modern mining approvals are such that offsetting and other mitigation measures are

available and commence at the beginning of a project. Moreover offsetting of modern mining projects is geared to achieve a net increase in vegetation so that the cumulative impacts of mines within a district can result in significant net increases in native vegetation and other fauna habitats in the medium to long term. Therefore mining as an industry is significantly different in terms of its ecological impacts to the widespread impacts that occur from agriculture where offsetting does not occur. We note that rehabilitation obligations are also secured via security bonds and guarantees lodged with government to ensure the outcome occurs. Therefore there is a high probability that these positive aspects of mining projects will occur.

Apart from existing and proposed mining operations in the locality (see below), extensive vegetation clearing has already occurred in the locality (20 km radius of the Project Boundary) and wider Gunnedah LGA as a result of agriculture, forestry, and other mining and industry projects. The vegetation clearance that will occur as a result of the Project will exacerbate these existing ecological impacts on MNES such as Box Gum Woodland and Derived Native Grassland and Inland Grey Gum Woodland.

Cumulative impacts are expected to be felt as a result of several mine leases that occur within the locality and wider region, with the closest mine, Sunnyside Mine (which is currently in care and maintenance), occurring 15 km west of Gunnedah. Coal mining is currently taking place in several places in the wider region and there is potential for other large-scale operations to occur within the locality, such as Vickery Coal Mine (22 km north of Gunnedah). The impacts of any future mining operations will be similar to those described for this Project. Other large developments currently seeking approval elsewhere in the Gunnedah LGA (some of which are listed on the DP&I Major Projects registry), include the Werris Creek and Rocglen mines and Whitehaven Coal Handling and Preparation Plant (CHPP) (Whitehaven Coal Mining Pty Ltd); Caroon Coal Project (BHP Billiton), Keepit Dam Upgrade (State Water Corporation) and the Queensland to Hunter gas pipeline (Hunter Gas Pipeline Pty Ltd).

It is difficult to undertake cumulative assessments as information on future operations are difficult to obtain and impacts may have temporal and spatial extents that cannot be studied at the project assessment level (Franks et al. 2008). What is known however, is that each project has or will have a significant disturbance footprint and requires land for associated infrastructure, and if approved, these projects are expected to have cumulative ecological impacts on MNES in the region by clearing substantial areas of vegetation and habitat (see **Table 2.1**). Cumulative impacts of future development in the locality of the Project will likely include both direct and indirect impacts. Likely short to medium term cumulative impacts are those relevant to mining operations, such as noise, light and dust impacts. Long term cumulative impacts include loss of habitat, habitat fragmentation and edge effects. Further clearing of habitat within the locality is likely to impact the local wildlife corridor which occurs between Breeza State Forest and Wondoba State Conservation Area. The impact of further habitat clearing and fragmentation is accentuated by the general paucity of robust corridor functionality in the existing landscape.

If no mitigation or compensatory measures are provided, further development within the locality will also result in cumulative impacts on MNES as known and potential habitats are

further reduced and fragmented. However, the identification and management of cumulative impacts has the potential to benefit regional environments, as integrated mitigation strategies can have greater benefit than individual mitigation measures implemented by each mine (Franks et al. 2008). This may include strategic rehabilitation of corridors, or substantial investment in recovery plans for affected species. Despite the land clearance predicted to take place, all of the developments offer mitigation or compensatory measures, including proposals 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. Mines are likely to purchase additional surrounding lands that contain forest, woodland and derived native grasslands. These will collectively and significantly increase the total areas of native vegetation, including MNES communities 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. Further details about the collective benefits of offsetting by mines in the locality are provided in **Chapter 10**. Despite these collective impacts, the Project is unlikely to directly threaten the occurrence of MNES recorded within the Project Boundary. Large areas of vegetation will remain both within the Project Boundary and outside of it, including areas within the Breeza State Forest and surrounding rural areas. Some vegetation communities to be impacted, particularly MNES such as Box Gum Woodland and Derived Native Grasslands, Inland Grey Box Woodland and Weeping Myall Woodland are not well represented within secure tenures, particularly within conservation reserves. However, a comprehensive biodiversity offset strategy has been prepared for the Project and is presented in **Chapter 10**. The offsetting arrangements will both protect existing forest and woodland communities and restore vegetation on farmland, with the net result being an increase in total woodland vegetation and an increase in such vegetation under conservation tenures. As discussed above, the cumulative impacts in the area are likely to be adequately offset by the cumulative benefits of offsetting from several projects.

8.8 Duration and Timing of Impacts

The duration and timing of the impacts of the Project has important effects on the magnitude of the overall impacts on the ecology of the Project Boundary.

The total or net impacts of the Project will not occur simultaneously as the mining will be staged and rehabilitation will be progressive, following the first stage of clearing and mining. Woodland will be progressively cleared by the Project; however, these areas will be progressively rehabilitated with the primary aim of restoring much of it to woodland cover. Further details of the amount of land to be rehabilitated to woodland and the amount to be rehabilitated for agricultural production will be provided in the Rehabilitation Management Plan.

This means that for much of the 30 year Project life, the majority of the Project Boundary will be vegetated, although rehabilitated mine areas will have young, vegetation. These young rehabilitated areas will still represent habitat for some fauna species, including woodland birds and Koalas and will play an important role in maintaining habitat areas as the Project progresses. Thus the net loss of vegetation at any given stage of the Project time will be

minimised through the progressive clearance and concurrent rehabilitation of the land within the Project Boundary.

Not all areas will be permanently cleared and disturbed. Areas to be used for buildings and other mine infrastructure will be returned to forest and woodland in the long term once mining has ceased. Moreover, all of the open cut mining areas other than the final void will be revegetated to forest and woodland using local provenance species in the long term.

8.9 Permanence and Reversibility of Impacts

Despite the relatively large areas of woodland that will be cleared for the Project, it is important to recognise that it is for the most part a temporary change in land use.

Apart from some components of the Project that will permanently alter the topography of the site, the majority of the development is likely to have reversible impacts, and flora and fauna are likely to recover well with appropriate rehabilitation measures.

The majority of cleared woodland within the Disturbance Area will be rehabilitated following the completion of mining. If appropriate effort is put into the subsequent rehabilitation of these areas, it is likely that the communities that previously existed in these areas will be recreated.

Rehabilitation and regeneration of woodland is possible on degraded areas and has the potential to reduce the impacts of habitat removal on threatened species. The planting of threatened plant species in rehabilitation efforts, which are known to occur in the Disturbance Area would reduce impacts on these species and enable recovery of populations within the Project Boundary.

In the long term Shenhua Watermark would maintain the area of woodland within the Project Boundary by rehabilitating mined areas, and increase the area of woodland by the strategic acquisition of lands in surrounding areas for biodiversity offsets (see **Chapter 10**).

8.10 Summary of Impacts

The major impact of the Project will be from the clearance of broad areas of woodland, directly removing areas of EECs and CEECs listed under the EPBC Act. These areas of woodland also provide biodiverse habitats and important habitat resources for a wide range of species including several listed under the EPBC Act. Without substantial mitigation and compensation measures, the Project would add significantly to ecological impacts within the locality, denuding it of native vegetation and habitat for many native species.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 9** and **Chapter 10**. This includes minimizing clearing of woodland, pre-clearance surveys and rehabilitation of vegetation within the Project Boundary. An offset strategy has been developed for the Project that will result in the protection of extensive areas of land for conservation that provides habitat for

MNES. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the Project will result in a significant impact to threatened species or ecological communities.

Chapter 9

Ecological Impact Mitigation Measures

The purpose of this chapter is to outline the mitigation measures proposed to ameliorate the impacts of the Project on flora and fauna. As demonstrated in previous chapters, the Project Boundary is biodiverse and provides habitat for a wide range of flora and fauna, including species listed under State and Commonwealth threatened species legislation.

The policy basis for reducing the ecological impacts of the Project follow the Commonwealth *Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999* (DEWR 2007), which state that avoidance and mitigation measures should be considered prior to the use of offsets.

The impact reduction measures for the Project include the following hierarchy of principles:

- Avoid – to the extent possible, the Project has been designed to avoid or minimize ecological impacts;
- Mitigate – where certain impacts are unavoidable through design changes, mitigation measures have been introduced to ameliorate the ecological impacts of the Project; and
- Compensate – the residual impacts of the Project, following the implementation of mitigation measures, have been compensated to offset what would otherwise be a net loss of habitat.

Furthermore, an ecological monitoring program will be established to monitor the ongoing status and health of flora and fauna communities that will be retained within the Project Boundary in order to assess the success of the mitigation and compensation measures.

In order to coordinate the implementation of the proposed mitigation measures, a Biodiversity Management Plan (BMP) will be prepared prior to the commencement of mining operations. The BMP will also provide specifications for the restoration and management of biodiversity offset areas. The BMP is the key document that will ensure that the conservation objectives of the Project are met and that impacts to biodiversity are adequately managed for the life of the Project. This is explained further in **Section 9.4**.

The structure of this chapter is as follows:

- Measures to Avoid Impacts (**Section 9.1**);

- Measures to Mitigate Impacts (**Section 9.2**);
- Monitoring (**Section 9.3**); and
- Biodiversity Management Plan (**Section 9.4**).

A comprehensive Biodiversity Offset Package has been provided in **Chapter 10** that outlines the measures taken to mitigate for the residual impacts of the Project once the appropriate avoidance and mitigation measures outlined in this chapter have been implemented.

9.1 Measures to Avoid Impacts

Avoiding environmental impacts has been considered where possible throughout the Project planning and design phases. In the first instance, significant modification to the design of the Project was undertaken to improve biodiversity outcomes, as outlined in **Section 2.2.4**. The conceptual mine plan for the Project has been devised through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities and species. In this regard, the Project and mine plan has been specifically designed to ensure the following:

- No disturbance of Breeza State Forest (where Box Gum Woodland CEEC is known to exist);
- The Infrastructure Area is designed and located to minimise impacts on CEEC;
- No disturbance of Mt Watermark (where Box Gum Woodland CEEC is known to exist); and
- No disturbance on the black soil plains.

Further to this, the Eastern Mining Area Overburden Emplacement Area has been modified to avoid the disturbance of 143 ha of Box Gum Woodland CEEC adjacent to Mt Watermark. This involved a full redesign of the mine plan and overburden emplacement strategies and mass balances.

Further avoidance of impacts may be achieved where possible during the detailed design phase of the Project. Substantive mitigation and compensation measures are proposed to offset the unavoidable impacts of the Project on flora and fauna as described below.

9.2 Measures to Mitigate Impacts

Where the design of the Project is determined, measures can be considered to mitigate some of the direct and indirect impacts of the construction and operation of the Project. This section describes the proposed mitigation measures for the Project that will be undertaken by Shenhua Watermark. No mitigation measures are currently proposed to be undertaken by State or Local Governments.

9.2.1 General Mitigation Measures

Shenhua Watermark will develop and implement an Environmental Management System (EMS) for the Project, consistent with the principles of AS/NZS ISO 14001:2004 which will include a variety of mitigation and management measures to minimise social and environmental impacts. The EMS will incorporate all relevant aspects from Commonwealth and State approvals and licences, policies and guidelines.

The EMS will be subject to regular reviews and audits, recording of incidents and non-conformances and the maintenance of a Corrective Action Register. All Management Plans will also have measurable Key Performance Indicators. All of these tools will assist in regular feedback and improvement of the EMS, which in turn assess its effectiveness.

As part of the EMS, management measures for MNES are also incorporated. **Table 9.1** outlines the key activities where the Project may impact on MNES, the proposed actions to reduce impacts on MNES, objectives of the management actions and identification of the detailed EMS documentation to be prepared for the Project.

Table 9.1 Proposed Actions to Reduce Impacts on MNES			
Aspect	Management Objective	Action	EMS Documentation
Clearing & Disturbance	Maintain the abundance, species diversity, geographic distribution and productivity of significant habitat or flora populations, by avoiding or minimising clearing, and utilising appropriate engineering and management of areas to be cleared	Baseline surveys will be completed in all areas with planned mining developments and infrastructure.	* Surface Disturbance Protocol
	Progressively restore habitat for flora and fauna, particularly areas of habitat for significant species/ populations, and develop self sustaining, non-polluting final landforms to support ecosystems	Location of species of MNES and their habitats identified within and adjacent to the Project Boundary will be recorded on a GIS database.	* Permit to Disturb
		Proposed clearing and disturbance will be assessed through a Surface Disturbance Protocol. Surface Disturbance will only be permitted by the Environmental Manager once a Permit to Disturb has been completed and approved. This will ensure:	* Construction Management Plan [^]
		- disturbance remains within approved boundaries	* Rehabilitation Plan [^]
		- clearing is minimised to meet specific demands	* Land Management Plan
Spread of weed species	Minimise the introduction and spread of weed species to significant flora and fauna habitat and populations	- planned clearing is adjusted where possible to avoid disturbance of significant areas	
		- planned clearing meets legal obligations.	* Mine Closure Plan [^]
		All areas to be cleared will be demarcated prior to disturbance.	
		Pre-clearance surveys will be completed prior to any disturbance	
Spread of weed species	Minimise the introduction and spread of weed species to significant flora and fauna habitat and populations	Completion criteria will be developed as part of the closure and rehabilitation plan to provide the basis for functioning habitat post mining.	* Weed and Feral Animal Management Plan [^] * Land Management Plan [^]
		Weed management measures will be implemented in accordance with the Weed Management Plan and equipment hygiene procedures to ensure weeds are controlled and recorded and equipment is cleaned to minimise the spread of weeds.	

Table 9.1 Proposed Actions to Reduce Impacts on MNES			
Aspect	Management Objective	Action	EMS Documentation
Increase in feral animals	Minimise the effect of feral animals on native terrestrial fauna by controlling spread and mitigating impacts through management	Feral animal control will be undertaken by: - prohibiting feeding animals - prohibiting keeping pets - appropriate waste disposal for food scraps and other wastes as per the Waste Management Plan - regular feral animal reduction programs	* Weed and Feral Animal Management Plan^ * Land Management Plan^
Dust generation	Protect significant fauna habitat and vegetation by controlling dust emissions	Dust control measures (including road watering, water sprays and dust suppression systems) will be used to minimise dust as per the Air Quality Management Plan A meteorological forecast system and real-time dust monitoring network will be established within and surrounding the Project	* Air Quality Management Plan^ * Air Quality Monitoring Program
Direct MNES encounter	Protect native fauna by avoiding species / ecological communities with conservation significance wherever practicable; utilising engineering designs, management controls, education of site personnel and traffic management	A register of any MNES encountered on site will be developed and maintained. This will include GIS locations, and MNES status. Native fauna encountered on site will be given the opportunity to move on if there is no threat to personnel safety in doing so. Fauna (including injured fauna) encountered on site will be handled and transported in accordance with the relevant guidelines and policies. Feeding of native fauna, hunting, keeping of firearms or pets on site will be prohibited Appropriate speed limits for mining equipment and light vehicles will be implemented, sign-posted and enforced, and communicated via education of site personnel Vehicles will remain on designated roads and will not be permitted off designated roads unless in the case of emergency Location of any significant roost sites adjacent to the operations will be demarcated	* Biodiversity Management Plan^ * Surface Disturbance Protocol * Permit to Disturb

Table 9.1 Proposed Actions to Reduce Impacts on MNES			
Aspect	Management Objective	Action	EMS Documentation
		and access prohibited to all personnel.	
		Taking water only from points licensed by the NSW Office of Water and remaining within licence limits	* Groundwater Management Plan ^
		Monitoring surface water and groundwater quality as per the Management Plans and comparing to trigger levels	* Groundwater Monitoring Program
Changes to hydrology and hydrogeology	Maintain the quantity and quality of water to protect existing and potential values, including ecosystem maintenance, flow paths and water quality.	Maintain all water monitoring data in a database to analyse trends and assess/ revise trigger levels	* Surface Water Management Plan^
		Storing, handling and disposing of effluent in accordance with the environmental licence	* Surface Water Monitoring Program
		Adhering to site specific Groundwater, Surface Water and Sediment and Erosion Control Plans	* Erosion & Sediment Control Plan^
		Installing appropriate hydrocarbon bunding and management practices at hydrocarbon use and storage facilities	* Waste and Hydrocarbon Management Plan
Altered fire regimes	Protect significant habitat from fire where beneficial and minimise fire occurring from human activities	Control fires caused by operations	* Fire Management Plan^
		Minimise risk of fire from ignition sources	* Land Management Plan^

^ Subject to approval by the NSW Department of Planning

9.2.2 Minimising Vegetation and Habitat Loss

As noted in **Table 9.1** above, in order to minimise clearing impacts and unnecessary disturbance to native vegetation, the following procedures will be implemented:

- The limits of clearing will be delineated during the construction and mining operation process and marked clearly on plans and on the ground;
- Native vegetation beyond the identified clearing areas will not be disturbed; and
- Ancillary facilities such as stockpile sites, site compounds and construction zones will not be located beyond the limits of clearing.

Where clearing of vegetation and fauna habitats will take place, clearing protocols will be followed, including:

- Preparation of an inventory of trees and hollows to be removed, prior to clearing;
- Checking hollow-bearing trees for the presence of bird nests and arboreal mammals, such as possums, gliders and microbats, prior to felling;
- Animals found to be occupying trees should be safely removed before the clearing of trees and relocated into nearby woodlands;
- Nest boxes or salvaged tree hollows should be provided in nearby woodland to compensate for the hollows to be removed due to vegetation clearance, and the numbers should be proportional to the number of hollows removed; and
- Boulders and large logs should be placed in nearby areas of retained vegetation to allow their continued use as fauna habitat.

9.3 Monitoring

Shenhua Watermark is committed to designing and implementing monitoring programs to meet all regulatory requirements and minimise impacts to MNES. Monitoring will be designed to enable an assessment of the effectiveness of flora and fauna management measures as explained further below. An example of considerations to be addressed by the monitoring programs is shown in **Table 9.2**.

Table 9.2 Monitoring Requirements	
Sources of Monitoring Requirements	Commonwealth EPBC approval conditions / State approval conditions / Licence requirements / Part IV assessment commitments
Monitoring and Survey guidelines	Significant Impact guidelines 1.1 Matters of National Environmental Significance

Table 9.2 Monitoring Requirements	
Sources of Monitoring Requirements	Commonwealth EPBC approval conditions / State approval conditions / Licence requirements / Part IV assessment commitments
	Species significant guidelines issued by SEWPAC
Purpose of monitoring	Collection of baseline data Knowledge gain Measurement of impacts on matters of National Environmental Significance Determination of trigger values to change practices on site Determine effectiveness of management measures
Reporting of monitoring	Present findings and trends in the Annual Environment Report Identify and understand impacts and cumulative impacts Identify trigger values and responses required for exceedance of trigger values Trigger updates to management plan where required Include justification for survey methodology Include discussion on scientific reliability of surveys

A monitoring program will be developed to monitor the ongoing status and health of flora and fauna that is to be retained within the Project Boundary and in the Onsite and Offsite Offset Areas (see **Chapter 10**) including both vegetation monitoring and threatened species monitoring. This will include MNES recorded from the Project Boundary or considered to have potential to occur, including the following:

- Box Gum Woodland and Derived Native Grassland;
- Inland Grey Box Woodland;
- Weeping Myall Woodland;
- Brigalow;
- Semi-evergreen Vine Thicket;
- *Bothriochloa biloba*;
- *Dichanthium setosum*;
- *Digitaria porrecta*;
- *Cadellia pentastylis*;

- *Swainsona murrayana*;
- *Tylophora linearis*;
- *Thesium australe*;
- *Pterostylis cobarensis*;
- Koala (*Phascolarctos cinerea*);
- Spotted-tailed Quoll (*Dasyurus maculatus*);
- Grey-headed Flying Fox (*Pteropus poliocephalis*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- South-eastern Long-eared Bat (*Nyctophilus corbeni*);
- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*);
- Pink-tailed Legless Lizard (*Aprasia parapulchella*);
- Five-clawed Worm-skink (*Anomalopus mackayi*);
- Swift Parrot (*Lathamus discolor*);
- Regent Honeyeater (*Anthochaera phrygia*); and
- Superb Parrot (*Polytelis swainsonii*)

The monitoring program will provide feedback data to determine the level of success of the mitigation and compensation measures.

The proposed monitoring program will include the use of appropriate reference sites that are located away from mining activities to use as a baseline against which to compare the status of habitats in close proximity to mining.

This section discusses the proposed monitoring programs specific to MNES that will be developed for the Project.

More detailed prescriptions for monitoring strategies and the development of reference sites will be incorporated into the BMP, including a framework for reporting on the results of the monitoring. Details on monitoring frequency and duration, responsibilities, corrective actions and corrective action thresholds as appropriate to MNES will be developed as part of the BMP in consultation with SEWPAC and relevant state authorities. The agency responsible for endorsing or approving each mitigation measure or monitoring program will be SEWPAC.

9.3.1 Vegetation Monitoring

The vegetation monitoring strategy would provide information to quantify the change in biodiversity over time within the Project Boundary.

It is proposed that monitoring sites be established in areas of vegetation both inside and outside of the Disturbance Area and in designated reference sites. Regenerated areas are also proposed to be monitored in the long term to allow changes in species composition and structure over time to be quantified. Information will be used in adaptive management, in order to continually improve the outcomes of the rehabilitation and land management strategy. Appropriate data management procedures will be implemented to ensure that all data is collected using appropriate techniques and suitably analysed to allow meaningful spatial and temporal comparisons to be made.

The aims of the vegetation monitoring include the following:

- Establishment of monitoring plots in areas of representative vegetation both within and outside of the Disturbance Area and within the rehabilitation areas once rehabilitation commences;
- Regular collection of floristic data such as species abundance, cover abundance, percentages of weeds and condition of vegetation;
- Analysis of data to determine patterns of change in species composition and structure over time;
- Provision of management recommendations based on the results of the monitoring that will address issues identified and ensure the management objectives of the vegetation are being met; and
- Provide certainty as to the outcome of rehabilitation.

More specific details of the vegetation monitoring strategy will be contained in the BMP.

9.3.2 Threatened Species Monitoring

Monitoring should also be undertaken on selected threatened species of flora and fauna, in order to determine whether populations are being adversely affected by the Project.

The aims of the threatened species monitoring are to:

- Enable the identification of the impacts of the Project on threatened species;
- Identify changes in population numbers over time;
- Determine the success of impact mitigation and conservation measures; and
- Highlight areas for improvement if these measures are found to be inadequate.

Threatened species monitoring should involve conducting targeted threatened species surveys annually in areas of known habitat in order to record the abundance of selected species. This should include both flora and fauna species. The level of monitoring effort would be determined according to risk level and biology of the particular species in question (e.g. coordinating with breeding or movement times).

9.3.3 Reference Sites

The establishment of reference sites is recommended by the *ICMM Good Practice for Mining and Biodiversity guidelines* to enable impacts resulting from mining to be better understood and quantified (International Council on Mining and Metals 2006). Reference areas serve as a benchmark against which changes in biodiversity over time can be compared (for example, through the use of the before-after/control-impact (BACI) approach). This approach collects and compares data from sites before and after the impact has occurred, and also from control (un-impacted) and impacted sites. Reference sites help to determine which changes are directly attributable to the mining operations and which are the results of unrelated outside factors. Reference sites can also be very useful in rehabilitation, as they allow a desired endpoint to be set for rehabilitation efforts, and progress towards this endpoint through time can be quantified.

The aims of the establishment of reference sites are as follows:

- Collection of benchmark of data at these sites against which changes in biodiversity over time can be compared;
- Determine which changes are directly attributable to the mining operations and which are the results of unrelated outside factors;
- Set a desired endpoint for rehabilitation efforts, so that progress towards this endpoint through time can be quantified.

Reference sites should be selected before mining commences and should be determined in consultation with relevant government agencies as part of the finalisation of the BMP. These sites should be established in areas within the Project Boundary that will not be subject to impacts from mining, or outside of but as close as possible to the Project Boundary. Locations suitable as reference sites should ideally contain the same ecological community that is being impacted, should be in a similar position in the landscape, should have similar topography and disturbance history, and should not be subject to impacts from the Project (International Council on Mining and Metals 2006). At each reference site, a range of data will be collected in order to allow comparisons to be made between impacted and non-impacted sites. This will provide an indication of the impacts occurring as a result of the Project. The full range of data to be collected at each reference site will be developed during the preparation of the BMP.

9.4 Biodiversity Management Plan

In order to provide a comprehensive framework for the implementation of the proposed biodiversity impact mitigation and offset measures, a BMP will be developed for the Project. The BMP will ensure that the Project's conservation objectives are met and that impacts to biodiversity are adequately managed for the life of the Project. The BMP will incorporate all of the impact mitigation measures as described in this chapter that are proposed to be undertaken for the Project, and provide detailed specifications for their implementation. The focus of the BMP will be all the MNES that have potential to be impacted by the project. This includes those that have been recorded from the Project Boundary and those which have potential to occur, including ecological communities such as Box Gum Woodland and Derived Native Grassland, threatened species of flora and fauna, as well as migratory birds.

The aims of the BMP are as follows:

- An overarching document that pulls together all the proposed avoidance, mitigation and compensation measures proposed for the Project;
- A document that provides detailed instructions and specifications for the implementation of the proposed mitigation measures;
- A document that provides the administrative framework for the implementation of the proposed mitigation measures, including timeframes, key performance indicators and provides direction when these indicators are not met.

The BMP will include the following:

- A description and plan of onsite conservation measures (long and short term);
- Measures to protect local biodiversity values;
- Provisions to address specific issues such as the occurrence of threatened species;
- Details of appropriate areas for rehabilitation and conservation;
- Details of revegetation priorities and techniques;
- Details of reference sites, monitoring methodology, and other contributions to conservation;
- Description of key performance indicators against which to measure progress; and
- Specification of appropriate review periods where progress is reviewed and the document updated as required.

The BMP is intended to be a working document that guides all facets of biodiversity management and biodiversity mitigation for the Project, and should include clear objectives and actions. The BMP will specify what measures will be undertaken, how they will be

undertaken, and should provide a timeline to ensure that all activities are conducted according to the plan. The BMP will enable site environmental managers to enact the 'avoid and mitigate' principles during the operation of the Project.

The BMP will contain comprehensive details of the proposed management measures that will be implemented in the offset properties to ensure that there is an improvement in the biodiversity values, including phased reduction of livestock management, the management of weeds and feral animals, as well as shrub and tree planting and direct seeding of groundcover species in more modified areas. Different properties and different areas within a single property will inevitably require varying levels and methods of management.

The baseline survey information will be used to identify site specific issues; formulate scope of works and indicator performance criteria; prepare a series of site specific management actions; and prepare a set of implementation timeframes and key milestones for the offset properties. These will be guided by best practice guidelines and will be consistent with the desired outcomes of the draft National Recovery Plan for Box Gum Woodland and Derived Native Grassland (DECCW (NSW) 2010), and incorporated as appropriate into the BMP.

The BMP will include, where appropriate, specifications for the following:

- Detailed design of mitigation measures such as fencing, rehabilitation and soil conservation;
- Pre-clearing surveys and fauna rescue or translocation where practical;
- Vegetation clearing protocols;
- Rehabilitation and restitution of adjoining habitat where possible;
- Control and ongoing management of environmental and noxious weeds;
- Control and ongoing management of feral animals;
- Rehabilitation methods and protocols; and
- Details of the ecological monitoring program.

The BMP will include clear objectives, key performance objectives and management actions of biodiversity values to be protected and of the proposed mitigation measures including, where appropriate:

- Minimising human disturbance to native flora and fauna;
- Limiting clearance or disturbance of native vegetation;
- Minimising impacts to, and where possible protecting, threatened species and communities;
- Minimising impacts to aquatic habitats and species; and

- Ongoing monitoring of impacts on flora and fauna and implementation of adaptive management plans.

The BMP will also contain further information on the staged rehabilitation of the Disturbance Area and will specify how the Project Boundary will be closed to mining and returned to other land uses. This will include post-mining land use, conceptual final landform design, and rehabilitation methodology.

9.5 Assessment of the Effectiveness of Mitigation Measures

The proposed mitigation measures are expected to be highly effective in minimising the loss of vegetation and habitat, and will ensure that the surrounding vegetation will not be unnecessarily impacted by clearing for the Project. This includes MNES such as Box Gum Woodland and Derived Native Grassland, Inland Grey Box Woodland and Weeping Myall Woodland. It will ensure that incremental loss of habitat and ecological communities will not occur by degrading activities being undertaken outside of approved disturbance areas. This will benefit all the threatened species that have potential habitat in the Project Boundary by minimising the area of habitat that will be lost.

The pre-clearing protocols will ensure that animals occupying areas to be cleared will be safely relocated, thereby ensuring persistence of these populations. These pre-clearance surveys are likely to be effective in relocating the flying threatened species with potential to occur, such as the birds; Parrot (*Lathamus discolor*), Superb Parrot (*Polytelis swainsonii*) and Regent Honeyeater (*Anthochaera phrygia*), as well as the Grey-headed Flying Fox (*Pteropus poliocephalis*). If these species are present during the pre-clearing surveys, they are likely to fly to safety, and there are large areas of similar habitat in the locality that will provide shelter habitat for such species. Other threatened terrestrial mammals such as the Spotted-tailed Quoll (*Dasyurus maculatus*) are also likely to be able to relocate successfully on their own, and if present, these will be moved on during the pre-clearance surveys. This will avoid mortality of these individuals, and as large areas of similar habitat occurs in the locality, the individuals that may be present in the study area are expected to find other suitable habitat and to persist. The checking of hollow bearing trees prior to felling is relevant to the threatened hollow-dependent species listed under the EPBC Act that have potential to occur in the Project Boundary; the South-eastern Long-eared Bat (*Nyctophilus corbeni*) and the Superb Parrot (*Polytelis swainsonii*). If any individuals are found in hollow trees, they will be moved to nearby areas of suitable habitat where they are expected to persist.

The pre-clearance protocols are therefore considered to be a highly effective mitigation measure to reduce impacts on these threatened species that have potential to occur in the study area. Threatened reptiles such as the Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*); Pink-tailed Legless Lizard (*Aprasia parapulchella*) and Five-clawed Worm-skink (*Anomalopus mackayi*) are not likely to be detected during pre-clearance surveys, and other mitigation/compensation measures will address potential impacts to these species.

The salvage and transfer of habitat resources such as boulders and logs, and hollow bearing trees, as well as the installation of nest boxes if required, will ensure that some of the key

habitat features in the Project boundary will be retained. Hollows are very important for Australian native fauna and are often a limiting resource. Their translocation will ensure these resources persist in the Project Boundary and continue to provide habitat for native fauna species. This mitigation measure is relevant to the threatened hollow-dependent species listed under the EPBC Act that have potential to occur in the Project Boundary; the South-eastern Long-eared Bat (*Nyctophilus corbeni*) and the Superb Parrot (*Polytelis swainsonii*). The Spotted-tailed Quoll (*Dasyurus maculatus*) is also likely to benefit from hollow logs that are placed on the ground.

The monitoring program is expected to benefit all the MNES that have potential to be impacted by the Project. As monitoring will provide feedback on the success of the mitigation measures, in particular the revegetation and rehabilitation of habitats, it will ensure that high quality habitat will be provided. It will identify areas that need improvement and will help ensure that the desired outcomes of the rehabilitation and revegetation are achieved. This will directly benefit the ecological communities that are being rehabilitated such as Box Gum Woodland and Derived Native Grassland, as well as the flora and fauna species that depend on these habitats. This includes all the MNES that have been recorded from the Project Boundary or which have potential to occur. Monitoring is therefore considered to be a highly effective strategy to mitigate the potential impacts of the Project.

Chapter 10

Biodiversity Offsetting

10.1 Introduction

For the purposes of preparing this EIS, Shenhua Watermark has devised a Biodiversity Offset Package (BOP) that includes “direct” and “indirect” biodiversity offsets. Direct offsets are aimed at on ground maintenance and improvement of habitat or landscape values, while indirect offsets include a range of other actions that improve knowledge, understanding and management leading to improved conservation outcomes, such as provision of funds for applied research (DEWR 2007).

The concept of biodiversity offsetting has been evolving in NSW and throughout Australia. However, currently it is in a state of flux. As expectations for the quantum of offsets for major projects have been increased by OEH, SEWPaC and green groups, farming lobby groups have expressed concern that increased areas of offsets are being sourced largely from farmlands with the result that broad areas of agricultural land have been permanently redesignated as biodiversity offsets in recent times. In response to this the NSW Government released Strategic Land Use Regional Plans (SLURPs) intended to protect the most valuable farmland from mining and/or acquisition for offsetting. The tension between farming and biodiversity needs creates a dilemma for agencies responsible for approving offset packages for major projects such as the Watermark Project. There is a balance to be struck between protecting valuable farmland and providing appropriate biodiversity offsets (particularly threatened species such as the Koala). Shenhua Watermark has taken account of these issues to develop an offsets package that attempts to appropriately balance these issues.

The Project is located on the Liverpool Plains, a fertile farming area that still retains both EEC remnants and substantial Koala habitat. The tension between protecting farmland and offsetting needs is therefore intense. For this reason, Shenhua Watermark has devised a strategy for the finalisation of the BOP that will require ongoing negotiation with Government agencies via an independent committee that Shenhua Watermark proposes be established. It is proposed that the committee include representatives of OEH, SEWPaC, Gunnedah Council, Namoi CMA and conservation groups. The role of the committee would be to develop an overarching strategy for the management of biodiversity in the locality of the Liverpool Plains, referred to here as the “Regional Biodiversity Strategy Committee for the Shenhua Watermark Complex”. The strategy will include provisions to improve biodiversity values in the region, such as reinstatement and/or improvement of existing wildlife corridors

and conservation and management of EECs and threatened species habitat. The final BOP would be consistent with the Regional Biodiversity Strategy.

This chapter explains the overall rationale for offsetting of the biodiversity residual impacts via the Biodiversity Strategy. It then presents what is currently contained within the BOP to offset the predicted residual impacts of the Project on flora and fauna, once the avoidance and mitigation measures outlined in **Chapter 9** have been implemented.

Shenhua Watermark will fund the final BOP as determined by the Regional Biodiversity Strategy Committee and relevant government agencies.

10.2 The Shenhua Watermark Biodiversity Offset Strategy

Shenhua Watermark is committed to developing the BOP that maintains and improves biodiversity within the Namoi CMA. The current version of the Offset Strategy entails acquisition of offset properties for permanent conservation of flora and fauna, including species predicted to be impacted by the Project, and by provision of indirect offsets. The Offset Strategy targets Box Gum Woodland and Derived Native Grassland and other habitats for all threatened fauna known to occur within the Project Boundary. The current composition of the BOP includes:

1. **Onsite Offset Areas**, comprising:
 - a. Conservation and ongoing management of existing vegetated land within the Mt Watermark Offset Area and Offset Area 6 ;
 - b. Restoration of vegetation communities and associated habitat within the aforementioned offset areas and the Mooki River Offset Area; and
 - c. Rehabilitation of mined areas.
2. **Offsite Offset Areas**, comprising:
 - a. Conservation of existing vegetated areas; and
 - b. Restoration of vegetation communities and associated habitat.
3. **Indirect Offsets**, such as funding for Landcare, targeted research or recovery planning.

Based on preliminary mapping, the Onsite and Offsite Offset Areas are likely to contribute 13,015 ha of native woodland and grassland communities. These offset properties contain 1,332 ha of remnant Box Gum Woodland and Derived Native Grassland, and a further 5,034 ha is proposed for revegetation and rehabilitation. The Onsite Offset Areas will also provide extensive areas of habitat for the Koala.

The offset properties also include various forms of woodland, which constitute habitat for threatened birds and microbats. Importantly, these properties would provide upfront

mitigation of the Project's impacts on biodiversity. The inclusion of these lands as potential biodiversity offsets would provide additional conservation areas.

In its current form, the BOP is substantial and will have a significant net benefit to flora and fauna. When a 50% discount is applied to the mine rehabilitation areas, the BOP provides an offset ratio of 7.3:1 for Box Gum Woodland and Derived Native Grassland, 45.6:1 for other EECs and 29.8:1 for other woodland vegetation. The available data indicates that in the medium to long term the mining activities will result in a net increase in woodland in and around the Project Boundary, and in the wider region.

The major clearing of land for the Project will occur within the proposed East Pit, which will take place in the first ten years of the project. The current BOP has acquired enough "like for like" native vegetation to offset the clearing of the East Pit (i.e. the first 10 years worth of clearing) at a ratio of 5:1. It also provides for an opportunity to implement widespread local revegetation within onsite offsets prior to clearance of other mining areas, and allows time to monitor, verify and where necessary improve revegetation work. If revegetation and rehabilitation are unsuccessful, the proponent may deploy alternate methods or, in extreme circumstances consider the purchase of additional offset lands.

The Offset Strategy places a high degree of reliance on revegetation and rehabilitation within onsite and adjacent areas for following reasons.

- High quality Koala habitat is restricted largely to the Liverpool plains and surrounds;
- The proponent is working to utilise land already owned by a foreign entity for the purposes of offsetting; and
- Offsetting policy of both the OEH and SEWPaC generally encourages offsets to be as near as possible to the impacts from the proposed development.

During years 1 to 10 the following will occur in respect of rehabilitation and revegetation:

- Rehabilitation/revegetation trials will be conducted to verify and where necessarily improve techniques specific to the Liverpool Plains; and
- Development and implementation of a revegetation rehabilitation schedule to ensure target offset ratios are met.

The progress of offsets would also be subject to annual monitoring where achievement of measureable key performance targets would be determined. These would include but not be limited to:

- Monitoring surveys to verify that the relevant threatened species are using offsets and increasing in their use of offsets.

- Monitoring surveys to verify that EECs and other vegetation communities are being maintained and improved by reference to quantitative, standard biometric benchmark data;
- Monitoring of weeds to verify that significant weeds are declining or being maintained at sustainable levels; and
- Monitoring of feral animals to verify that significant feral pests (eg foxes, pigs and goats) are declining or being maintained at sustainable low levels.

The success of the BOP would be determined independently as follows:

- 1. Independent audit by appropriately qualified person at years 3, 7 and 10 appointed Director General in consultation with OEH/SEWPaC;
- 2. the audit would assess progress against key performance criteria to be assessed at years 3, 7 and 10.

There is currently ongoing work relating to the BOP that includes investigation of other potential land-based offsets to add to the offset package, and negotiation for the funding of research programs relating maintaining and improving the Koala population in the Gunnedah LGA.

This remainder of this chapter explains the methods utilised in the development of the BOP, describes the offset properties and their proposed management, and describes the proposed indirect offsetting measures. It then assesses the adequacy of the current version of the BOP to compensate for impacts to threatened flora and fauna.

10.3 Biodiversity Offsets Package

10.3.1 Introduction

The avoidance and mitigation measures described in the **Chapter 9** would be insufficient on their own to ameliorate all anticipated ecological impacts of the Project. For this reason offsetting is proposed to compensate for what would otherwise result in a net loss of biodiversity.

Direct offsets are aimed at on ground maintenance and improvement of habitat or landscape values and indirect offsets are the range of other actions that improve knowledge, understanding and management leading to improved conservation outcomes (DEWR 2007).

Based upon recent precedents for mining projects in NSW, there are a number of acceptable approaches to evaluate the type and quantum of offsets required for major projects:

- Ratios: Calculation of the ratios of areas of vegetation within proposed offsets and expressing such areas as a ratio for the areas of vegetation proposed to be cleared. The intention is to demonstrate that offsets are several times the size of the proposed impact area so as to provide for a net gain in biodiversity; and

- Offset Principles: SEWPaC has recently released the EPBC Act Environmental Offsets Policy (SEWPaC 2012c) that sets out principles that offsets should follow. Proposed offset packages should be designed according to such principles and then formally evaluated against the principles to demonstrate adequacy.

These approaches are explained in more detail below.

i. Vegetation Removal and Offset Ratios

Offsets for major projects have been conventionally developed based upon a ratio method whereby for every hectare of habitat cleared, a multiple of habitat is provided as an offset. Offsets ratios also typically factor in future habitat improvement and so offsets consist of a mixture of existing habitat in good condition, and habitat in low to moderate condition that can be regenerated. This means that in future, if the offsets are acquired and fully regenerated, there will be a net increase in the total amounts of vegetation/habitat. Such increases are important because endangered ecological communities and threatened species are generally listed as such because their habitats have been over cleared in the past. Offset packages need to be designed to redress this.

The Disturbance Area contains approximately 937 ha of native woodland and derived grassland, including several communities listed as threatened under the EPBC Act. This includes approximately 738 ha of Box Gum Woodland and Derived Native Grassland, 30 ha of Inland Grey Box Woodland and 3 ha of Weeping Myall Woodland. Highly modified vegetation (Low Diversity Grassland, Planted & Exotic Pasture) and cleared areas (roads, dams, buildings, etc.) totalling 3,147 ha will not require offsetting.

For the purpose of establishing minimum area thresholds for the BOP, a ratio of 5:1 for Commonwealth C/EECs and native vegetation has been adopted. This means that for every hectare of these vegetation types that is cleared, five hectares will be provided in offset areas. The minimum offset area required to compensate for the Project impacts is 4,685 ha. This includes 3,690 ha of Box Gum Woodland and Derived Native Grassland CEEC. A summary of the minimum offsetting requirements for the Project is provided in **Table 10.1**.

Table 10.1 Total Offset Areas Required for the Project			
Vegetation Community	Disturbance Area (ha)	Ratio	Offset Required (ha)
Box Gum Woodland (CEEC)	665		
Derived Native Grassland (CEEC)	73		
Subtotal Box Gum Woodland and Derived Native Grassland CEEC	738	5:1	3,690
Inland Grey Box Grassy Woodland (EEC)	30		
Weeping Myall Woodland (EEC)	3		

Table 10.1 Total Offset Areas Required for the Project			
Vegetation Community	Disturbance Area (ha)	Ratio	Offset Required (ha)
Brigalow (EEC)	0		
Semi-evergreen Vine Thicket (EEC)	0		
Subtotal Other EEC	33	5:1	165
Fuzzy Box Woodland	18		
Poplar Box Woodland	45		
Belah Woodland	1		
Whitewood Woodland	13		
Tumbledown Red Gum Grassy Open Woodland	16		
White Box Shrubby Woodland	24		
Regenerating White Box Shrubby Woodland	43		
Blakely's Red Gum Shrubby Woodland	6		
Subtotal Other Woodland	166	5:1	830
Low Diversity Grassland, Planted & Exotic Pasture	3,084		
Cleared Areas (roads, dams, buildings, etc.)	63		
Subtotal Other	3,147	n/a	n/a
TOTAL	4,084		4,685

ii. *Consistency with SEWPaC Principles of Offsets*

SEWPaC has recently released the EPBC Act Environmental Offsets Policy (SEWPaC 2012c) which contains the offsetting principles that determine the suitability of offsets. These have been considered in the development of the BOP and are reproduced below:

Suitable offsets must:

- 1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action*
- 2. be built around direct offsets but may include other compensatory measures*
- 3. be in proportion to the level of statutory protection that applies to the protected matter*
- 4. be of a size and scale proportionate to the residual impacts on the protected matter*
- 5. effectively account for and manage the risks of the offset not succeeding*
- 6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)*
- 7. be efficient, effective, timely, transparent, scientifically robust and reasonable*
- 8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.*

In assessing the suitability of an offset, government decision-making will be:

- 9. informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty*
- 10. conducted in a consistent and transparent manner.*

Consistency with these principles will ensure that the residual impacts of the Project are addressed in a strategic and meaningful way that will deliver a real biodiversity outcome. An assessment of how the BOP for the Project is consistent with these principles is provided in **Section 10.8.3.**

10.3.2 Components of the BOP

Shenhua Watermark is committed to developing the BOP that maintains and improves biodiversity within the Namoi CMA. The current version of the Offset Strategy entails acquisition of offset properties for permanent conservation of flora and fauna, including species predicted to be impacted by the Project, and by provision of indirect offsets. The Offset Strategy targets Box Gum Woodland and Derived Native Grassland and other habitats for all threatened fauna known to occur within the Project Boundary.

The current composition of the BOP includes:

1. **Onsite Offset Areas**, comprising:
 - a. Conservation and ongoing management of existing vegetated land within the Mt Watermark Offset Area and Offset Area 6;
 - b. Restoration of vegetation communities and associated habitat within the aforementioned offset areas and the Mooki River Offset Area; and
 - c. Rehabilitation of mined areas.
2. **Offsite Offset Areas**, comprising:
 - a. Conservation of existing vegetated areas; and
 - b. Restoration of vegetation communities and associated habitat.
3. **Indirect Offsets**, such as funding for Landcare, targeted research or recovery planning.

Further details of each component of the BOP are provided in **Section 10.3, 10.4 and 10.7**, respectively.

The Onsite Offset Areas have been developed to maximise the opportunities for conservation *in situ* and will address a significant proportion of the Project's offsetting requirements. The Offsite Offset Areas have been developed to compliment the Onsite Offset Areas through the provision of additional areas of intact vegetation and areas available for restoration. The locations of the Onsite and Offsite Offset Areas are shown in **Figure 10.1**.



10.4 Onsite Offset Areas

10.4.1 Location

The Onsite Offset Areas are located both within and immediately adjacent to the Project Boundary (see **Figure 10.1**). The following parcels of land form the Onsite Offset Areas:

- Mt Watermark Offset Area;
- Offset Area 6;
- Mooki River Offset Area; and
- Mine Rehabilitation Area.

The properties that comprise the Onsite Offset Areas are either owned by Shenhua Watermark or currently subject to discussions to negotiate access and/or purchase.

10.4.2 Vegetation

The vegetation within the Onsite Offset Areas has been subject to numerous site inspections and mapping. **Table 10.2** lists the vegetation communities currently occurring within the Onsite Offset Areas (excluding the Mine Rehabilitation Area), their EPBC Act status and their total area. The majority of the vegetation communities occurring within the Onsite Offset Areas are identical to those recorded within the Project Boundary. Descriptions of the communities occurring both within the Project Boundary and the Onsite Offset Areas are provided in **Section 4.1** and within the EIA. One community not recorded within the Project Boundary was recorded within Offset Area 6 (Dwyer's Red Gum Woodland) and is described below. The distribution of vegetation communities within the Onsite Offset Areas is shown in **Figure 10.2**.

Table 10.2 Vegetation Communities Occurring within the Onsite Offset Areas					
Vegetation Community	Mt Watermark Offset Area (ha)	Offset Area 6 (ha)	Mooki River Offset Area (ha)	Total Onsite Offset Areas (ha)	
Box Gum Woodland (CEEC)	165	591	0	757	
Subtotal Box Gum Woodland (CEEC)	165	591	0	757	
Inland Grey Box Grassy Woodland (EEC)	0	21	0	21	
Weeping Myall Woodland (EEC)	0	10	0	10	
Brigalow (EEC)	0	11	0	11	
Semi-evergreen Vine Thicket (EEC)	n/a*	0	0	n/a*	
Subtotal Other EEC	0	42	0	42	
Fuzzy Box Woodland	0	4	0	4	
Poplar Box Woodland	0	49	0	49	
Belah Woodland	0	37	0	37	
Whitewood Woodland	26	99	0	125	
Tumbledown Red Gum Grassy Open Woodland	0	0	0	0	
White Box Shrubby Woodland	26	915	0	941	
Blakely's Red Gum Motherumbah Shrubby Woodland	0	15	0	15	
Dwyer's Red Gum Woodland	0	13	0	13	

Table 10.2 Vegetation Communities Occurring within the Onsite Offset Areas					
Vegetation Community	Mt Watermark Offset Area (ha)	Offset Area 6 (ha)	Mooki River Offset Area (ha)	Total Onsite Offset Areas (ha)	
Subtotal Other Woodland	52	1,132	0	1,184	
Low Diversity Grassland, Planted & Exotic Pasture	78	5,648	44	5,770	
Cleared Areas (roads, dams, buildings, etc.)	0	44	0	44	
Subtotal Other	78	5,692	44	5,814	
TOTAL	296	7,457	44	7,797	

*Area of occurrence is <0.1ha and has therefore not been mapped

i. *Dwyer's Red Gum Woodland*

EPBC Act Status: Not listed

Dwyer's Red Gum Woodland was recorded on plateaus on Long Mountain above slopes supporting White Box Shrubby Woodland. This community is relatively low and open (6-8m) with *Eucalyptus dwyeri* dominating and *Acacia cheelii* often co-dominating (**Photograph 10.1**). The shrub stratum is generally sparse becoming shrubbier at the edges of the community. The groundcover is dominated by native grasses, including *Microlaena stipoides* var. *stipoides* and *Aristida ramosa*. Herbs occurring within the groundcover include *Sida trichopoda*, *Calotis hispidula* and *Pomax umbellata*.



Photograph 10.1 **Dwyer's Red Gum Woodland**

10.4.3 *Habitat for Threatened Species*

The majority of the habitats occurring within the Onsite Offset Areas are identical to those recorded within the Project Boundary and thus provide habitat for the threatened flora and fauna species listed under the EPBC Act that are known from, or potentially occurring within, the Disturbance Area. Descriptions of the habitats occurring both within the Project Boundary and the Onsite Offset Areas are provided in **Section 5.1**.

The habitats available within the Onsite Offset Areas provide potential habitat for a suite of species listed under the EPBC Act, and two threatened fauna species have been recorded during surveys; the Koala (*Phascolarctos cinereus*), and the South-eastern Long-eared Bat (*Nyctophilus corbeni*).

The locations of these species within the Onsite Offset Areas are provided in **Figure 10.3**. There is also the potential for other threatened fauna species known from the locality to occur within the properties, including threatened microbats and birds. The tree hollows and stags within the property provide potential shelter, roosting and nesting habitat for threatened microbats listed under the EPBC Act including the Large-eared Pied Bat (*Chalinolobus dwyeri*). Foraging and nesting resources are also available for a range of bird species listed under the EPBC Act such as the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*).

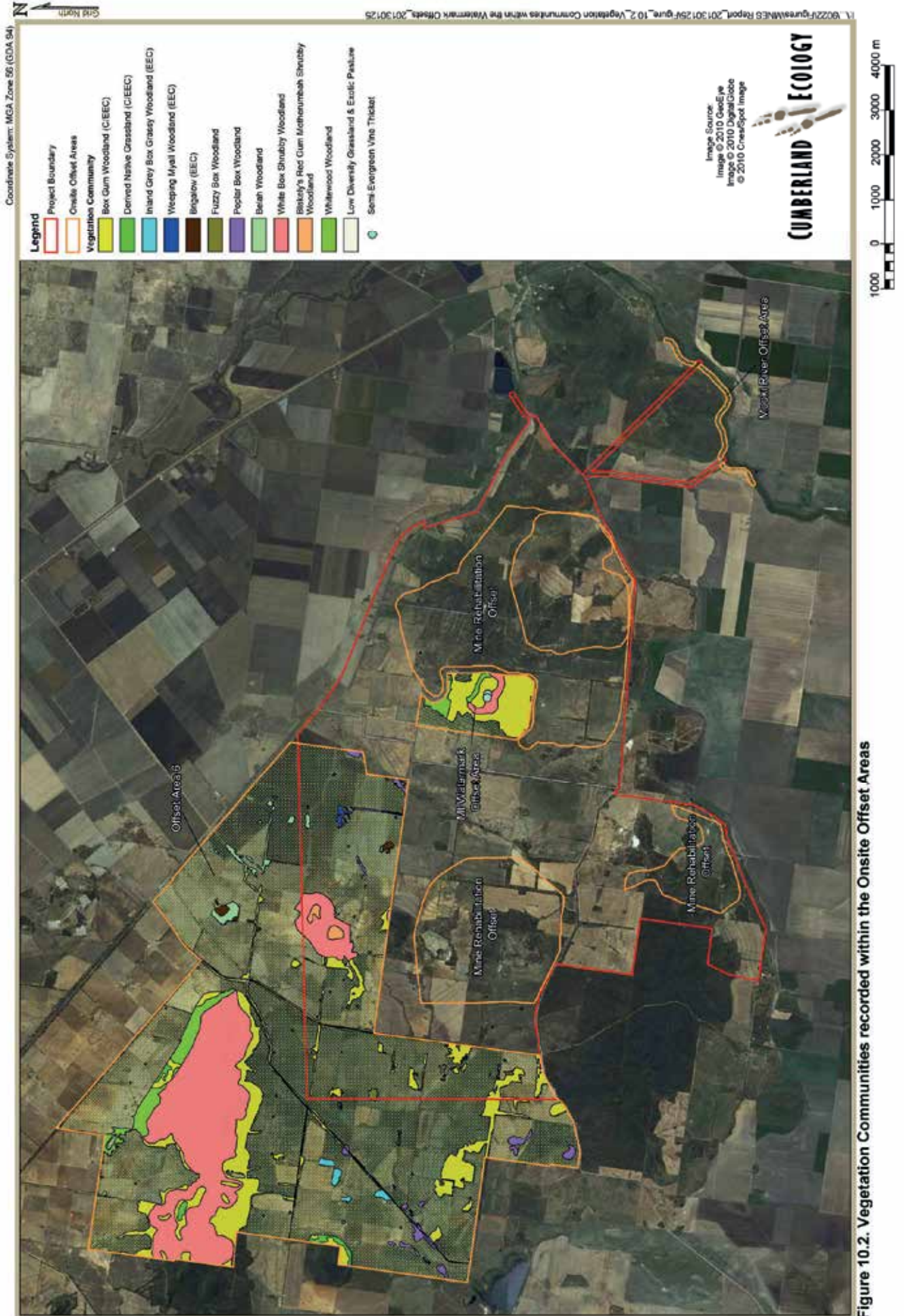
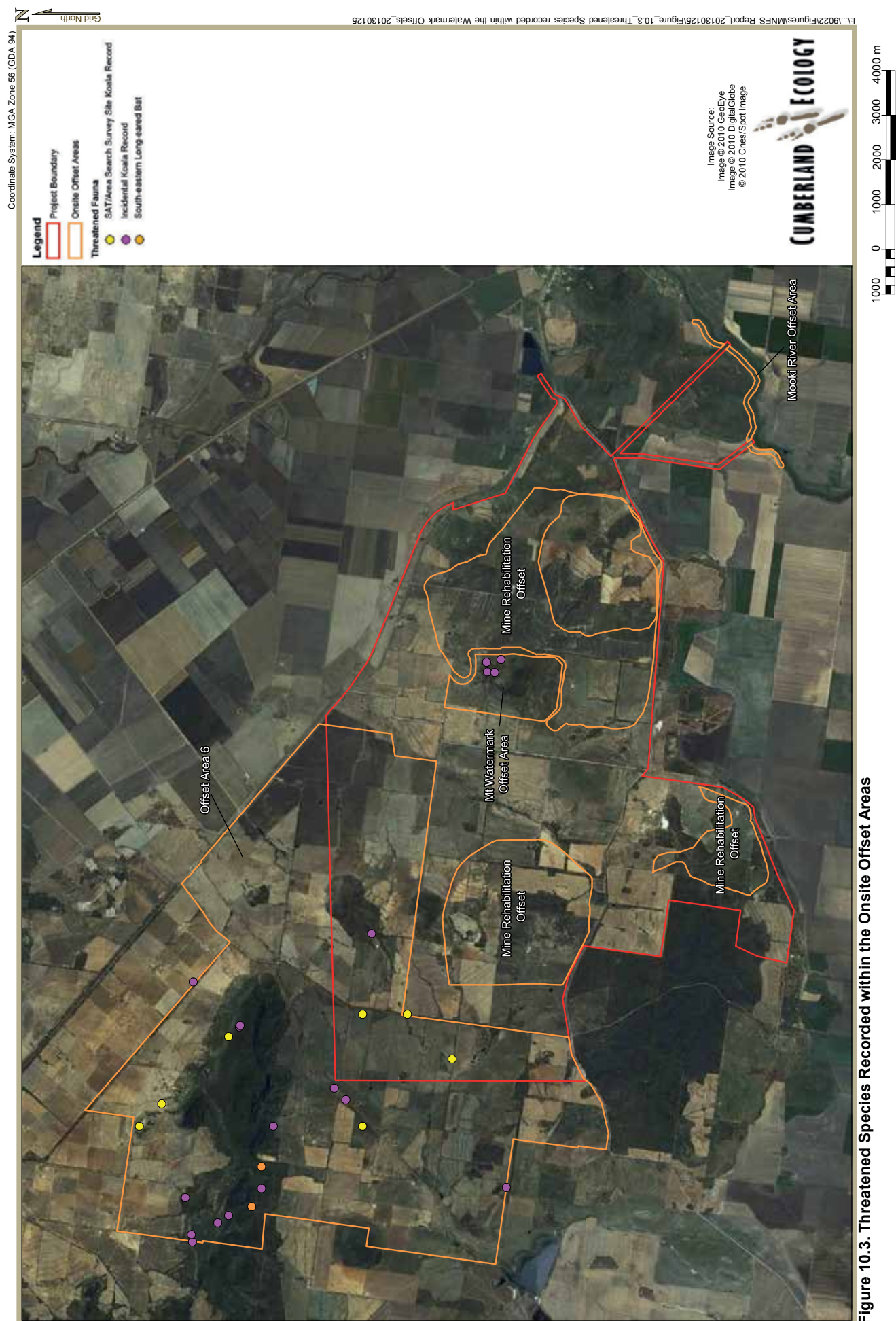


Figure 10.2. Vegetation Communities recorded within the Onsite Offset Areas



10.5 Offsite Offset Areas

10.5.1 Description

The Offsite Offset Areas are located approximately 30 km west of the township of Barraba and approximately 100 km north of the Project Boundary (see **Figure 10.1**). The two properties comprising the Offsite Offset Areas, namely Clonmeen Offset Area and Aandra Offset Area, are adjacent to one another and are nestled within the northern reaches of the Nandewar Ranges. Both properties connect to the proposed Northern Offset Area for the Maules Creek Coal Project and are indirectly connected to Mount Kaputar National Park and Horton Falls National Park. These properties have been acquired or are subject to an acquisition agreement.

10.5.2 Vegetation

The vegetation within the Offsite Offset Areas has been subject to site inspections and preliminary mapping. Further baseline surveys will be required to refine the vegetation maps. Nevertheless, the current vegetation mapping provides a broad indication of the types and proportions of various community types across the properties.

Table 10.3 lists the vegetation communities currently occurring within the Offsite Offset Areas, their EPBC Act status and their total area. Descriptions of these vegetation communities are provided below and their distribution within the Offsite Offset Areas is shown in **Figure 10.4**.

Table 10.3 Vegetation Communities Occurring within the Offsite Offset Area			
Vegetation Community	Clonmeen Offset Area (ha)	Aandra Offset Area (ha)	Total Offsite Offset Areas (ha)
Box Gum Woodland	130	144	274
Derived Native Grassland	0	301	301
Subtotal Box Gum Woodland (CEEC)	130	445	575
Red Stringybark/Blakely's Red Gum Woodland	244	0	244
Red Stringybark/Rough-barked Apple Woodland	389	828	1,217
New England Blackbutt Woodland	148	33	181
Orange Gum Woodland	2	320	322
Manna Gum Riparian Woodland	0	29	29
River Oak Riparian Woodland	39	13	52
Subtotal Other Woodland	822	1,223	2,045

Table 10.3 Vegetation Communities Occurring within the Offsite Offset Area			
Vegetation Community	Clonmeen Offset Area (ha)	Aandra Offset Area (ha)	Total Offsite Offset Areas (ha)
Low Diversity Grassland, Planted & Exotic Pasture	181	77	258
Subtotal Other	181	77	258
TOTAL	1,133	1,745	2,878

i. White Box, Yellow Box, Blakely's Red Gum Grassy Woodland

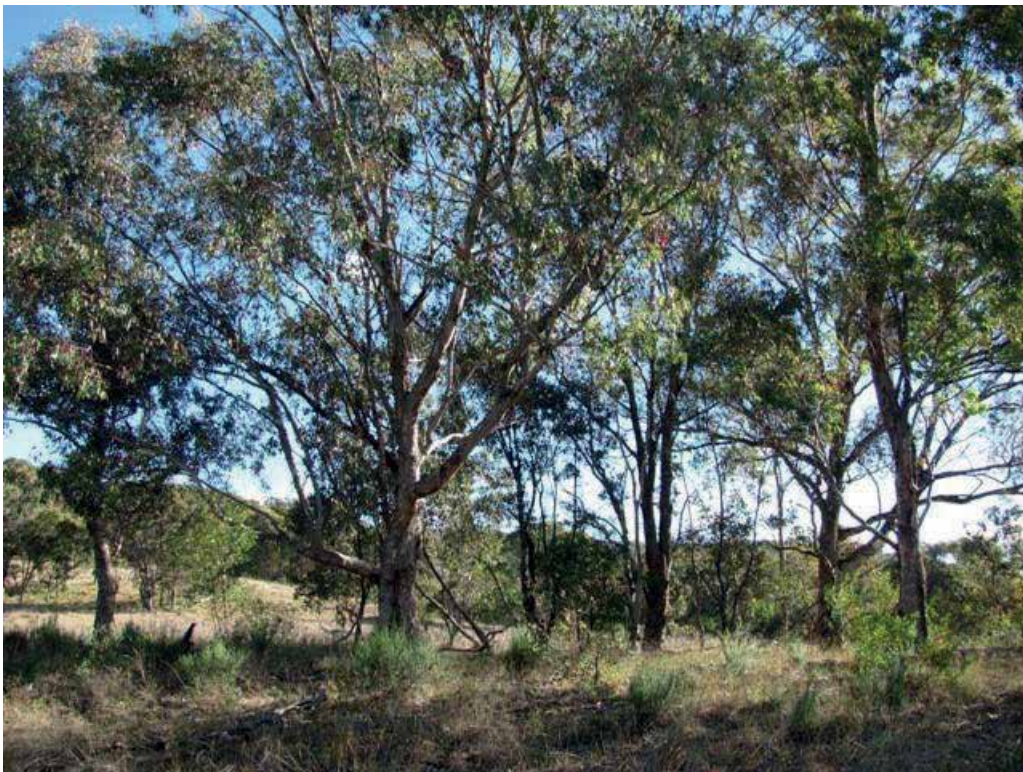
EPBC Act Status: White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

Although some areas of this community remain intact, historic land use has resulted in the clearing of large areas of this community within the Offsite Offset Areas, which is reflected by occurrences restricted to small pockets at the edge of derived native grassland. This community is dominated or co-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). The shrub layer is sparse and species include *Cassinia quinquefaria*, *Notelaea microcarpa* var. *microcarpa*, *Swainsona* sp. and *Olearia viscidula*. Grasses dominate the groundcover and include *Microleana stipoides*, *Aristida vagans*, *Sporobolus creber* *Bothriochloa* sp., *Cymbopogon refractus* and *Chloris ventricosa*. Herb species occurring within this community include *Sigesbeckia australiensis*, *Geranium solanderi*, *Dichondra* sp. A, *Asperula conferta*, *Rumex brownii*, *Cymbonotus lawsonianus*, *Cheilanthes sieberi*, *Glycine tabacina* and *Cyperus gracilis*. The proximity of this community to cleared areas utilised for grazing purposes has resulted in the presence of some exotic species. The main structural features of this community are shown in **Photograph 10.2** and **Photograph 10.3**.

Although the most patches of this community are modified, they still conform to the definition of Box Gum Woodland and Derived Native Grassland CEEC as defined under the EPBC Act.



Photograph 10.2 **White Box, Yellow Box, Blakely's Red Gum Grassy Woodland (Clonmeen Offset Area)**



Photograph 10.3 **White Box, Yellow Box, Blakely's Red Gum Grassy Woodland (Aandra Offset Area)**

ii. *Red Stringybark/Blakely's Red Gum Woodland*

EPBC Act Status: Not listed

This community is dominated by *Eucalyptus macrorhyncha* (Red Stringybark). Other tree species occurring include *E. blakelyi* (Blakely's Red Gum) and *Eucalyptus albens* (White Box). Shrubs are common and include *Olearia elliptica* subsp. *elliptica*, *Cassinia quinquefaria*, *Lissanthe strigosa* and *Dodonaea viscosa* subsp. *mucronata*. Common species in ground layer include *Goodenia hederacea* subsp. *hederacea*, *Hypericum gramineum*, *Cheilanthes sieberi*, *Galium gaudichaudii*, *Lomandra multiflora* subsp. *multiflora*, *Eragrostis leptostachya*, *Aristida ramosa* and *Aristida vagans*. The main structural features of this community are shown in **Photograph 10.4**.



Photograph 10.4 **Red Stringybark/Blakely's Red Gum Woodland**

iii. *Red Stringybark/Rough-barked Apple Woodland*

EPBC Act Status: Not listed

This community is dominated by *Eucalyptus macrorhyncha* (Red Stringybark) and *Angophora floribunda* (Rough-barked Apple) with *Eucalyptus bridgesiana* (Apple Box) occurring less frequently. Shrub cover is variable and species include *Cassinia quinquefaria*, *Pimelea linifolia* subsp. *linifolia*, *Swainsona* sp. and *Melichrus urceolatus*. Common species in ground layer include *Cymbopogon refractus*, *Microlaena stipoides*, *Aristida vagans*, *Cheilanthes sieberi*, *Galium leptogonium*, *Geranium solanderi*, *Poranthera microphylla*, *Glycine microphylla* and *Desmodium varians*. The main structural features of this community are shown in **Photograph 10.5**.



Photograph 10.5 **Red Stringybark/Rough-barked Apple Woodland**

iv. *New England Blackbutt Woodland*

EPBC Act Status: Not listed

This community is dominated by *Eucalyptus andrewsii* (New England Blackbutt). Other tree species occurring include *Eucalyptus macrorhyncha* (Red Stringybark) and *Angophora floribunda* (Rough-barked Apple). Shrub cover is generally sparse and species within this community include *Bossiaea obcordata*, *Olearia microphylla*, *Melichrus urceolatus* and *Olearia viscidula*. The ground layer is dominated by *Anisopogon* sp., *Dianella revoluta*, *Lepidosperma laterale* and *Aristida vagans*, with *Pteridium esculentum* and *Lomandra longifolia* dominating in more sheltered locations. Other species in the ground layer include *Operularia diphylla*, *Desmodium varians* and *Hardenbergia violacea*. The main structural features of this community are shown in **Photograph 10.6**.



Photograph 10.6 **New England Blackbutt Woodland**

v. *Orange Gum Woodland***EPBC Act Status:** Not listed

Common canopy species within this community include *Eucalyptus prava* (Orange Gum), *Eucalyptus caleyi* subsp. *caleyi* and *Eucalyptus macrorhyncha* (Red Stringybark). *Callitris endlicheri* occurs in the small tree layer predominately on steep north-facing slopes. Shrub cover variable and species include *Cassinia quinquefaria*, *Olearia viscidula*, *Dodonaea viscosa*, *Pultenaea microphylla* and *Melichrus urceolatus*. The groundlayer within this community is diverse and includes *Microlaena stipoides*, *Aristida vagans*, *Cymbopogon refractus*, *Hovea linearis*, *Veronica plebeia*, *Geranium solanderi*, *Hypericum gramineum*, *Cheilanthes sieberi* and *Lomandra multiflora* subsp. *multiflora*. The main structural features of this community are shown in **Photograph 10.7**.

**Photograph 10.7** **Orange Gum Woodland**

vi. *Manna Gum Riparian Woodland*

EPBC Act Status: Not listed

This community has some affinities within the adjacent Red Stringybark/Rough-barked Apple Woodland, however it is dominated by *Eucalyptus viminalis* (Manna Gum) and *Angophora floribunda* (Rough-barked Apple). The shrub layer is predominately comprised of *Leptospermum* sp. Grasses and sedges dominate the groundcover and include *Lomandra longifolia* and *Imperata cylindrica*. The main structural features of this community are shown in **Photograph 10.8**.



Photograph 10.8 **Manna Gum Riparian Woodland**

vii. *River Oak Riparian Woodland*

EPBC Act Status: Not listed

This community occurs along Second Water Creek within the Clonmeen Offset Area. It is characterised by the presence of *Casuarina cunninghamiana* with *Angophora floribunda* also commonly occurring. A shrub layer is generally absent. The groundcover is dominated by *Lomandra longifolia* and *Microleana stipoides*. Rocky outcropping is common at the fringes of this community. The main structural features of this community are shown in **Photograph 10.9**.



Photograph 10.9 **River Oak Riparian Woodland**

viii. *Derived Native Grassland*

EPBC Act: White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CEEC)

Native grassland within the Offsite Offset Areas that were derived from the clearing of woodlands dominated by White Box, Yellow Box, or Blakely's Red Gum trees is referred to as Derived Native Grassland. The main structural features of this community are shown in **Photograph 10.10**. Dominant grass species include *Sporobolus creber*, *Eragrostis leptostachya*, *Echinopogon sp.* and *Panicum effusum*. Commonly occurring herb species include *Asperula conferta*, *Geranium solanderi*, *Hypericum gramineum*, *Rumex brownii* and *Pimelea curviflora var. divergens*.

These grasslands conform to the description of the EPBC Act listed CEEC, Box Gum Woodland and Derived Native Grassland. In order to be identified as Derived Native Grassland and conform to the CEEC, at least 12 native non grassy understorey species (such as forbs, ferns shrubs and sedges) must be present within a 0.1 ha plot with at least one being a recognised "important" species (as identified by the species list for the EPBC Act policy statement - White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland (DEH 2006).



Photograph 10.10 **Derived Native Grassland**

ix. *Low Diversity Grassland*

EPBC Act Status: Not listed

The grassland within the Clonmeen Offset Area and a small portion of the grassland within the Aandra Offset Area has been modified by past clearing and grazing practices. These areas are dominated by native grasses such as *Sporobolus creber*, *Eragrostis leptostachya* and *Aristida ramosa*. However there is a low diversity of native herb species and variable levels of exotic species. Remnant trees are sparsely scattered through this community and include *Eucalyptus albens* and *Eucalyptus melliodora*. This grassland does not conform to the CEEC Box Gum Woodland and Derived Native Grassland listed under the EPBC Act. This is because the diversity of the groundcover herb assemblage is too low to meet the condition criteria under the published definitions of the listed communities. The main structural features of this community are shown in **Photograph 10.11**.



Photograph 10.11 **Low Diversity Grassland**

10.5.3 *Habitat for Threatened Species*

There are extensive areas of well connected woodland and forest that provides good quality habitat for a wide variety of threatened species, include those that are predicted to be impacted by the Project. Structural diversity varies across the properties with both grassy and shrubby understoreys present. The canopy species present within the property include both smooth and rough-barked species. The habitat features available are numerous and provide potential foraging, shelter and breeding opportunities for a variety of threatened fauna species. These habitats occur at a range of altitudes including along ridgelines, steep and gently sloping topography and along creeklines.

Key habitat features recorded within the properties include fallen timber, permanent and ephemeral drainage lines (including Second Water Creek and Noogera Creek), hollow-bearing trees (including hollows of various sizes), stags, extensive rocky outcrops, nectar-producing trees, mistletoes and primary (*Eucalyptus viminalis*) and secondary (*E. melliodora*, *E. albens*, *E. blakelyi*, *E. prava* and *E. bridgesiana*) Koala feed trees.

The habitats available within the properties provide potential habitat for a suite of species listed under the EPBC Act, and there is the potential for the threatened fauna species known from the locality to occur within the properties, including threatened microchiropteran bats, birds and mammals. The tree hollows and stags within the property provide potential shelter, roosting and nesting habitat for threatened microchiropteran bats including the Large-eared Pied Bat (*Chalinolobus dwyeri*) and the Greater Long-eared Bat (*Nyctophilus timoriensis*). Foraging and nesting resources are also available for threatened bird species such as the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*).

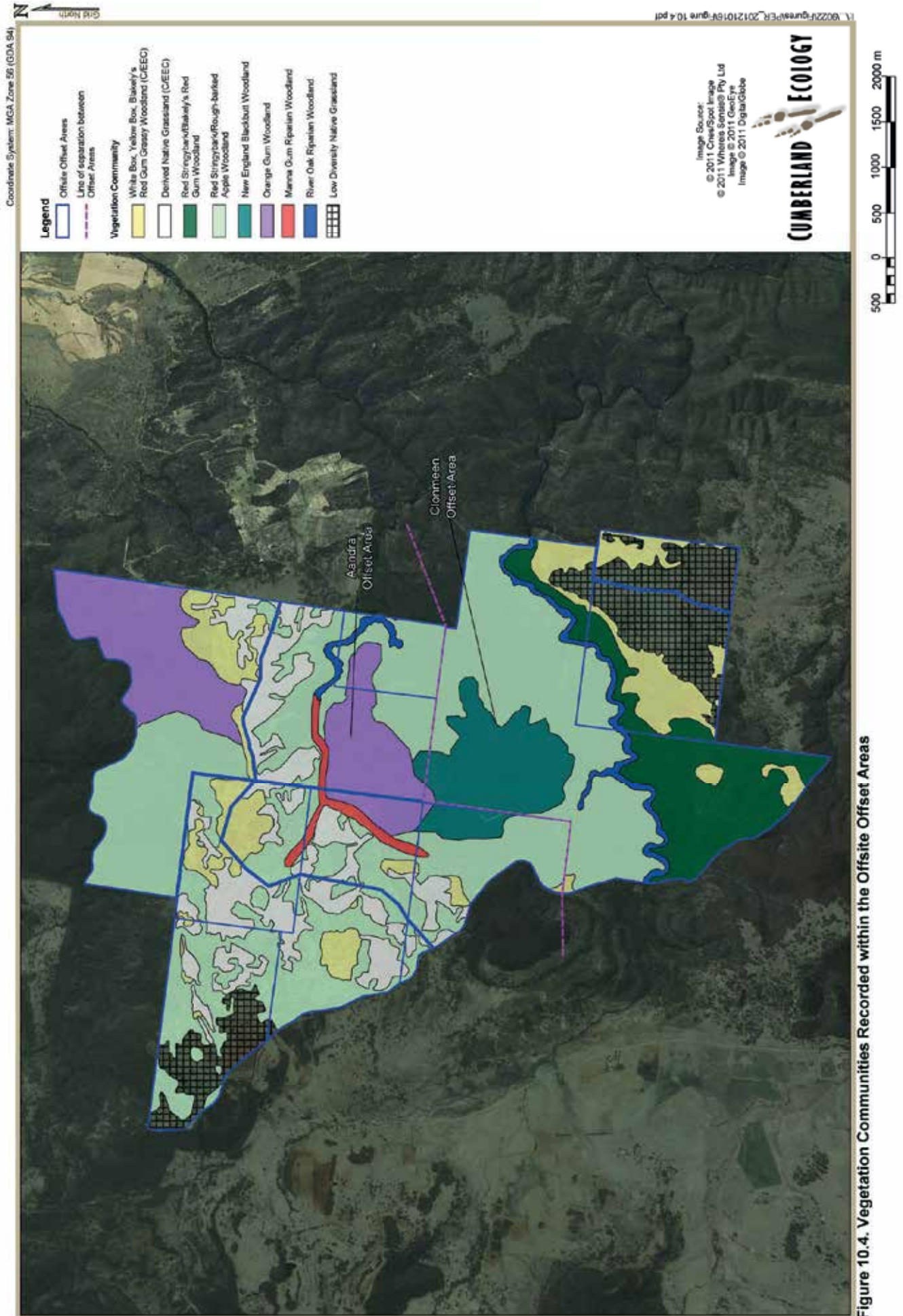


Figure 10.4. Vegetation Communities Recorded within the Offsite Offset Areas

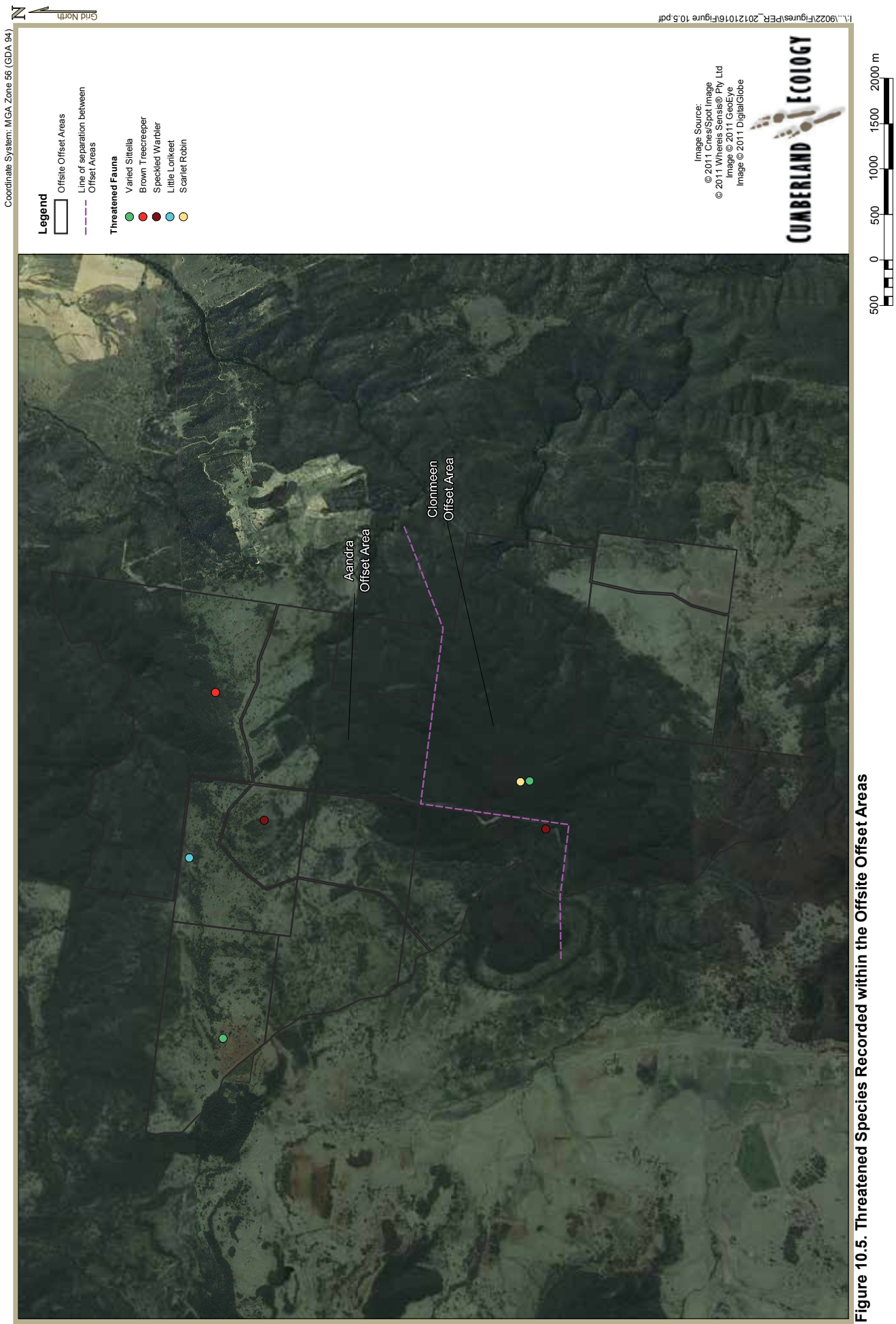


Figure 10.5. Threatened Species Recorded within the Offsite Offset Areas

10.6 Proposed Management of Offset Areas

The proposed management of the Onsite and Offsite Offset Areas includes the conservation and ongoing management of existing vegetation, revegetation and rehabilitation of mined areas. Details of the management procedures to be implemented within the Onsite and Offsite Offset Areas will be contained within the BMP (see **Section 9.4**).

10.6.1 Conservation and Ongoing Management of Existing Vegetation

Conservation and ongoing management of existing vegetation will occur within Mt Watermark Offset Area, Offset Area 6 and the Offsite Offset Areas in order to maintain -and improve their ecological value and facilitate regeneration of native vegetation and associated fauna habitat. This will include weed and feral animal management, phased reduction of livestock management, active replanting and reseeding of vegetation and monitoring.

The objectives for the management of existing vegetation within the offsets are:

- Maintenance and improvement of the condition of existing forest and woodland;
- Maintenance and improvement of habitat for threatened flora and fauna;
- Improvement of derived native grassland to promote, natural succession towards woodland and or open forest;
- Revegetation of areas of low diversity native grassland by replanting trees and shrubs to promote a more rapid regeneration towards forest or woodland (further detail provided in **Section 10.6.2**); and
- Improvement of habitat connectivity across offset lands, and from offset lands to adjacent native vegetation and mine rehabilitation in order to improve wildlife movement in the long term.

The offset properties contain extensive areas of existing woodland and open forest that will form nuclei for ongoing regeneration of trees and shrubs into grassland areas. Such habitats would provide immediate and ongoing habitats for native plants and animals. Existing forest and woodland areas are currently mature, functioning examples of natural ecosystems, but their condition is expected to improve with time as trees mature, tree hollows are generated and as regeneration of understorey takes place when livestock are progressively removed (McIntyre et al. 2002).

Derived Native Grassland within the offsets has significant floral diversity, including scattered trees and shrubs. It is intended that grazing management, combined with the management of weeds and feral animals would accelerate regeneration of Derived Native Grassland to forest and woodland areas. Such habitats are semi-natural and cannot currently be considered fully functional as they generally lack trees and shrubs. However, in the medium to long term, trees and shrubs are expected to regenerate into such areas if the condition of the land is improved through grazing and weed management (Lindenmayer et al. 2010). It is

expected that substantial regeneration will occur within the life of the Project and a mature, functional ecosystem will be established across much of these grassland areas within 50 years.

Full details of the proposed management activities to be conducted within the Onsite and Offsite Offset Areas will be provided as part of the BMP (see **Section 9.4**).

10.6.2 Revegetation

A number of the EECs relevant to the Project are listed because so much has been cleared in the past, largely as a result of agricultural practices. In order to recover such woodland, it is essential to recover land from old farmlands. As there are limited opportunities for conservation of large intact patches of these EECs, revegetation of these communities within modified landscapes is being undertaken.

Significant revegetation is proposed to occur within the Onsite and Offsite Offset Areas in order to establish extensive areas of woodland. The location of revegetation areas within the Onsite and Offsite Offset Areas are shown in **Figure 10.6** and **Figure 10.7**, respectively. The objectives for the revegetation of existing vegetation within the offsets are:

- Provide future habitat for the local population of the Koala;
- Restore extensive areas of CEEC vegetation, including Box Gum Woodland; and
- Restore extensive areas of habitat for the suite of threatened species impacted by the Project; and
- Establish linkages between patches of remnant vegetation.

The draft National Recovery Plan for Box Gum Woodland and Derived Native Grassland and other manuals on restoration of grassy woodlands (e.g. McIntyre *et al* 2002, Rawlings *et al* 2010) support the notion that woodland is quite feasible to recover or regenerate from derived native grassland, with correct management. Correct management can also be relatively simple and involve reductions or controls on grazing to promote recovery, fencing, weeding and monitoring. Some areas of grassland can be recovered to woodland in the long term without extensive replanting, such as within the Offsite Offset Areas.

In the past, revegetation has typically been conducted by using almost solely tree species and the occasional shrub species, with the assumption that the native understorey would eventually colonise (Florabank 2012). Given that an objective of the revegetation works is to restore extensive areas of C/EEC vegetation, there is a need to ensure a diverse ground layer is present. Within the Onsite Offset Areas, this is likely to require extensive planting and/or reseeding.

It is anticipated that initial revegetation work will be focussed on expanding existing patches of woodland. Trees and shrubs should be planted into such areas to form nuclei of regenerating woody habitats that would then be able to progressively grow back into woodland or open forest. Replanting of such areas will take place early in the life of the

Project (within the first five years) and it is expected that substantial regeneration of woody plants will occur within the life of the Project.

The BMP is proposed to contain details on revegetation priorities and techniques, as well as details of reference sites and monitoring methodology. Methods for revegetation could include direct seeding and tubestock planting. Direct seeding involves sowing seeds directly into the site to be revegetated. Methods to plant tubestock include manual planting by hand (hand spot planting), or using mechanical planters. Revegetation methods will be undertaken in conjunction with weed control and feral animal management, so as to minimise threats to seedlings/tubestock. A number of other factors, such as site preparation, monitoring and adaptive management are an important component of revegetation works.

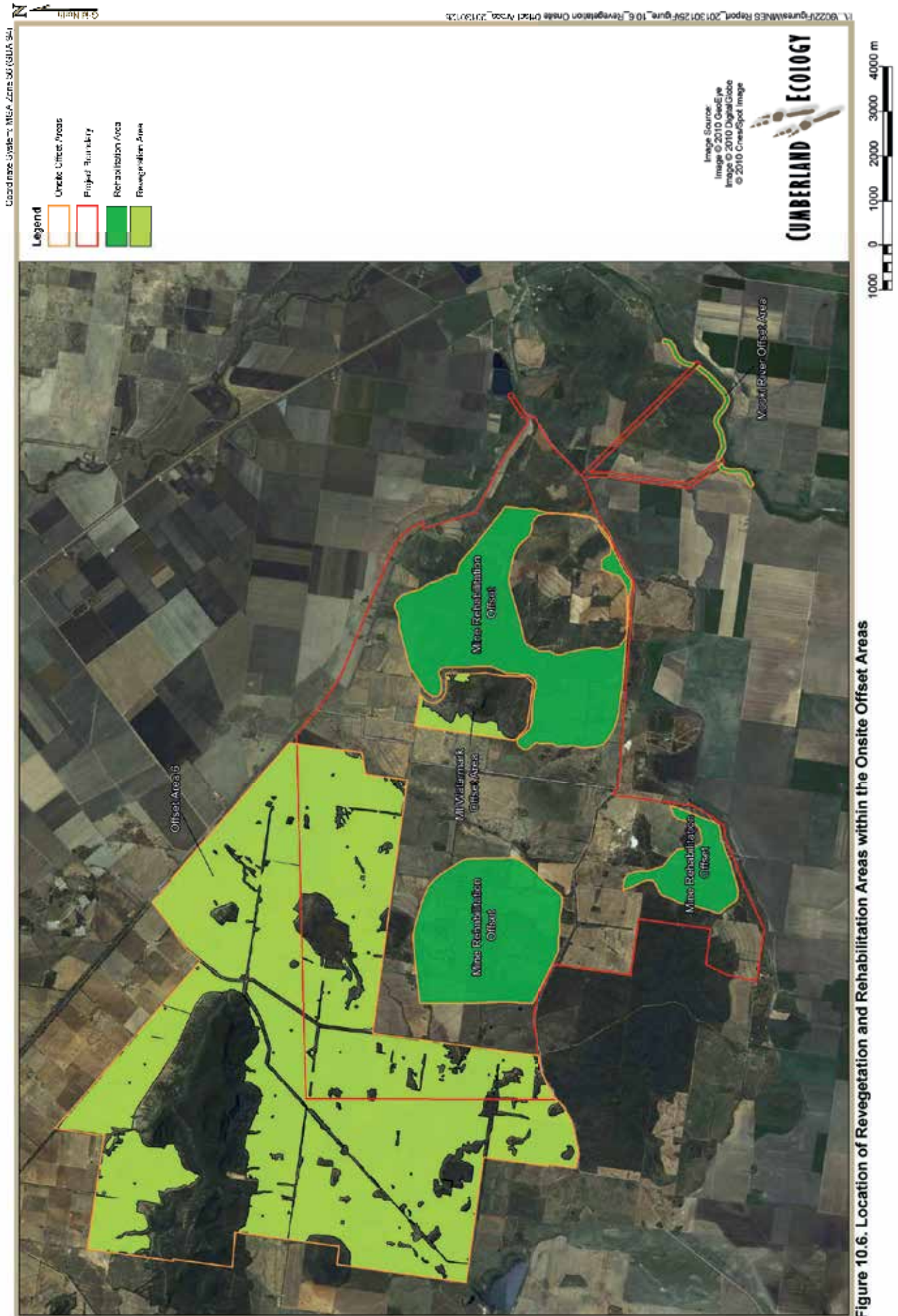
Restoration of forest and woodland to a structural complexity with diverse age classes comparable to the original community structure will take many decades, but natural regeneration can be achieved with supplemented revegetation to replace missing community layers. A major part of this is maintaining or increasing the number of large old canopy trees (in areas where they remain) which provide habitat resources including hollows, woody debris and reliable blossom production, throughout box-ironbark areas. Restoration of forest and woodland also involves protection of any remaining medium sized trees which are future large old trees.

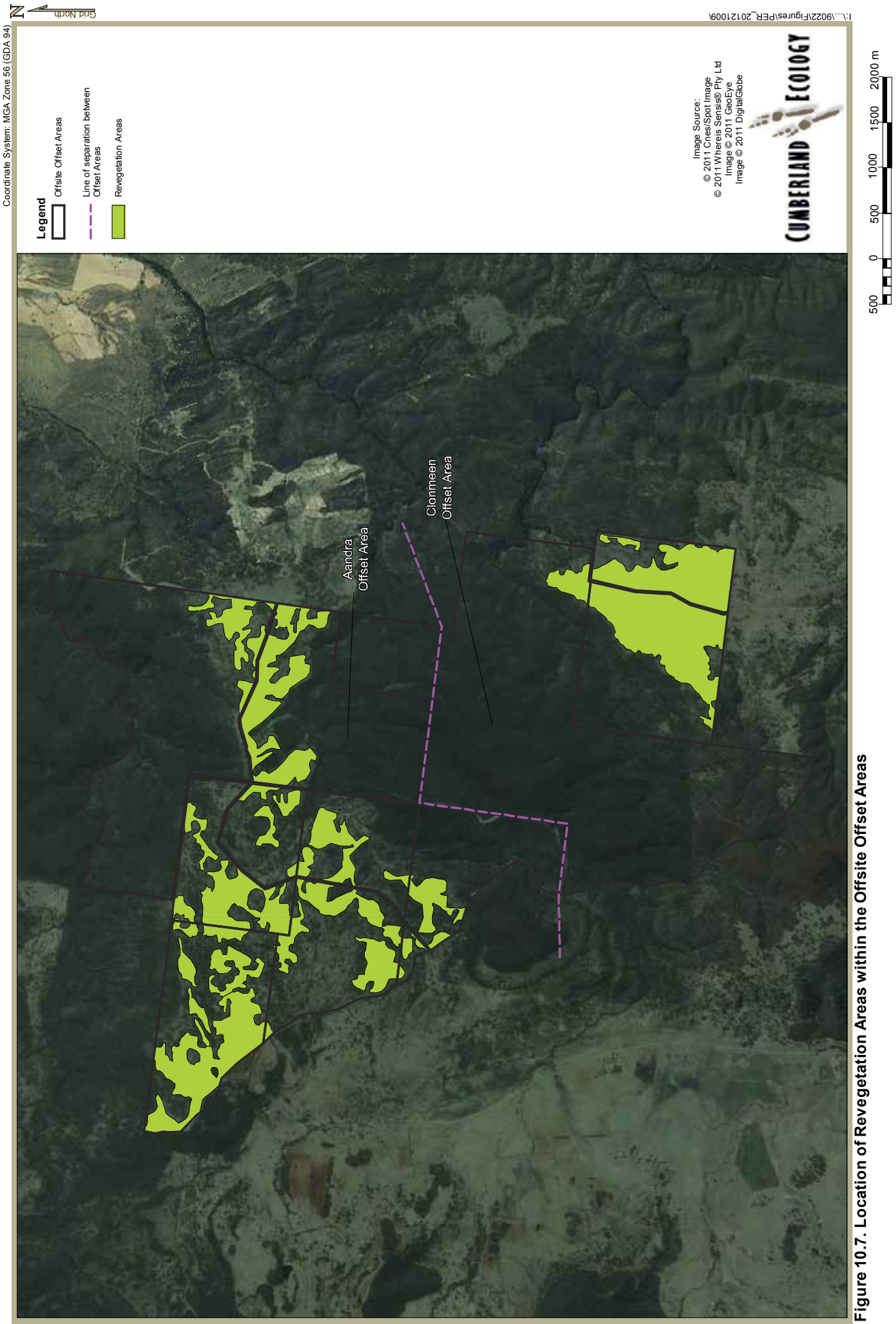
Research has highlighted the importance of maintaining treed habitats in the intervening disturbed landscape between remnant patches of vegetation, as these patches or corridors are important for fauna movement and seed dispersal (Cooper et al. 2002, Fischer and Lindenmayer 2002, DSE (VIC) 2008, Goldingay and Taylor 2009). Remnant patches also serve as “stepping stone” corridors that facilitate the movement of fauna in the landscape (DSE (VIC) 2008). Stepping stones have been shown to be important in maintaining landscape connectivity and maintaining gene flow between separate vegetation populations due to the movement of pollen and seed vectors such as animals and insects (Lindenmayer and Fischer 2006).

As a general indication, a tree density of about 30 to 40 mature trees per hectare is accepted as being ecological optimal for woodland habitat maintenance and minimum woodland patch sizes should be at least 5 ha to be viable (McIntyre et al. 2002). Continuous groundcover of tussock grasses, forbs and woody debris are also important in woodland and riparian corridors for soil stabilisation and attenuation of surface water flows. Detailed prescriptions of planting densities will be contained in the BMP (see **Section 9.4**).

Local provenance plant species should be utilised when required for revegetation, and additional seed will be collected from native vegetation within the Project Boundary to ensure genetic diversity is maintained. If feasible, species considered to have a high retention value should be translocated from the Disturbance Area to elsewhere within the Project Boundary that has similar site conditions. Where possible, topsoil will be translocated from active mining areas to areas being rehabilitated/revegetated to conserve the native seed bank of local ecological communities. This will improve the quality and diversity of native growth in rehabilitation areas and maximise the establishment of a diversity of native species,

particularly the understorey species that maintain the ecological function of native vegetation communities.





10.6.3 Mining Area Rehabilitation

Significant portions of the Eastern, Western and Southern Mining Areas disturbed by mining activities will be progressively rehabilitated over the life of the Project. Approximately 2,386 ha is proposed to be rehabilitated within the Disturbance Area. Consideration has been given to the retention of land for agricultural purposes.

The principle objective of the Project rehabilitation strategy will be to recreate and establish, as best as possible, a self-sustaining post-mining landscape that resembles the original vegetation communities and is able to support a diverse range of viable flora and fauna populations. It will focus on the establishment of the threatened ecological communities, including Box Gum Woodland and Derived Native Grassland and Inland Grey Box Grassy Woodland. The BMP will contain further information on the staged rehabilitation of all open cut mining areas and will specify how the Project Boundary will be closed to mining and returned to other land uses.

Local native plant species should be utilised where possible which should be supplemented by additional native species represented in the area to ensure the rehabilitation objectives are achieved. Where practical, topsoil should be translocated from proposed mining areas to conserve the native seed bank of local ecological communities. This would:

- Maintain or establish corridor connectivity as mining progresses;
- Improve the quality and diversity of native growth in rehabilitation areas;
- Maximise the establishment of a diversity of native species, particularly the understorey species that maintain the ecological function of native vegetation communities; and
- Provide additional habitat for native flora and fauna.

The rehabilitation of portions of the Disturbance Area would be a staged process and has been designed with the intention of creating an acceptable balance between self-sustaining farming practices and improving biodiversity by restoring areas of woodland to their pre-European state. A Rehabilitation Management Plan will be developed that prescribes the staged rehabilitation of all open cut mining areas.

Progressive rehabilitation will ensure that the net loss of vegetation and fauna habitat over the life of the Project will be minimised. If appropriate effort is put into the rehabilitation of mined areas, it is possible to recreate self-sustaining ecological communities that previously existed within much of the Project Boundary, encourage the recovery and relocation of flora and fauna and improve connectivity in the landscape, including linkages to other areas of habitat.

The rehabilitation of mined areas has been included as a component of the offsets at a 0.5:1 ratio due to the local and regional ecological values that can be added by restoring these areas to viable ecosystems. The proponent proposes to rehabilitate mined areas to

floristically and structurally complex vegetation comparable to the original community, including functional EECs.

i. Final Void

The final void occurs in the western portion of the Western Mining Area and will be surrounded by rehabilitation. A perimeter fence will be erected around the final void, so as to prevent the entry of most terrestrial fauna. The rehabilitation of land surrounding the void, in conjunction with the revegetation of Offset Area 6 to the west of this area, will ensure fauna movement is maintained. The mine rehabilitation surrounding the void would form a component of a corridor connecting Breeza State Forest to stepping stone habitat to the north.

10.6.4 Likely Success of Rehabilitation/Revegetation

The proposed vegetation conservation and rehabilitation measures have been designed to produce measurable biodiversity outcomes and are based on recognised principles of rehabilitation and land management (McIntyre et al. 2002). Despite this, it is difficult to predict how long it will take a given rehabilitation area to regenerate into a fully functioning ecosystem, as this is dependent on many factors including disturbance history, proximity of nearby remnant vegetation, condition of the soil and the management regime implemented.

There are few areas of mature rehabilitation in Australia, which means that there is little information currently available on the long-term ecological development of rehabilitated communities (Nichols 2005, Nichols et al. 2005). Due to the inherent variability of ecological systems, the ability to predict long-term successional trends in rehabilitation is low, and it is difficult to accurately predict the composition and structure of vegetation beyond 10 years (Nichols 2005). Nevertheless, it is clear that ceasing agricultural activities and the implementation of appropriate management techniques such as weed control and supplementary planting have the potential to substantially increase biodiversity.

The implementation of a well designed rehabilitation program will increase the likelihood of the long term success of maintaining and improving the condition and diversity of vegetation within the Project Boundary. To measure and evaluate the progress and quality of rehabilitation and ensure the 0.5:1 offset ratio is met, the rehabilitation will follow best practice guidelines and the BMP will provide performance and completion criteria, regular monitoring programs to determine the effectiveness of works and contingency plans.

Rehabilitation and regeneration of woodland is possible on degraded areas and has the potential to reduce the Project's impacts of habitat removal on threatened species.

10.6.5 Wildlife Corridor Management

The reinstatement and/or improvement of existing wildlife corridors has been an important consideration in the design of the BOP. Conservation of existing habitat, revegetation and rehabilitation is proposed to address the loss of connectivity resulting from the Project. The proposed Offset Areas will be capable of providing for the movement of species across the

landscape and will improve the current connectivity values of the lands in several important ways:

- Vegetation will be planted to connect existing patches of remnant vegetation that are currently isolated;
- Planting will increase the size of the existing remnant patches, which will decrease the distance between patches and provide better connectivity; and
- Planting will increase the size and number of patches in the existing landscape to provide better stepping stone corridors.

An important component of the Onsite Offset Areas is the restoration and establishment of a corridor linking Breeza State Forest to stepping stone habitat to the north, which continues on to Wondoba State Conservation Area. This corridor has been identified as regionally significant by Taylor and Drielsma (Taylor and Drielsma 2012). It is currently fragmented, with larger stepping stones of habitat surrounded by agricultural land with some scattered trees, primarily along road corridors. Management activities within the Offset Areas, particularly within Offset Area 6 and Mine Rehabilitation Areas, will assist in the reinstatement of connectivity. Additionally, the local corridor will be extended to the east through the Mine Rehabilitation Areas.

The Offsite Offset Areas also play an important role in protection and establishment of wildlife corridors. The Offsite Offset Areas build on to existing proposed offset areas (Maules Creek Coal Project – Northern Offsets) and are indirectly connected to Mount Kaputar National Park and Horton Falls National Park.

The inclusion and management of the Onsite and Offsite Offset Areas within the BOP would provide additional conservation areas in the region for threatened flora and fauna, which has previously been highly fragmented. After cessation of mining, the combined areas of the Onsite and Offsite Offsets Areas will provide a greater area of habitat than is being impacted by the Project.

10.6.6 Securing the Offsets

At the time of writing, Shenhua Watermark are considering a number of mechanisms to permanently secure the offset properties for conservation and management. There are a number of options to permanently protect land for conservation and these include:

- Voluntary conservation agreements, which are a joint agreement between landowners and the Minister for the Environment under the National Parks and Wildlife Act 1974;
- Conservation covenants under Section 88 of the *Conveyancing Act 1919*; this is a joint agreement between the landowner and an authorised body;
- Application to change zoning regulation that dictates land use; and

- Land acquisition and management of the land under private ownership with conditions commitments.

The final outcome will depend on negotiations with relevant land owners and agencies. Offset properties will be secured and under the management of Shenhua Watermark prior to the commencement of operations.

10.7 Summary of Onsite and Offsite Offset Areas

10.7.1 *Vegetation*

Table 10.4 provides a summary of the BOP, including the area of each vegetation community to be cleared within the Disturbance Area and the area of each community in the Onsite and Offsite Offset Areas. These areas take into account proposed revegetation and rehabilitation within the Onsite and Offsite Offset Areas. An assessment of the adequacy of the BOP is provided in **Section 10.8**.

Table 10.4 Summary of Vegetation Clearance and Offsetting

Vegetation Community	Disturbance Boundary (ha)	Onsite Offset Areas						Offsite Offset Areas						Total Offsets			
		Mt Watermark Offset Area			Offset Area 6			Mooki River Offset Area			Clonmeen Offset Area			RT (ha)	RV (ha)	RH (ha)	Total (ha)
		RT (ha)	RV ^a (ha)	Total (ha)	RT (ha)	RV ^a (ha)	Total (ha)	RT (ha)	RV ^a (ha)	Total (ha)	RT (ha)	RV ^a (ha)	Total (ha)				
White Box Grassy Woodland (C/EEC)	517	166	47	213	451	1,352	1,803	0	0	0	0	0	0	617	1,399	1,631	3,647
Regenerating White Box Grassy Woodland (C/EEC)	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blackley's Red Gum Grassy Woodland (C/EEC)	89	0	0	0	103	601	704	0	0	0	0	0	0	103	601	313	1,017
Regenerating Blackley's Red Gum Grassy Woodland (C/EEC)	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow Box Grassy Woodland (C/EEC)	14	0	0	0	37	780	817	0	0	0	0	0	0	37	780	31	848
Derived Native Grassland (C/EEC)	73	0	0	0	0	21	21	0	0	0	0	0	0	301	21	0	322
White Box/Blackley's Red Gum/Yellow Box Woodland	0	0	0	0	0	0	0	130	181	311	144	77	221	274	258	0	532
Subtotal Box Gum Woodland (C/EEC)	738	166	47	213	591	2,754	3,345	0	0	0	181	445	77	1,332	3,059	1,975	6,366
Inland Grey Box Grassy Woodland (EEC)	30	0	0	0	21	640	661	0	0	0	0	0	0	21	640	46	707
Weeping Myall Woodland (EEC)	3	0	0	0	10	461	471	0	0	0	0	0	0	10	461	0	471
Brigalow (EEC)	0	0	0	n/a*	11	340	351	0	0	0	0	0	0	11	340	0	351
Semi-Evergreen Vine Thicket (EEC)	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a*	0	0	n/a*
Subtotal Other EEC	33	0	0	0	42	1,441	1,483	0	0	0	0	0	0	42	1,441	46	1,529
Fuzzy Box Woodland (TSC - EEC)	18	0	0	0	4	190	194	0	0	0	0	0	0	4	190	36	230
Poplar Box Woodland	45	0	0	0	49	293	342	0	0	0	0	0	0	49	293	73	415
Belah Woodland	1	0	0	0	37	970	1,007	0	0	0	0	0	0	37	970	0	1,007
Whitewood Woodland	13	26	31	57	99	0	99	0	0	0	0	0	0	125	31	27	183
Tumbledown Red Gum Grassy Open Woodland	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	39
White Box Shrubby Woodland	24	26	0	26	915	0	915	0	0	0	0	0	0	941	0	171	1,112
Regenerating White Box Shrubby Woodland	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blackley's Red Gum Shrubby Woodland	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17
Blackley's Red Gum Motherbush Shrubby Woodland	0	0	0	0	15	0	15	0	0	0	0	0	0	15	0	0	15
Dwyer's Red Gum Woodland	0	0	0	0	13	0	13	0	0	0	0	0	0	13	0	0	13
River Red Gum Riparian Woodland	0	0	0	0	0	0	0	44	44	0	0	0	0	0	44	0	44
Red Stringybark/Blackley's Red Gum Woodland	0	0	0	0	0	0	0	0	0	244	0	0	0	244	0	0	244
Red Stringybark/Rough-barked Apple Woodland	0	0	0	0	0	0	0	0	0	389	828	0	0	1,217	0	0	1,217
New England Blackbutt Woodland	0	0	0	0	0	0	0	0	0	148	33	0	33	181	0	0	181
Orange Gum Woodland	0	0	0	0	0	0	0	0	0	2	320	0	0	320	0	0	320
Manna Gum Riparian Woodland	0	0	0	0	0	0	0	0	0	0	29	0	29	29	0	0	29
River Oak Riparian Woodland	0	0	0	0	0	0	0	0	0	39	13	0	13	52	0	0	52
Subtotal Other Woodland	166	52	31	83	1,732	1,453	2,585	0	44	44	822	1,223	0	3,229	1,528	363	5,120
Low Diversity Grassland, Planted & Exotic Pasture	3,084	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cleared Areas (roads, dams, buildings, etc.)	63	0	0	0	44	0	44	0	0	0	0	0	0	44	0	0	44
Subtotal Other	3,147	0	0	0	44	0	44	0	0	0	0	0	0	44	0	0	44
TOTAL	4,084	218	78	296	1,809	5,648	7,457	0	44	44	952	1,133	1,668	4,647	6,028	2,384	13,059

*Area of occurrence is <0.1ha and has therefore not been mapped
 *Areas proposed for revegetation were previously mapped as Low Diversity Grassland, Planted & Exotic Pasture
 RT = Retained; RV = Revegetated; RH = Rehabilitated

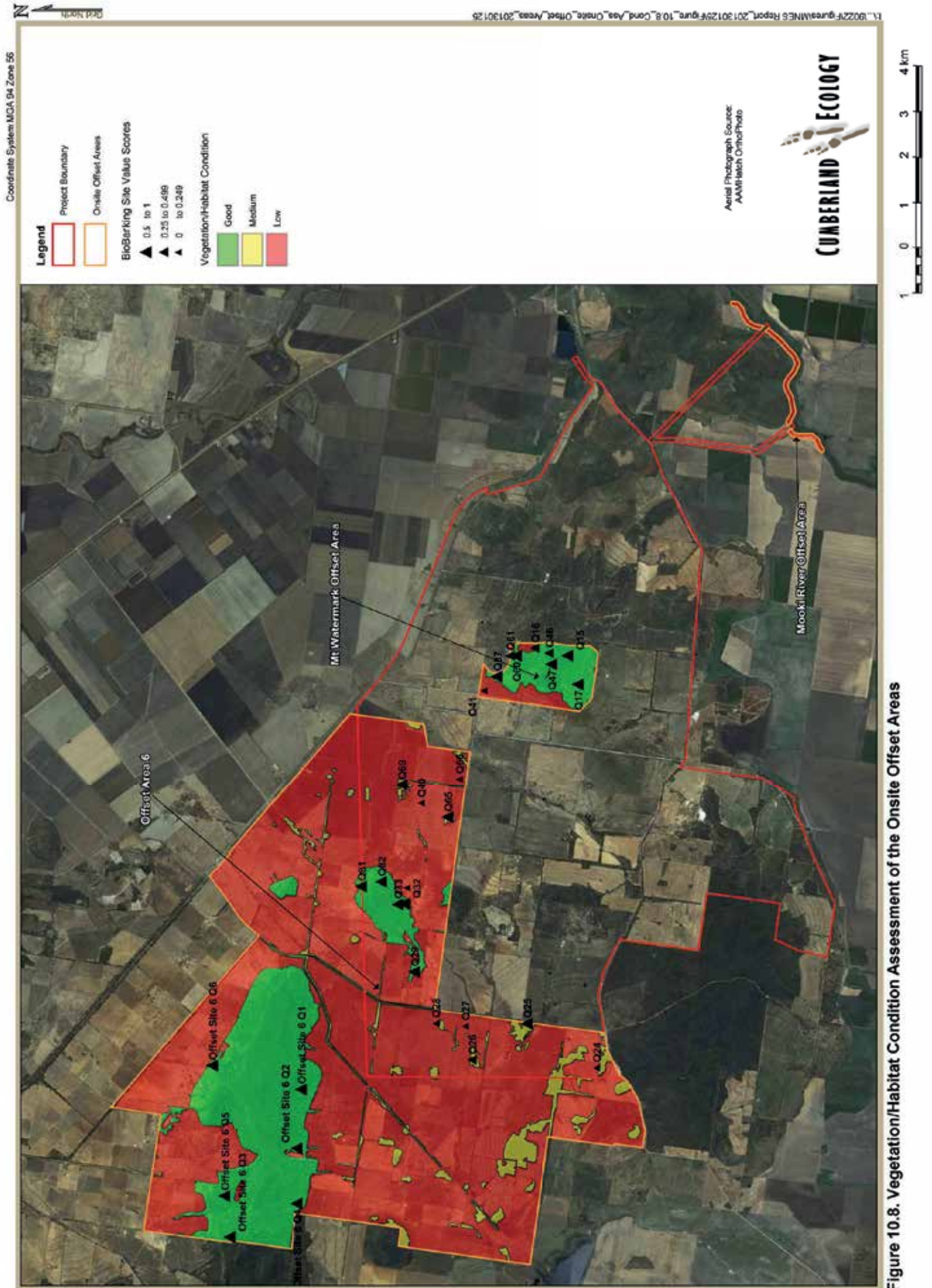
10.7.2 Vegetation/Habitat Condition Assessment

The results of the vegetation/habitat condition assessments for the Onsite and Offsite Offset Areas are shown in **Figure 10.8** and **Figure 10.9**, respectively. In most instances the BioBanking attribute score reflects and confirms the underlying general vegetation condition assessment mapping.

A high proportion of the offset land is in good condition, as shown in **Figure 10.8** and **Figure 10.9**. However, broad areas of the offsets are in average and to a lesser extent low, condition. What this means is that the offset areas will be able to be improved significantly in value as land use shifts from grazing to conservation. The quality of the vegetation within the Onsite and Offsite Offset Areas is comparable to the vegetation being impacted by the Project.

In the medium to long term, with conservation management the current condition of the vegetation of the offsets will shift from a mixture of low, average and good condition, to predominantly good condition. The proposed revegetation and rehabilitation will increase native vegetation cover and condition.

In particular, 5,352 ha of the Onsite and Offsite Offset Areas will revegetated or rehabilitated to Box Gum Woodland. This is consistent with the draft Recovery Plan for Box Gum Woodland. This community is endangered because so much has been cleared in the past as it is essentially where farming has occurred in the past. In order to recover such woodland, it is essential to recover land from old farmlands. This is anticipated within the draft National Recovery Plan and no other feasible alternatives are available as the vast majority of remaining Box Gum Woodland and Derived Native Grassland is within farmland.



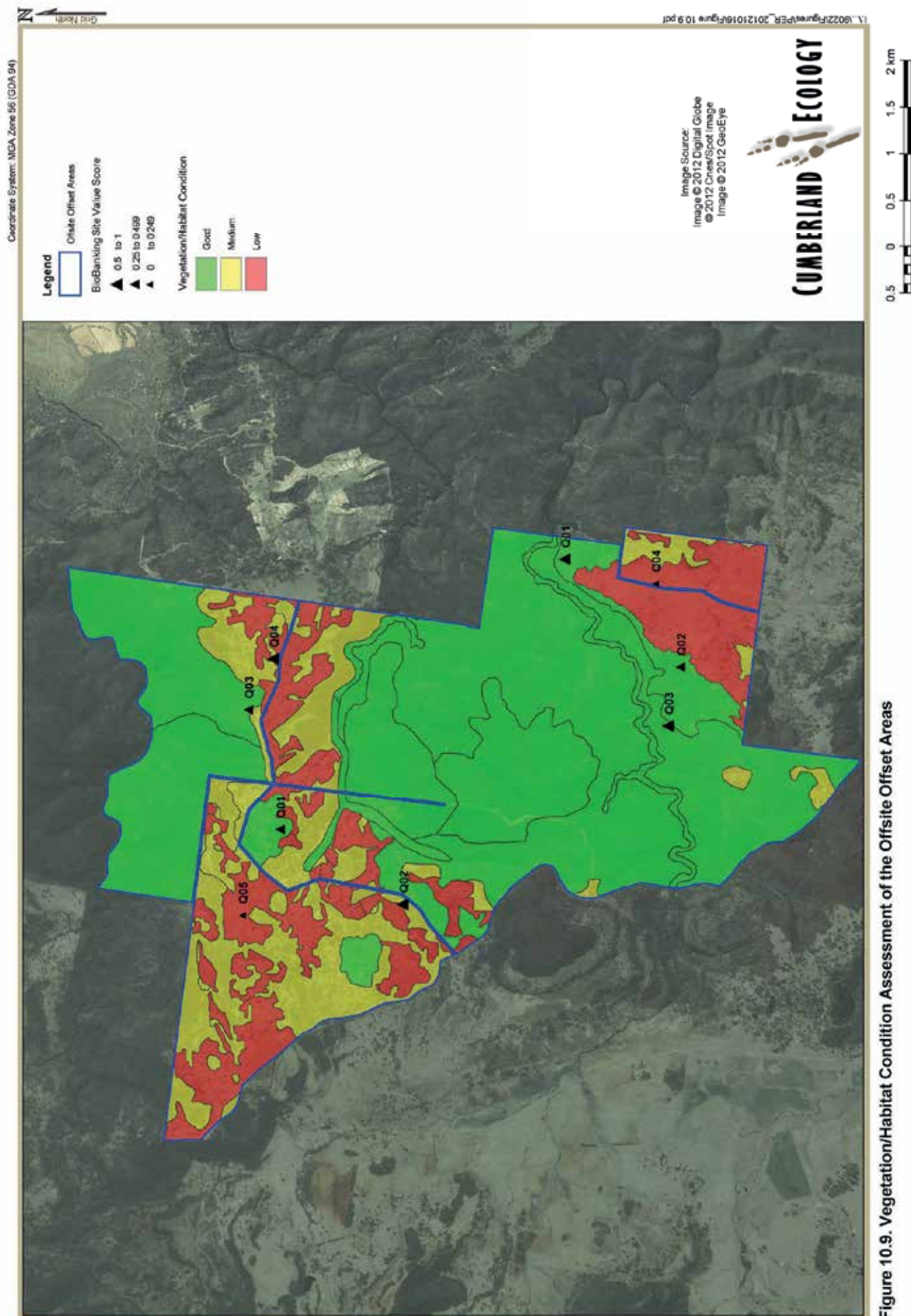


Figure 10.9. Vegetation/Habitat Condition Assessment of the Offsite Offset Areas

10.7.3 Habitat for Threatened Species

The native vegetation within the Onsite and Offsite Offset Areas currently provides grassland, woodland and forest habitat for many of the threatened and migratory fauna that are predicted to be impacted by the Project.

The habitat areas of the Onsite Offset Areas are within proximity to the habitat within the Disturbance Area and are considered likely to provide habitat for the fauna present in the Disturbance Area. Within the Offsite Offset Areas, there are extensive areas of well connected forest and woodland that provide good quality habitat for a wide variety of species, including species that are not found within the Disturbance Area. The Offsite Offset Areas also contain permanent streams, which are valuable resources for many fauna species. The Offsite Offset Areas are also located in a known habitat area for Regent Honeyeater and have habitat that appears highly suitable for this species. A breakdown of the areas of habitat to be removed by the Project and the areas of habitat that are expected to be provided within the Offset areas is provided in **Table 10.5** below.

Table 10.5 Area of Habitat Provided by the BOP for Threatened Species					
Threatened Species	EPBC Act Status	Occurrence within Project Boundary	Preferred Habitat	Area of Habitat Cleared within the Project Boundary (ha)	Area of Habitat Provided in Offset Strategy (ha)
PLANTS					
<i>Bothriochloa biloba</i>	Vulnerable	Known	W,G	4,021	13,015
<i>Dichanthium setosum</i>	Vulnerable	Potential	W,G	4,021	13,015
<i>Digitaria porrecta</i>	Endangered	Potential	W,G	4,021	13,015
<i>Cadellia pentastylis</i>	Vulnerable	Potential	W	864	12,693
<i>Swainsona murrayana</i>	Vulnerable	Potential	W,G	4,021	13,015
BIRDS					
White-bellied Sea Eagle	Migratory	Known	G	3,157	322
Regent Honeyeater	Endangered, Migratory	Potential	W	864	12,693
Swift Parrot	Endangered	Potential	W	864	12,693
Superb Parrot	Vulnerable	Potential	W	864	12,693
White-throated Needletail	Migratory	Potential	W,G	4,021	13,015
Fork-tailed Swift	Migratory	Potential	W,G	4,021	13,015
Rainbow Bee-eater	Migratory	Potential	W,G	4,021	13,015
Cattle Egret	Migratory	Potential	G	3,157	322

Table 10.5 Area of Habitat Provided by the BOP for Threatened Species					
Threatened Species	EPBC Act Status	Occurrence within Project Boundary	Preferred Habitat	Area of Habitat Cleared within the Project Boundary (ha)	Area of Habitat Provided in Offset Strategy (ha)
Great Egret	Migratory	Potential	G	3,157	322
MAMMALS					
Koala	Vulnerable	Known	W	864	12,693
Spotted-tailed Quoll	Endangered	Potential	W	864	12,693
Large-eared Pied Bat	Vulnerable	Potential	W	864	12,693
South-eastern Long-eared Bat	Vulnerable	Potential	W	864	12,693
REPTILES					
Border Thick-tailed Gecko	Vulnerable	Potential	W	864	12,693
Five-clawed Worm-skink	Vulnerable	Potential	W, G	4,021	13,015
Pink-tailed Legless Lizard	Vulnerable	Potential	W, G	4,021	13,015

10.7.4 Strategic Values

i. Onsite Offset Areas

Several strategic values of the Onsite Offset Areas have been identified and include:

- They are proximate to the location of the Project;
- They contain comparable, or “like for like” vegetation community types to the vegetation within the Disturbance Area. These vegetation communities are currently in reasonably good condition but are currently not managed for conservation and could be improved;
- They contain areas of C/EECs, including Box Gum Woodland;
- They contain known habitat for the local population of the Koala and areas proposed for revegetation of habitat to ensure a maintained or improved outcome is met;

- They contain known habitat for a number of threatened fauna species;
- They contain reasonably large areas of woodland that:
 - Constitute valuable habitat for native flora and fauna, particularly those that will be impacted by the Project;
 - Increase the natural regeneration of nearby derived native grasslands and pastures by providing a seed source for recruitment (Rawlings et al. 2010);
 - Can secure valuable “stepping stone” patches of remnant forest in a largely cleared, agricultural landscape;
- A significant portion of the properties have the potential to be improved and revegetated to provide additional areas of C/EECs and habitat for threatened fauna species, and contribute to the improvement of regional wildlife corridors.

ii. Offsite Offset Areas

Several strategic values of the Offsite Offset Areas have been identified and include:

- They contain areas of Box Gum Woodland CEEC;
- They contain known habitat for a number of threatened fauna species;
- The vegetation communities are currently in reasonably good condition but are currently not managed for conservation and could be improved;
- They contain reasonably large areas of woodland and forest that:
 - Constitute valuable habitat for native flora and fauna, including those that will be impacted by the Project;
 - Increase the natural regeneration of nearby derived native grasslands and pastures by providing a seed source for recruitment (Rawlings et al. 2010);
 - Can secure valuable “stepping stone” patches of remnant woodland and forest in a modified landscape;
- Portion of the properties have the potential to be improved and revegetated to provide additional areas of C/EECs and habitat for threatened fauna species;
- They build onto existing proposed offset areas (Maules Creek Coal Project – Northern Offsets); and
- They are indirectly connected to Mount Kaputar National Park and Horton Falls National Park through the proposed Maules Creek Coal Project Northern Offsets.

10.8 Indirect Offsets

Indirect offsets are those that support, rather than provide, direct biodiversity outcomes. Indirect offsets must be over and above the offset requirements specified by relevant government agencies.

The Commonwealth considers that, for some situations, indirect offsets may be acceptable provided that they are well targeted towards the threatened species or communities that are to be impacted. This may include research into threatened species and matters of national significance and may include implementing action(s) in a Recovery Plan or BMP. Potential research and management topics may include:

- Research to improve restoration and management of Box Gum Woodland or other Woodland that will be impacted by the Project (e.g. White Box Woodland);
- Research to better manage populations of key threatened species in the Namoi Catchment (e.g. threatened birds, microbats or the Koala); or
- Landcare projects or similar that are aimed at restoring flora and fauna habitats within the Namoi Catchment.

10.9 Adequacy of the BOP

A substantial BOP has been proposed for the Project. The adequacy of the Watermark BOP has been assessed using a number of methods. These methods include assessment of the vegetation removal and offset ratios and consistency with SEWPaC principles for offsetting. The Watermark BOP is also being assessed using the new SEWPaC offsets calculator and consultation with SEWPaC is proposed to finalise this assessment.

10.9.1 *Vegetation Removal and Offset Ratios*

For the purpose of establishing minimum size thresholds for the BOP, a ratio of 5:1 for Commonwealth C/EECs and native vegetation has been adopted. Ideally offsets were on a 'like for like' basis in that they offset identical vegetation communities, however where this was not possible, other communities were used as surrogates. The BOP includes the retention of existing vegetation and extensive revegetation and rehabilitation.

Table 10.6 provides the offset ratios for retained vegetation only during the life of the Project for the major vegetation groups. The current BOP will provide woodland and grassland habitat for threatened species at just under a 5:1 ratio for the life of the Project. The table also indicates that the Project will provide over a 5:1 offset ratio of retained Box Gum Woodland and Derived Native Grassland in the first 10 years. This provides the opportunity to implement widespread revegetation within the Onsite Offset Areas prior to clearance of other mining areas, and allows time to monitor, verify and where necessary improve revegetation work.

Table 10.6 Summary of Offset Ratios for Retained Vegetation									
Vegetation Group	Offsets - Retained (ha)	Year 0	Year 0-1	Year 2-5	Year 6-10	Year 11-15	Year 16-21	Year 22-25	Year 26-30
Box Gum Woodland and Derived Native Grassland (C/EEC)	1,332	41.6	20.2	6.7	5.7	4.3	3.0	1.8	1.8
Other EECs	42	3.0	2.3	1.3	1.3	1.3	1.3	1.3	1.3
Other Woodland	3,229	358.8	322.9	100.9	80.7	49.7	21.1	19.5	19.5
Total	4,603	83.7	49.0	17.5	15.0	11.3	7.2	4.9	4.9

A summary of the vegetation removal and offset ratios for the Project for retained, revegetated and rehabilitated land is provided in **Table 10.7**. Rehabilitation has been included in the BOP calculations but a discount has been applied to it in recognition that it is to be on rehabilitated land where vegetation will take a considerable period to develop. As has been accepted for other mining projects in NSW in recent times, a discount of 50% has been applied to the mine rehabilitation areas.

The BOP will provide a total of 6,366 ha of Box Gum Woodland and Derived Native Grassland, 1,529 ha of other EPBC Act listed EECs and 5,120 ha of other woodland vegetation. When the 50% discount is applied to the mine rehabilitation areas the BOP provides the following offset ratios:

- 7.3:1 for Box Gum Woodland and Derived Native Grassland;
- 45.6:1 for other EPBC Act listed EECs; and
- 29.8:1 for other woodland vegetation.

The total area of remnant and revegetated/rehabilitated Box Gum Woodland and Derived Native Grassland that will be supplied by the BOP in the long term will offset the predicted impacts on the community. The proposed revegetation/rehabilitation will further complement the regeneration and will also ensure that there is no net loss of habitat for the suite of species predicted to be impacted by the Project.

Table 10.7 Summary of Offset Ratios for the Project						
Vegetation Community	Disturbance Area (ha)	Offsets – Retained (ha)	Offsets – Revegetated^ (ha)	Offsets – Rehabilitated (ha)	Offsets – Total (ha)	Ratio (Retained, Revegetation and Rehabilitation) – Rehabilitation discounted at 50%
Box Gum Woodland (CEEC)	665	1,031	3,038	1975	6,044	
Derived Native Grassland (CEEC)	73	301	21	0	322	
Subtotal Box Gum Woodland (CEEC)	738	1,332	3,059	1,975	6,366	7.3
Inland Grey Box Grassy Woodland (EEC)	30	21	640	46	707	
Weeping Myall Woodland (EEC)	3	10	461	0	471	
Brigalow (EEC)	0	11	340	0	351	
Subtotal Other EEC	33	42	1,441	46	1,529	45.6
Fuzzy Box Woodland (TSC - EEC)	18	4	190	36	230	
Poplar Box Woodland	45	49	293	73	415	
Belah Woodland	1	37	970	0	1,007	
Whitewood Woodland	13	125	31	27	183	
Tumbledown Red Gum Grassy Open Woodland	16	0	0	39	39	
White Box Shrubby Woodland	24	941	0	171	1,112	
Regenerating White Box Shrubby Woodland	43	0	0	0	0	
Blakely's Red Gum Shrubby Woodland	6	0	0	17	17	
Blakely's Red Gum Motherumbah Shrubby Woodland	0	15	0	0	15	

Table 10.7 Summary of Offset Ratios for the Project						
Vegetation Community	Disturbance Area (ha)	Offsets – Retained (ha)	Offsets – Revegetated^ (ha)	Offsets – Rehabilitated (ha)	Offsets – Total (ha)	Ratio (Retained, Revegetation and Rehabilitation) – Rehabilitation discounted at 50%
Dwyer's Red Gum Woodland	0	13	0	0	13	
River Red Gum Riparian Woodland	0	0	44	0	44	
Red Stringybark/Blakely's Red Gum Woodland	0	244	0	0	244	
Red Stringybark/Rough-barked Apple Woodland	0	1,217	0	0	1,217	
New England Blackbutt Woodland	0	181	0	0	181	
Orange Gum Woodland	0	322	0	0	322	
Manna Gum Riparian Woodland	0	29	0	0	29	
River Oak Riparian Woodland	0	52	0	0	52	
Subtotal Other Woodland	166	3,229	1,528	363	5,120	29.8
Low Diversity Grassland, Planted & Exotic Pasture	3,084	0	0	0	0	
Cleared Areas (roads, dams, buildings, etc.)	63	44	0	0	44	
Subtotal Other	3,147	44	0	0	44	n/a
TOTAL	4,084	4,647	6,028	2,384	13,059	

^{*}Area of occurrence is <0.1ha and has therefore not been mapped

[^] Areas proposed for revegetation were previously mapped as Low Diversity Grassland, Planted & Exotic Pasture

10.9.2 Compliance with SEWPaC Offsetting Principles

In order to achieve the best environmental outcomes, the BOP for the Project aims to meet the Commonwealth standards in offsetting. **Table 10.8** below shows how the EPBC Act Environmental Offset Policy (SEWPaC 2012c) principles for offsetting have been addressed by the Watermark BOP. The Watermark BOP is also being assessed using the new SEWPaC offsets calculator and consultation with SEWPaC is proposed to finalise this assessment.

Table 10.8 Compliance with the EPBC Act Environmental Offset Policy	
Offset Principles	Justification
1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action	The proposed offsets contain the same EPBC Act listed ecological communities that will be cleared for the proposed action. The regeneration and proposed re-vegetation of the offset areas will increase the area of Box Gum Woodland and Derived Native Grassland currently conserved. They also contain similar habitat for the listed threatened flora/fauna and migratory species that are known or may potentially occur within the Project Boundary. The offsets will provide extensive areas of ecological communities and habitat that will be managed for long term conservation outcomes, thereby maintaining the viability of the species and communities that will be affected.
2. Suitable offsets must be built around direct offsets but may include other compensatory measures	The large majority of the proposed offset package consists of direct offsets, however a suite of other compensatory measures are also proposed.
3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter	The proposed offsets are proportionate to the Critically Endangered status of Box Gum Woodland, and offer in excess of five times the area of this community to be cleared. This area will also provide habitat for other threatened species, however none have a higher level of statutory protection than Box Gum Woodland. Therefore, the offsets will provide a very high level of protection even for species that have a lower level of statutory protection.
4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter	The offsets package provides over five times the area of Box Gum Woodland and Derived Native Grassland to be cleared as well as at least the same area of habitat for threatened species that will be removed.
5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.	The risks of the offset not succeeding have been minimised by the provision of a large proportion of direct offsets, and also the advance provision of offsets.

Table 10.8 Compliance with the EPBC Act Environmental Offset Policy	
Offset Principles	Justification
6. Suitable offsets must be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)	The proposed offsets are proposed to be used as offsets under the EP&A Act in NSW.
7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable	The proposed offsets are considered to be efficient and effective, as measurable conservation gains will be achieved with reasonable investment of time and money. They are timely as they are being provided in advance of the disturbance (with the exception of rehabilitation which would occur progressively) and are proposed to be long lasting. They are transparent, in that measurable conservation gains will be achieved and monitoring of results will be conducted. They are scientifically robust, and are known to produce conservation outcomes. They are reasonable, and utilise well known approaches for biodiversity conservation.
8. Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	A comprehensive BMP has been prepared for monitoring and auditing the performance of the offset lands and rehabilitation undertaken within the Project Boundary.
9. In assessing the suitability of an offset, government decision-making will be informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty	Not relevant to this assessment
10. In assessing the suitability of an offset, government decision-making will be conducted in a consistent and transparent manner.	Not relevant to this assessment

Chapter **11**

Conclusion

The land throughout the Project Boundary has been historically used for farming, which has resulted in significant modification and disturbance, ranging from severely modified cropping lands, to improved pastures and native grasslands used for grazing. Notwithstanding this, there are large areas of relatively intact remnant vegetation, precluded from clearing on steeper slopes and mountain tops, as well as numerous isolated and linear remnants on flatter country within the Project Boundary.

The Project would remove approximately 937 ha of native woodland and derived grassland, including several communities listed as threatened under the EPBC Act. This includes approximately 738 ha of Box Gum Woodland and Derived Native Grassland, 30 ha of Inland Grey Box Woodland and 3 ha of Weeping Myall Woodland. One threatened plant species listed under the EPBC Act has been recorded within the Project Boundary; *Bothriochloa biloba*, and several others are known to occur in the region and have potential habitat within the Project Boundary.

The woodland vegetation within the Project Boundary provides habitat for a range of threatened species, including several fauna species listed under the EPBC Act, notably the Koala. The Project Boundary supports a relatively large Koala population and the majority of the woodland areas comprise secondary Koala habitat.

In recognition of the potential ecological impacts of the Project, substantial mitigation and amelioration measures have been proposed. The considerations for reducing the ecological impacts follow a hierarchy of principles:

- Avoid – to the extent possible, the developments has been designed to avoid or minimize ecological impacts;
- Mitigate – where impacts are unavoidable through design changes, mitigation measures have been introduced to ameliorate the ecological impacts of the Project; and
- Compensate – the residual impacts of the Project, following the implementation of mitigation measures, have been compensated to offset what would otherwise be a net loss of habitat.

The Project will remove broad areas of vegetation and associated habitat from the Project Boundary in the short term. This however, is only considered to be a temporary disturbance and the Project would incorporate an extensive rehabilitation program as part of the mine closure procedures.

A substantial BOP has been proposed to offset the predicted residual impacts of the Project. The BOP will protect approximately 4,603 ha of woodland and derived native grassland, revegetate 6,028 ha of woodland and derived native grassland and rehabilitate 2,384 ha of woodland. This includes a total of 6,366 ha of Box Gum Woodland and Derived Native Grassland, 1,529 ha of other EPBC Act listed EECs and 5,120 ha of other woodland vegetation. The BOP includes significant areas of known and potential habitat for the suite of species predicted to be impacted by the Project. This will also restore habitat for the Koala. The Onsite Offset Areas will provide a significant area of conservation land within the locality of the Project and the Offsite Offset Areas will build into existing proposed offset areas. The adequacy of the Watermark BOP is also being assessed using the new SEWPaC offsets calculator and consultation with SEWPaC is proposed to finalise this assessment.

The proposed avoidance, mitigation and offset measures are likely to sufficiently ameliorate the impacts of the Project to the extent that no threatened species are likely to become extinct as a result of the Project. Moreover, the long term objective of the BOP is to provide for a net benefit to flora and fauna within the locality and region, substantially increasing the proportions of native woodland in conservation tenure. The ratio of Box Gum Woodland to be conserved to that cleared for the Project will exceed 7:1, including areas to be revegetated and rehabilitated. When the mitigation and offsetting package is considered, no significant impacts are predicted to occur to threatened species as a result of the Project, and the Project will provide a major ecological benefit in the medium to long term.

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Appendix A

SEWPaC DGRs

Department of the Sustainability, Environment, Water, Population and Communities – requirements for environmental assessment

Section 75F(3) of the NSW *Environmental Planning and Assessment Act 1979*

The Commonwealth Minister for Sustainability, Environment, Water, Population and Communities has determined the Watermark Coal Project (EPBC 2011/6201), involving the proposed construction and operation of an open cut coal mine approximately 35 km south east of Gunnedah in New South Wales, to be a controlled action under section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The controlled action is likely to have a significant impact on the EPBC Act listed critically endangered ecological community White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland) and EPBC Act listed migratory and threatened species including the Regent Honeyeater (*Anthochaera phrygia*). Significant impacts are also considered possible for a number of other species and communities protected by the EPBC Act including, but not limited to, those listed in Appendix A.

In accordance with the one-off accredited assessment process for this project, the environmental assessment of the impacts of the controlled action must be assessed under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Pursuant to section 75F(3) of part 3A of the EP&A Act the Director-General is required to notify the proponent of these requirements.

The assessment should include enough information about the controlled action and its relevant impacts to allow the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities to make an informed decision whether or not to approve the controlled action under the EPBC Act.

The following assessment requirements are to be integrated into the assessment requirements of the EP&A Act. The following matters in the EPBC Act and schedule 4 of the *Environment Protection and Biodiversity Conservation Regulations 2000* should be considered.

General information

1. The background of the action, including:

- a. the title of the action;
- b. the full name and postal address of the designated proponent;
- c. a clear outline of the objective of the action;
- d. the location of the action;
- e. the background to the development of the action;
- f. how the action relates to any other actions (of which the proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;
- g. the current status of the action; and
- h. the consequences of not proceeding with the action.

Description of the controlled action

2. A description of the action, including:

- a. all the components of the action;
- b. the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts;
- c. how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;
- d. the timing and duration of the works to be undertaken; and
- e. to the extent reasonably practicable, a description of any feasible alternatives to the controlled action that have been identified through the assessment, and their likely impact, including:
 - i. if relevant, the alternative of taking no action;
 - ii. a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action;
 - iii. sufficient detail to clarify why any alternative is preferred to another.

Description of the existing environment

3. A description of the existing environment of the proposal location and the surrounding areas that may be affected by the action, including:

- a. surveys using accepted methodology for targeting listed threatened species, ecological communities and their respective habitat, including but not limited to OEH's *Survey and assessment guidelines* (2009), available at: <http://www.environment.nsw.gov.au/threatenedspecies/surveymethodsfauna.htm> and the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) species-specific survey guidelines for nationally threatened species, available at: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

In addition to the requirements outlined in OEH's *Survey and assessment guidelines* (2009) and DSEWPaC survey guidelines for relevant species, the following must also be included:

- b. a description of the distribution and abundance of threatened species and ecological communities, as well as suitable habitat (including breeding, foraging, roosting habitat, habitat critical to the survival of threatened species) within the site and in surrounding areas that may be impacted by the proposal; and
- c. the regional distribution and abundance of suitable and potential habitat surrounding the site.

Description of the relevant impacts of the controlled action

4. An assessment of all relevant impacts³ with reference to the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines Matters of National Environmental Significance* (2009) that the controlled action has, will have or is likely to have on relevant threatened species and/or threatened ecological communities (s18 and s18A), and migratory species (s20 and s20A). Information must include:

³ The term "relevant impact" is defined in section 82 of the EPBC Act.

- a. a description of the relevant impacts of the action on matters of national environmental significance;
 - b. a detailed assessment of the nature and extent of the likely short term and long term relevant impacts;
 - c. a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
 - d. analysis of the significance of the relevant impacts;
 - e. notwithstanding mitigation and offset, details on the cumulative impacts on matters of National Environmental Significance at a regional scale; and,
 - f. any technical data and other information used or needed to make a detailed assessment of the relevant impacts.
5. A description of the relevant impacts on the ecological communities should include an analysis of the vegetation condition on the site, as well as the methods by which this was determined. It should also include direct, indirect, cumulative and facilitative impacts on the:
- a. extent of the ecological community, including connectivity with other areas of the ecological communities;
 - b. quality or integrity of the ecological community including, but not limited to, assisting invasive species, that are harmful to the ecological communities to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the communities which kill or inhibit the growth of species in the ecological community;
 - c. EPBC Act listed species in, or in any way dependent upon, the ecological community;
 - d. composition of the ecological community;
 - e. habitat present on site critical to the survival of the ecological community⁴; and
 - f. abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community survival, for example increasing groundwater levels or making the site wetter, soil disturbance or substantial alteration of surface water drainage patterns.

These impacts should be described for the construction and operation phases of the controlled action.

This information should be provided with reference to the ecological community as it is defined and listed under the EPBC Act.

6. Where there is a potential habitat for EPBC Act listed species (Appendix A), surveys must be undertaken. These surveys must be timed appropriately and undertaken for a suitable period of time by a qualified person⁵. A subsequent description of the relevant impacts on such EPBC Act listed species should include, inter alia, direct, indirect, cumulative and facilitative impacts on the:

⁴ "habitat critical to the survival of a species or ecological community" refers to areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of population or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the register of Critical Habitat maintained by the Minister under the EPBC Act.

⁵ Where available, species-specific survey guidelines can be obtained on the department's *Species Profile and Threats Database*: <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>

- a. population of the species at the site;
- b. area of occupancy of the species;
- c. habitat critical to the survival of the species;
- d. breeding cycle of the population; and
- e. availability or quality of habitat for the species.

If an endangered ecological community, threatened or migratory species listed at Appendix A is not believed to be present on the proposed site, detailed information must be included in the Environmental Assessment Report to provide certainty that this community will not be impacted.

Information relating to water

The Environmental Assessment Report must consider any water related impacts associated with the proposed project on MNES.

7. How the proponent will comply with all relevant Commonwealth, state and local government environment laws and policies pertaining (either directly or indirectly) to water quality management;
8. A description and maps of all surface water and groundwater sources relevant to the Project, and a delineation of their associated NWQMS environmental values;
9. The results of surface water and groundwater hydrological assessments, including an assessment of hydrological interactions where water sources are connected;
10. Hydro-geological reports;
11. A geological map showing fault lines;
12. A topographical map;
13. Hydrological modelling information;
14. Baseline data and information on current water quality, including reference and test site data. Where this information does not exist, there should be an undertaking to carry out the necessary investigations in order to provide the required baseline data, including a description of how these investigations will be carried out (methodology and timeframe);
15. Data and information on proposed discharge water quality, including timing of discharges, concentrations, and loads of toxicants and stressors;
16. Water quality issues, including planning, monitoring and management informed by the National Water Quality Management Strategy (<http://www.environment.gov.au/water/policy-programs/nwqms>):
 - a. Sewage treatment; and,
 - b. Water way crossings;
17. Modelling showing the cumulative environmental impacts of the action; and
18. A comprehensive water quality risk management and monitoring plan for the project, including management triggers to detect potential issues in a timely manner and to avoid, minimise or ameliorate adverse impacts. This should include:
 - a. Identification and description of all potential water quality hazards;
 - b. Water quality risks should be considered and, where possible, quantified;
 - c. Cumulative effects, including environmental impacts, should be considered;

- d. Threshold trigger and/or guideline values that protect MNES should be considered;
 - e. Biological as well as chemical monitoring and assessment;
 - f. Statistical analysis such as data averages, standard deviation and number of samples;
 - g. Test and reference site locations;
 - h. Sampling and analytical methods; and,
 - i. Quality control and quality assurance data
19. Some of the main water quality issues the proponent should consider include:
- a. Salinity;
 - b. Sedimentation;
 - c. Nutrients;
 - d. Stressors such as pH, EC, turbidity
 - e. Heavy metals and metalloids;
 - f. Macroinvertebrate species assemblages, compositions and assessment results
 - g. Disturbed/exposed acid sulfate soils;
 - h. Hydrocarbons, hydrocarbon derivatives and PAHs.

Proposed safeguards and mitigation measures

20. A description of feasible mitigation measures, changes to the controlled action or procedures, which have been proposed by the proponent or suggested in public submissions, and which are intended to prevent or minimise relevant impacts. Information must include:
- a. a description of the mitigation measures that will be undertaken to prevent or minimise the relevant impacts of the action. These mitigation measure should be substantiated and based on best available practices;
 - b. an assessment of the expected or predicted effectiveness of the mitigation measures including the effect on abundance and condition of species, suitable habitat and ecological communities;
 - c. any statutory or policy basis for the mitigation measures;
 - d. the cost of the mitigation measures;
 - e. an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs (including any relevant thresholds for corrective actions) for the relevant impacts of the action. Include the person or agency responsible for implementing these programs and the effectiveness of all mitigation measures, including any provisions for independent environmental auditing;
 - f. the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;
 - g. identification of mitigation measures proposed to be undertaken by State governments, local governments or the proponent;
 - h. any changes to the controlled action which prevent or minimise relevant impacts on listed threatened species and communities.

Offsets

21. Should any residual impact exist that cannot be mitigated it may be necessary for offset measures to be considered in order to ensure the protection of matters of national environmental significance in perpetuity. If required, the department may negotiate offsets with you during the assessment phase. Reference should be made to the Department's draft

policy statement, including any revisions to this statement, at :

<http://www.environment.gov.au/epbc/publications/draft-environmental-offsets.html>

- a. the description of any offset package should include how the offset compensates for the residual impacts, when the offset will be delivered and how the offset will be managed;
- b. an assessment of the impact of the offsets on other matters of environmental, economic, or social significance; and
- c. analysis of cost, both financial and other, related to offsets.

Other approvals and conditions

22. Any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. Information must include:

- a. details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:
 - i. what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and
 - ii. how the scheme provides for the prevention, minimisation and management of any relevant impacts;
- b. a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;
- c. a statement identifying any additional approval that is required;
- d. a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

Economic and social matters

23. A description of the short-term and long-term social and economic implications and/or impacts of the project.

Environmental record of person proposing to take the action

24. Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

- a. the proponent; and
- b. for an action for which a person has applied for a permit, the person making the application.

25. Details of the proponent's environmental policy and planning framework.

Information sources

26. For information given in an environment assessment, the draft must state:

- a. the source of the information;
- b. how recent the information is;
- c. how the reliability of the information was tested; and
- d. what uncertainties (if any) are in the information.

Consultation

27. Any consultation about the action, including:

- a. any consultation that has already taken place;
- b. proposed consultation about relevant impacts of the action;
- c. if there has been consultation about the proposed action — any documented response to, or result of, the consultation.

28. Identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.

Appendix A

Threatened Ecological Communities

- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland)
- The Weeping Myall Woodlands
- *Grey Box (Eucalyptus macrocarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia*
- *Weeping Myall Woodlands ecological community*

Threatened Flora

- *Prasaophyllum* sp. Wybong (C.Phelps ORG 5269)
- *Pterostylis cobarensis*
- *Swainsona murrayana*
- *Thesium austral*
- *Tylophora lineraris*

Threatened Fauna

- *Anthochaera phrygia* (Regent Honeyeater), also Migratory
- *Lathamus discolor* (Swift Parrot)
- *Polytelis swainsonii* (Superb Parrot)
- *Chalinolobus dwyeri* (Large-eared Pied Bat)
- *Petrogale penicillata* (Brush-tailed Rock-Wallaby)
- *Psedomys novaehollandiae* (New Holland Mouse)
- *Pteropus poliocephalis* (Grey-headed Flying-fox)
- *Rostratula australis* (Painted Snipe), also Migratory
- *Maccullochella peelii peelii* (Murray Cod)
- *Nyctophilus corbeni* (South-eastern Long-eared Bat)
- *Dasyurus maculatus maculatus* (Spotted-tailed Quoll)
- *Underwoodisaurus sphyrurus* (Border Thick-tailed Gecko)

Appendix B

Watermark Coal Project Environmental Policy



Environmental Policy

Shenhua Watermark Coal Pty Limited is committed to implement best practice environmental standards and performance and the principles of sustainable development.

This commitment will be achieved through a demonstrated understanding of environmental accountabilities, leadership at all levels of management and the effective implementation of an environmental management system.

Our environmental objectives are to:

- Plan, construct and operate the Watermark Project in a manner that considers sustainable development and best practice environmental management;
- Achieve continual environmental improvement through implementing an environmental management system which includes objectives and targets;
- Conduct environmental management to a standard that meets both legislative and business requirements.

To achieve our objectives we will:

- Comply with all applicable environmental legal requirements and other agreements to which we are a signatory;
- Develop and implement environmental management strategies to measure and address our risks and impacts;
- Set objectives and targets for continual improvement in environmental performance, allocate appropriate resources to achieve those targets and report our performance against these;
- Limit the environmental impacts of our operations through the efficient use of natural resources and the implementation of measures to prevent pollution and reduce waste;
- Promote the research and development of new practices and technologies that will improve environmental outcomes;
- Promote a culture in which all employees and contractors share a commitment to our environmental objectives; and
- Through training, consultation and risk management processes, make employees and stakeholders aware of the Environmental Policy and our environmental management system.



Paul Jackson
Project Manager
Shenhua Watermark Coal Pty Limited
20th October 2012

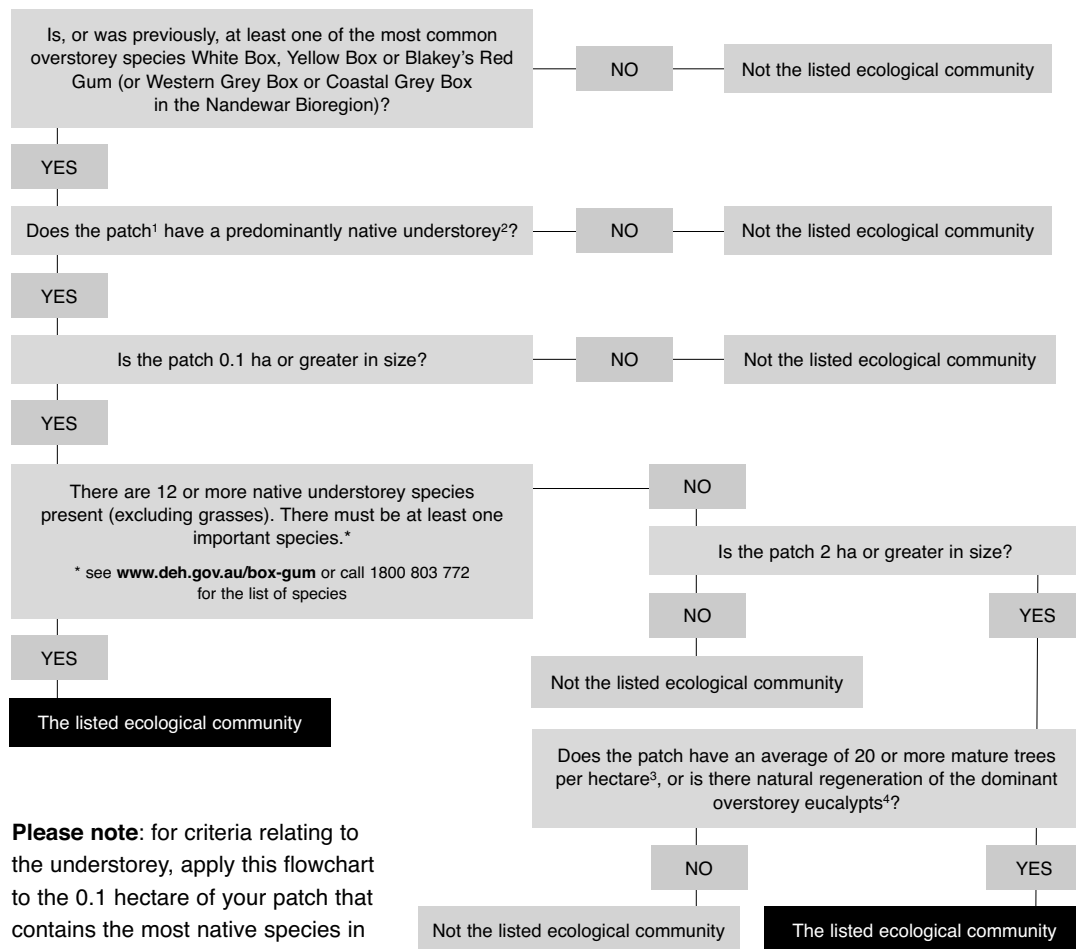
368-370 Conadilly St, Gunnedah NSW 2380 Tel: +61 2 6741 8800 Fax +61 2 9290 14 98
ABN 21133264230

Appendix C

Identification Guidelines from the EPBC Act
Policy Statement for Box Gum Grassy
Woodland and Derived Native Grassland

The flowchart below represents the lowest condition at which patches are included in the listed ecological community. This is not the ideal state of the ecological community. Large patches, those that link remnants in the landscape, those that occur in highly cleared areas, those that contain rare, declining or threatened species, and those that represent the entire range of the ecological community, are important for the long-term future of the ecological community.

Determining if your land has an area of the listed ecological community



Please note: for criteria relating to the understorey, apply this flowchart to the 0.1 hectare of your patch that contains the most native species in the ground layer.

- ¹ Patch – a patch is a continuous area containing the ecological community (areas of other ecological communities such as woodlands dominated by other species are not included in a patch). In determining patch size it is important to know what is, and is not, included within any individual patch. The patch is the larger of:
 - an area that contains five or more trees in which no tree is greater than 75 m from another tree, or
 - the area over which the understorey is predominantly native.
 Patches must be assessed at a scale of 0.1 ha (1000m²) or greater.
- ² A predominantly native ground layer is one where at least 50 per cent of the perennial vegetation cover in the ground layer is made up of native species. The best time of the year to determine this is late autumn when the annual species have died back and have not yet started to regrow. (At other times of the year, you can determine whether something is perennial or not if it is difficult to pull out of the soil. Annual species pull out very easily.)
- ³ Mature trees are trees with a circumference of at least 125 cm at 130 cm above the ground.
- ⁴ Natural regeneration of the dominant overstorey eucalypts when there are mature trees plus regenerating trees of at least 15 cm circumference at 130 cm above the ground.

Appendix D

Flora Quadrat Data

[illegible]

[illegible]

[illegible]

WA
ΩA

[illegible]

Table D.1	Flora Quadrat Data (Quadrats 1-45)

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44		
Asteraceae	* <i>Taraxacum officinale</i>	Dandelion																																														
Asteraceae	* <i>Tolpis barbata</i>	Yellow Hawkweed																																														
Asteraceae	<i>Tragopogon portifolius</i>	Oyster Plant													2																																	
Asteraceae	<i>Tripliodiscus pygmaeus</i>	Common Sunray											2																																			
Asteraceae	<i>Verbesina encelioides</i>																																															
Asteraceae	<i>Vitadnia cuneata</i> var. <i>hirta</i>	Fuzzweed	1	2	2	2	2	2	2	2	2	2	2	2			2	2	2	2	2	2	2	2	2	2	X	X		2	1	1	1	2														
Asteraceae	<i>Vitadnia dissecta</i> var. <i>hirta</i>		2					2																																								
Asteraceae	<i>Vitadnia gracilis</i>																																															
Asteraceae	<i>Vitadnia muelleri</i>		1										2																																			
Asteraceae	<i>Vitadnia pterochaeta</i>																																															
Asteraceae	* <i>Xanthium spinosum</i>	Bathurst Burr																																														
Asteraceae	<i>Xerochysum bracteatum</i> ssp. <i>bracteatum</i>	Golden Everlasting	2	2	2	2	1	2	2	2	2	2	2	2	2	2			2	2	2	2	2	2	2	2	X	2	1	2	1	2																
Asteraceae	* <i>Zinnia peruviana</i>																																															
Boraginaceae	* <i>Echium plantagineum</i>	Patterson's Curse														X																																
Boraginaceae	* <i>Ehretia membranifolia</i>																																															
Boraginaceae	* <i>Heliotropium amplexicaule</i>																																															
Boraginaceae	* <i>Heliotropium europaeum</i>																																															
Boraginaceae	* <i>Caposella bursa-pastoris</i>	Shepard's Purse			2	2																																										
Boraginaceae	* <i>Eruca sativa</i>									adj																																						
Boraginaceae	* <i>Hirschfeldia incana</i>														2																																	
Boraginaceae	* <i>Lepidium africanum</i>		X		2	2						X	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Boraginaceae	* <i>Lepidium bonariensis</i>		2	2	2	2									2																																	
Boraginaceae	* <i>Lepidium fasciculatum</i>																																															
Boraginaceae	* <i>Rapistrum rugosum</i>	Giant Mustard														2																																
Boraginaceae	* <i>Sinapis alba</i>	White Mustard																																														
Boraginaceae	* <i>Sisymbrium irio</i>	London Rocket	1																																													
Boraginaceae	* <i>Sisymbrium orientale</i>	Indian Hedge Mustard									X							2	X																													
Boraginaceae	<i>Wahlenbergia communis</i>	Tufted Bluebell									X																																					
Boraginaceae	<i>Wahlenbergia gracilis</i>	Australian Bluebell	2	2	2	2							2	2	2		X																															
Boraginaceae	<i>Wahlenbergia gracilis</i>	Granite Bluebell														2	2	2	2	2	2	2	2	2	X	2																						
Boraginaceae	<i>Wahlenbergia grandicola</i>														2																																	
Boraginaceae	<i>Wahlenbergia luteola</i>				2																																											
Boraginaceae	<i>Wahlenbergia planiflora</i>																																															
Boraginaceae	<i>Wahlenbergia planiflora</i> ssp. <i>longipila</i>		2	2		2							2	2	2																																	
Boraginaceae	<i>Wahlenbergia sp.</i>	Bluebell																																														
Capparaceae	<i>Capparis mitchellii</i> (seedling)	Wild Orange	1																																													
Caryophyllaceae	<i>Arenaria leptoclados</i>	Lesser Thyme-leaved Sand Wort																																														
Caryophyllaceae	<i>Gypsophila tubulosa</i>	Annual Chalk Wart																																														
Caryophyllaceae	* <i>Paronychia brasiliensis</i>	Braslian Willow Wort																																														
Caryophyllaceae	* <i>Petrothagia nanteuillii</i>	Velvet Pink	2	2	2	X	1	2					2				2																															
Caryophyllaceae	* <i>Petrothagia velutina</i>	Four-leaved Allseed											1																																			
Caryophyllaceae	<i>Polycarpon tetraphyllum</i>		2	2									2	2			2	2																														
Caryophyllaceae	<i>Silene gallica</i>																																															
Caryophyllaceae	<i>Silene gallica</i> var. <i>gallica</i>	Sandspurry	1																																													
Caryophyllaceae	* <i>Spergularia rubra</i>	Common Chickweed																																														
Caryophyllaceae	<i>Stellaria media</i>																																															
Caryophyllaceae	<i>Stellaria sp.</i>																																															
Caryophyllaceae	<i>Chenopodium auticumum</i>																																															
Caryophyllaceae	<i>Chenopodium carinatum</i>		1			2		2										2																														
Caryophyllaceae	<i>Chenopodium pumilio</i>	Small Crumbweed																X																														
Caryophyllaceae	<i>Einadia hastata</i>	Berry Saltbush	1	2	2	2	2	X				2	2	2	2		2	2	2	5	2	4	2	2	X																							
Caryophyllaceae	<i>Einadia nutans</i> ssp. <i>linifolia</i>																																															
Caryophyllaceae	<i>Einadia nutans</i> ssp. <i>nutans</i>		2		2	2	2					2			3																																	
Caryophyllaceae	<i>Einadia polygonoides</i>																																															

Table D.1 Flora Quadrat Data (Quadrats 1-45)

Family	Scientific Name	Common Name	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TT	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TT	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PP	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TT	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR

Table D.1	Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table D.1 Flora Quadrat Data (Quadrats 1-45)

Family	Scientific Name	Common Name	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD	FE	FF	FG	FH	FI	FJ	FK	FL	FM	FN	FO	FP	FQ	FR	FS	FT	FU	FV	FW	FX	FY	FZ	GA	GB	GC	GD	GE	GF	GG	GH	GI	GJ	GK	GL	GM	GN	GO	GP	GQ	GR	GS	GT	GU	GV	GW	GX	GY	GZ	HA	HB	HC	HD	HE	HF	HG	HH	HI	HJ	HK	HL	HM	HN	HO	HP	HQ	HR	HS	HT	HU	HV	HW	HX	HY	HZ	IA	IB	IC	ID	IE	IF	IG	IH	II	IJ	IK	IL	IM	IN	IO	IP	IQ	IR	IS	IT	IU	IV	IW	IX	IY	IZ	JA	JB	JC	JD	JE	JF	JG	JH	JI	IJ	JK	KL	KM	KN	KO	KP	KQ	KR	KS	KT	KU	KV	KW	KX	KY	KZ	LA	LB	LC	LD	LE	LF	LG	LH	LI	LJ	LK	LL	LM	LN	LO	LP	LQ	LR	LS	LT	LU	LV	LW	LX	LY	LZ	MA	MB	MC	MD	ME	MF	MG	MH	MI	MJ	MK	ML	MM	MN	MO	MP	MQ	MR	MS	MT	MU	MV	MW	MX	MY	MZ	NA	NB	NC	ND	NE	NF	NG	NH	NI	NJ	NK	NL	NM	NN	NO	NP	NQ	NR	NS	NT	NU	NV	NW	NX	NY	NZ	OA	OB	OC	OD	OE	OF	OG	OH	OI	OJ	OK	OL	OM	ON	OO	OP	OQ	OR	OS	OT	OU	OV	OW	OX	OY	OZ	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	PM	PN	PO	PQ	PR	PS	PT	PU	PV	PW	PX	PY	PZ	QA	QB	QC	QD	QE	QF	QG	QH	QI	QJ	QK	QL	QM	QN	QO	QP	QQ	QR	QS	QT	QU	QV	QW	QX	QY	QZ	RA	RB	RC	RD	RE	RF	RG	RH	RI	RJ	RK	RL	RM	RN	RO	RP	RQ	RR	RS	RT	RU	RV	RW	RX	RY	RZ	SA	SB	SC	SD	SE	SF	SG	SH	SI	SJ	SK	SL	SM	SN	SO	SP	SQ	SR	SS	ST	SU	SV	SW	SX	SY	SZ	TA	TB	TC	TD	TE	TF	TG	TH	TI	TJ	TK	TL	TM	TN	TO	TP	TQ	TR	TS	TU	TV	TW	TX	TY	TZ	UA	UB	UC	UD	UE	UF	UG	UH	UI	UJ	UK	UL	UM	UN	UO	UP	UQ	UR	US	UT	UU	UV	UW	UX	UY	UZ	VA	VB	VC	VD	VE	VF	VG	VH	VI	VJ	VK	VL	VM	VN	VO	VP	VQ	VR	VS	VT	VU	VV	VW	VX	VY	VZ	WA	WB	WC	WD	WE	WF	WG	WH	WI	WJ	WK	WL	WM	WN	WO	WP	WQ	WR	WS	WT	WU	WV	WW	WX	WY	WZ	XA	XB	XC	XD	XE	XF	YG	YH	YI	YJ	YK	YL	YM	YN	YO	YP	YQ	YR	YS	YT	YU	YV	YW	YX	YY	YZ	ZA	ZB	ZC	ZD	ZE	ZF	ZG	ZH	ZI	ZJ	ZK	ZL	ZM	ZN	ZO	ZP	ZQ	ZR	ZS	ZT	ZU	ZV	ZW	ZX	ZY	ZZ	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC	CD	CE	CF	CG	CH	CI	CJ	CK	CL	CM	CN	CO	CP	CQ	CR	CS	CT	CU	CV	CW	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR	DS	DT	DU	DV	DW	DX	DY	DZ	EA	EB	EC	ED	EE	EF	EG	EH	EI	EJ	EK	EL	EM	EN	EO	EP	EQ	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	

Table D.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

[illegible]WATERMARK
COAL PROJECT

Table D.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

[illegible]

Table D.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table D.2 Flora Quadrat Data (Quadrats 46-90)		
Family	Scientific Name	Common Name
Apiaceae	<i>Anmi. majus</i>	
	* <i>Cyclospermum leptophyllum</i>	Slender Celery
Apiaceae	<i>Daucus glochidatus</i>	
Apiaceae	<i>Xanthosia spinosa</i>	
Apocynaceae	* <i>Gomphocarpus fruticosus</i>	
Asteraceae	* <i>Arctotheca calendula</i>	Capeweed
Asteraceae	<i>Aster subulatus</i>	Wild Aster
Asteraceae	* <i>Bidens pilosa</i>	Cobbler's Pegs
Asteraceae	* <i>Bidens subailemans</i>	Greater Beggar's Ticks
Asteraceae	* <i>Bidens subailemans</i> var. <i>simulans</i>	
Asteraceae	<i>Brachyscome chrysoglossa</i>	
Asteraceae	<i>Brachyscome ciliaris</i>	
Asteraceae	<i>Calotis cuneifolia</i>	Purple Burr-daisy
Asteraceae	<i>Calotis hispidula</i>	Bogan Flea
Asteraceae	<i>Calotis lappulacea</i>	Yellow Burr-daisy
Asteraceae	* <i>Carthamus lanatus</i>	Saffron Thistle
Asteraceae	* <i>Centurea solstitialis</i>	St Barnaby's Thistle
Asteraceae	<i>Centipeda minima</i> subsp. <i>minima</i>	Spreading Sheezweed
Asteraceae	* <i>Chondrilla lutea</i>	Skeleton Weed
Asteraceae	<i>Chryscephalum apiculatum</i>	Common Everlasting
Asteraceae	<i>Chryscephalum semipapposum</i>	Clustered Everlasting
Asteraceae	* <i>Cirsium vulgare</i>	Spear Thistle
Asteraceae	* <i>Conyza alba</i>	Tall Fleabane
Asteraceae	* <i>Conyza bonariensis</i>	Flaxleaf Fleabane
Asteraceae	* <i>Conyza</i> sp.	Fleabane
Asteraceae	<i>Cotula australis</i>	Carrot Weed
Asteraceae	<i>Cymbonotus lawsonianus</i>	Bears-ear
Asteraceae	<i>Euchiton japonicus</i>	
Asteraceae	<i>Euchiton japonicus</i> spp. <i>complex</i>	
Asteraceae	<i>Euchiton sphaericus</i>	
Asteraceae	<i>Gnaphalium americanum</i>	Cud Weed
Asteraceae	<i>Glossocardia bidens</i>	Cobblers Tack
Asteraceae	* <i>Hedysrys rhagadioloides</i> subsp. <i>crelica</i>	
Asteraceae	* <i>Helianthus annuus</i>	Common Sunflower
Asteraceae	* <i>Hypochaeris albiflora</i>	White Flatweed
Asteraceae	* <i>Hypochaeris glabra</i>	Smooth Catsear
Asteraceae	* <i>Hypochaeris</i> sp.	
Asteraceae	* <i>Lactuca saligna</i>	Willow-leaved Lettuce
Asteraceae	* <i>Lactuca scariola</i>	Prickly Lettuce
Asteraceae	<i>Leiocarpa panaeoloides</i>	Woolly Buttons
Asteraceae	* <i>Onopordium acanthium</i> subsp. <i>acanthium</i>	Scotch Thistle
Asteraceae	* <i>Schkuhria pinnata</i> var. <i>abrotanoides</i>	
Asteraceae	<i>Senecio</i> sp.	
Asteraceae	<i>Senecio tenuiflorus</i>	
Asteraceae	<i>Sigesbeckia australis</i>	
Asteraceae	<i>Silvum marianum</i>	Milk Thistle
Asteraceae	<i>Solenogyne bellardoides</i>	
Asteraceae	* <i>Sonchus asper</i>	Prickly Sowthistle
Asteraceae	* <i>Sonchus oleraceus</i>	Common Sowthistle
Asteraceae	<i>Stardina hamata</i>	Hooked Cudweed
Asteraceae	<i>Stardina muelleri</i>	Spoon Cudweed

Country	Family	Scientific Name
Danmark	Asteraceae	<i>Taraxacum officinale</i>
Yellowstone	Asteraceae	<i>Trifolium pratense</i>
Yosemite	Asteraceae	<i>Trigonopogon porifolius</i>
Colorado	Asteraceae	<i>Triplodiscus pygmaeus</i>
Colorado	Asteraceae	<i>Verbesina encelioides</i>
Fuzzies	Asteraceae	<i>Vitadinia cureata</i> var. <i>cureata</i>
	Asteraceae	<i>Vitadinia dissecta</i> var. <i>hirta</i>
	Asteraceae	<i>Vitadinia gracilis</i>
	Asteraceae	<i>Vitadinia nuellei</i>
	Asteraceae	<i>Vitadinia tetrochaeta</i>
Bath	Asteraceae	<i>Xanthium spinosum</i>
Golconda	Asteraceae	<i>Xerochrysum bracteatum</i> ssp. <i>bracteatum</i>
	Asteraceae	<i>Zinnia peruviana</i>
Patit	Asteraceae	<i>Echium plantagineum</i>
	Boraginaceae	<i>Ehretia membranifolia</i>
	Boraginaceae	<i>Heliotropium amplexicaule</i>
	Boraginaceae	<i>Heliotropium europaeum</i>
	Boraginaceae	<i>Caposella bursa-pastoris</i>
Sheph	Boraginaceae	<i>Eruca sativa</i>
	Brassicaceae	<i>Hirschfeldia incana</i>
	Brassicaceae	<i>Lepidium africanum</i>
	Brassicaceae	<i>Lepidium bonariensis</i>
	Brassicaceae	<i>Lepidium fasciculatum</i>
	Brassicaceae	<i>Rapistrum rugosum</i>
Giant	Brassicaceae	<i>Sinapis alba</i>
Whill	Brassicaceae	<i>Sisymbrium irio</i>
London	Brassicaceae	<i>Sisymbrium orientale</i>
India	Brassicaceae	<i>Wahlenbergia communis</i>
Tuft	Brassicaceae	<i>Wahlenbergia gracilentia</i>
Austria	Brassicaceae	<i>Wahlenbergia gracilis</i>
Gran	Brassicaceae	<i>Wahlenbergia grandifolia</i>
	Brassicaceae	<i>Wahlenbergia luteola</i>
	Brassicaceae	<i>Wahlenbergia planiflora</i>
	Brassicaceae	<i>Wahlenbergia planiflora</i> ssp. <i>longifolia</i>
Blue	Brassicaceae	<i>Wahlenbergia</i> sp.
Wid	Brassicaceae	<i>Capparis mitchelli</i> (seedling)
Less	Caryophyllaceae	<i>Arenaria leptoclados</i>
Wor	Caryophyllaceae	<i>Gypsophila tubulosa</i>
Ann	Caryophyllaceae	<i>Paronychia brasiliensis</i>
Bras	Caryophyllaceae	<i>Petrothalia nartevii</i>
Velv	Caryophyllaceae	<i>Petrothalia retiniflora</i>
Fou	Caryophyllaceae	<i>Polycarpon tetraphyllum</i>
	Caryophyllaceae	<i>Silene gallica</i>
	Caryophyllaceae	<i>Silene gallica</i> var. <i>gallica</i>
Sans	Caryophyllaceae	<i>Spergularia rubra</i>
Com	Caryophyllaceae	<i>Stellaria media</i>
	Caryophyllaceae	<i>Stellaria</i> sp.
	Cenopodiaceae	<i>Cenopodium auticum</i>
	Cenopodiaceae	<i>Cenopodium carinatum</i>
	Cenopodiaceae	<i>Cenopodium pumilio</i>
	Cenopodiaceae	<i>Einadia hastata</i>
	Cenopodiaceae	<i>Einadia nutans</i> ssp. <i>linifolia</i>
	Cenopodiaceae	<i>Einadia nutans</i> ssp. <i>nulans</i>
	Cenopodiaceae	<i>Einadia polygonoides</i>

Family	Scientific Name	Common Name
Chenopodiaceae	<i>Eriodia sp.</i>	
	<i>Erinadia trigonos</i>	Fishweed
Chenopodiaceae	<i>Erinadia trigonos</i> subsp. <i>stellata</i>	Fishweed
Chenopodiaceae	<i>Enchylaena tomentosa</i>	Ruby Saltbush
Chenopodiaceae	<i>Maireana decalvans</i>	
Chenopodiaceae	<i>Salsola tragus</i>	
Chenopodiaceae	<i>Scleroalaena birchii</i>	Galvanized Burr
Chenopodiaceae	<i>Scleroalaena diacantha</i>	Grey Copperburr
Chenopodiaceae	<i>Scleroalaena divaricata</i>	Tangled Copperburr
Chenopodiaceae	<i>Scleroalaena intricata</i>	
Chenopodiaceae	<i>Scleroalaena muricata</i> var. <i>muricata</i>	Black Rolipoly
Chenopodiaceae	<i>Scleroalaena muricata</i> var. <i>seringlabra</i>	Black Rolipoly
Chenopodiaceae	<i>Scleroalaena muricata</i> var. <i>villosa</i>	Black Rolipoly
Chenopodiaceae	<i>Villosa</i>	
Chenopodiaceae	<i>Scleroalaena</i> sp.	
Chenopodiaceae	<i>Scleroalaena ventricosa</i>	
Chenopodiaceae	<i>Tecticornia triandra</i>	
Cuscutaceae	<i>Hypericum gramineum</i>	Small St. John's Wort
Convolvulaceae	<i>Convolvulus angustissimus</i>	
	ssp. <i>angustissimus</i>	
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed
Convolvulaceae	<i>Dichondra repens glaberrima</i>	
Convolvulaceae	<i>Dichondra</i> sp. A	
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	
Crassulaceae	* <i>Bryophyllum delagoense</i>	Mother-of-millions
Crassulaceae	<i>Crassula setzeriana</i>	
Cucurbitaceae	<i>Citrullus colocynthis</i>	Bitter Apple/Cucumber
Cucurbitaceae	<i>Cucumis mylocarpus</i> subsp. <i>leptodermis</i>	Paddy Melon
Dilleniaceae	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower
Euphorbiaceae	<i>Chamaesyce drummondii</i>	Cautic Weed
Euphorbiaceae	<i>Chamaesyce</i> sp. A	
Euphorbiaceae	<i>Euphorbia tannensis</i>	
Euphorbiaceae	<i>Phyllanthus hebecarpus</i>	
Euphorbiaceae	<i>Poranthura micophylla</i>	
Fabaceae (Caesalpinoideae)	<i>Petalostylis labicheoides</i>	
Fabaceae (Fabioideae)	<i>Gullen australasicum</i>	
Fabaceae (Fabioideae)	<i>Gullen tenax</i>	
Fabaceae (Fabioideae)	Large tick-trefoil	
Fabaceae (Fabioideae)	<i>Desmodium brachypodium</i>	
Fabaceae (Fabioideae)	<i>Desmodium varians</i>	
Fabaceae (Fabioideae)	<i>Glycine clandestina</i>	
Fabaceae (Fabioideae)	<i>Glycine tabacina</i>	
Fabaceae (Fabioideae)	* <i>Medicago minima</i>	Woody Burr-Medic
Fabaceae (Fabioideae)	<i>Medicago polymorpha</i>	
Fabaceae (Fabioideae)	* <i>Medicago sativa</i>	Lucerne
Fabaceae (Fabioideae)	<i>Medicago truncatula</i>	
Fabaceae (Fabioideae)	<i>Onobrychis vicifolia</i>	Saintfoin
Fabaceae (Fabioideae)	<i>Rhynchosia minima</i>	
Fabaceae (Fabioideae)	<i>Swainsona cadellii</i>	
Fabaceae (Fabioideae)	<i>Tephrosia brachydodon</i>	Narrow-leaved Clover
Fabaceae (Fabioideae)	<i>Trifolium angustifolium</i>	Haresfoot Clover
Fabaceae (Fabioideae)	* <i>Trifolium arvense</i>	Hop Clover
Fabaceae (Fabioideae)	* <i>Trifolium campestre</i>	Cluster Clover
Fabaceae (Fabioideae)	* <i>Trifolium glomeratum</i>	
Fabaceae (Fabioideae)	* <i>Trifolium scabrum</i>	Clover
Fabaceae (Fabioideae)	* <i>Trifolium</i> sp.	

Table D.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

[illegible]

Table D.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table D.2 Flora Quadrat Data (Quadrats 46-90)		
Family	Scientific Name	Common Name
Poaceae	* <i>Hordeum leopitum</i>	Barley Grass
Poaceae	<i>Hypparrhenia rufa</i> ssp. <i>altissima</i>	
Poaceae	<i>Lachnagrostis filiformis</i>	
Poaceae	<i>Lamarckia aurea</i>	Goldentop
Poaceae	<i>Leptochloa aspernes</i>	
Poaceae	<i>Leptochloa divaricatissima</i>	
Poaceae	* <i>Lolium perenne</i>	Perennial Ryegrass
Poaceae	* <i>Lolium</i> sp.	Weeping Meadow Grass
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	
Poaceae	<i>Notodanthonia longifolia</i>	Long-leaved Wallaby Grass
Poaceae	<i>Notodanthonia semiannularis</i>	
Poaceae	<i>Panicum buncel</i>	
Poaceae	<i>Panicum decompositum</i>	Native Millet
Poaceae	<i>Panicum effusum</i>	Hairy Panic
Poaceae	* <i>Panicum maximum</i> var. <i>trichoglume</i>	Green Panic
Poaceae	<i>Panicum queenslandicum</i> var. <i>queenslandicum</i>	Yadblia Grass
Poaceae	<i>Paspalum avarum</i>	
Poaceae	<i>Paspalum constrictum</i>	Knotybutt Grass
Poaceae	<i>Paspalum distans</i>	
Poaceae	<i>Paspalum gracile</i>	Slender Panic
Poaceae	<i>Paspalum jubilumum</i>	
Poaceae	<i>Paspalum</i> sp.	
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum
Poaceae	<i>Paspalum distichum</i>	Water Couch
Poaceae	* <i>Paspalum notatum</i>	Bahia Grass
Poaceae	* <i>Phalaris paradoxa</i>	
Poaceae	<i>Poa sieberiana</i> var. <i>hirtella</i>	Snowgrass
Poaceae	<i>Poa sieberiana</i> var. <i>sieberiana</i>	Snowgrass
Poaceae	* <i>Rostraria cristata</i>	Annual Cat's Tail
Poaceae	* <i>Sorghum halepense</i>	
Poaceae	<i>Sporobolus caroli</i>	Fairy Grass
Poaceae	<i>Sporobolus creber</i>	Western Rat-tail Grass
Poaceae	<i>Sporobolus</i> sp.	
Poaceae	<i>Themeda australis</i>	
Poaceae	<i>Themeda avenacea</i>	
Poaceae	* <i>Thinopyrum elongatum</i>	
Poaceae	<i>Tragus australianus</i>	
Poaceae	<i>Tridolia scariosa</i> subsp. <i>scariosa</i>	Porcupine Grass
Poaceae	<i>Tripogon loliformis</i>	Fiveminute Grass
Poaceae	* <i>Triticum aestivum</i>	Common Wheat
Poaceae	* <i>Triticum</i> sp.	Wheat
Poaceae	* <i>Urochloa panicoides</i>	Urochloa Grass
Poaceae	<i>Urochloa piligera</i>	Hairy Amngrass
Poaceae	* <i>Vulpia muralis</i>	
Poaceae	* <i>Vulpia</i> sp.	
Poaceae	<i>Walwhalleya prolata</i>	
Poaceae	<i>Walwhalleya pungens</i>	
Herbs - Monocots (Other)		
Anaryllidaceae	<i>Crinum flaccidum</i>	Darling Lily
Anthericaceae	<i>Dichopogon limbratus</i>	
Anthericaceae	<i>Athripodium milleflorum</i>	Pale Vanilla-lily
Anthericaceae	<i>Athripodium minus</i>	Small Vanilla Lily

Table D.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

* denotes exotic species

Appendix E

Flora Species List

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Trees							
Casuarinaceae		<i>Allocasuarina luehmannii</i>	Bulloak			X	
Casuarinaceae		<i>Casuarina cristata</i>	Belah			X	
Cupressaceae		<i>Callitris glaucophylla</i>	White Cypress Pine			X	X
Fabaceae (Mimosoideae)		<i>Acacia cheelii</i>	Motherumbah			X	
Fabaceae (Mimosoideae)		<i>Acacia pendula</i>	Weeping Myall			X	
Loranthaceae		<i>Amyema cambagei</i>				X	
Loranthaceae		<i>Amyema miquelii</i>	a mistletoe			X	
Loranthaceae		<i>Amyema quandang var. quandang</i>				X	
Loranthaceae		<i>Dendrophthoe glabrescens</i>				X	
Loranthaceae		<i>Lysiana subfalcata</i>				X	
Moraceae		<i>Ficus rubiginosa</i>	Port Jackson Fig			X	
Myrtaceae		<i>Angophora floribunda</i>	Rough-barked Apple			X	
Myrtaceae		<i>Eucalyptus albens</i>	White Box			X	X
Myrtaceae		<i>Eucalyptus bancroftii</i>	Orange Gum				
Myrtaceae		<i>Eucalyptus blakelyi</i>	Blakely's Red Gum			X	X
Myrtaceae		<i>Eucalyptus camaldulensis</i>	River Red Gum			X	
Myrtaceae		<i>Eucalyptus conica</i>	Fuzzy Box			X	X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Myrtaceae		<i>Eucalyptus dealbata</i>	Tumbledown Red Gum			X	
Myrtaceae		<i>Eucalyptus melliodora</i>	Yellow Box			X	X
Myrtaceae		<i>Eucalyptus microcarpa</i>	Western Grey Box			X	X
Myrtaceae		<i>Eucalyptus pilligaensis</i>	Narrow-leaved Grey Box			X	
Myrtaceae		<i>Eucalyptus populnea</i>	Poplar Box			X	X
Myrtaceae		<i>Eucalyptus sp.</i>	Ironbark?			X	
Santalaceae		<i>Exocarpos cupressiformis</i>	Native Cherry			X	
Sapindaceae		<i>Atalaya hemiglauc</i>	Whitewood			X	
Sterculiaceae		<i>Brachychiton populneus subsp. populneus</i>	Kurrajong			X	X
Viscaceae		<i>Korthalsella rubra subsp. geijericola</i>				X	
Shrubs							
Anacardiaceae	*	<i>Schinus areira</i>	Pepper Tree			X	
Apocynaceae		<i>Carissa ovata</i>	Kunkeberry				
Asteraceae		<i>Cassinia arcuata</i>	Sifton Bush			X	
Asteraceae		<i>Cassinia laevis ssp. rosmarinifolia</i>				X	
Asteraceae		<i>Cassinia quinquefaria</i>				X	
Asteraceae		<i>Cassinia sp.</i>				X	
Asteraceae		<i>Cassinia uncata</i>	Sticky Cassinia			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Boraginaceae		<i>Ehretia membranifolia</i>	Peach Bush			X	
Cactaceae	*	<i>Opuntia aurantiaca</i>	Tiger Pear			X	X
Cactaceae	*	<i>Opuntia stricta</i>	Prickly Pear			X	X
Capparaceae		<i>Capparis mitchellii</i> (seedling)	Wild Orange			X	
Celastraceae		<i>Maytenus cunninghamii</i>	Yellow-berry Bush			X	
Celastraceae		<i>Maytenus silvestris</i>	Narrow-leaved Orangebark			X	
Chenopodiaceae		<i>Atriplex pseudocampanulata</i>					X
Chenopodiaceae		<i>Atriplex semibaccata</i>	Creeping Saltbush			X	
Chenopodiaceae		<i>Atriplex suberecta</i>				X	
Chenopodiaceae		<i>Maireana aphylla</i>	Leafless Bluebush				X
Chenopodiaceae		<i>Maireana microphylla</i>	Small-leaf Bluebush			X	X
Chloanthaceae		<i>Spartothamnella juncea</i>	Bead Bush			X	X
Cucurbitaceae		<i>Cucumis myriocarpus</i> subsp. <i>leptodermis</i>	Paddy Melon			X	
Cupressaceae		<i>Callitris glaucophylla</i> (sapling)	White Cypress Pine			X	
Euphorbiaceae		<i>Beyeria viscosa</i>	Pinkwood			X	
Euphorbiaceae		<i>Euphorbia tannensis</i> ssp. <i>eremophila</i>				X	
Fabaceae (Caesalpinioideae)		<i>Cassia eremophila</i> var. <i>eremophila</i>					X
Fabaceae (Caesalpinioideae)		<i>Senna aciphylla</i>	Sprawling Cassia			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Fabaceae (Caesalpinioideae)		<i>Senna artemisioides</i>	Silver Cassia				X
Fabaceae (Faboideae)		<i>Hovea lanceolata</i>				X	
Fabaceae (Faboideae)		<i>Indigofera adesmiifolia</i>	Tick Indigo			X	
Fabaceae (Faboideae)		<i>Indigofera</i> sp.					X
Fabaceae (Faboideae)		<i>Swainsona cadellii</i>				X	
Fabaceae (Faboideae)		<i>Swainsona galegifolia</i>	Smooth Darling-pea			X	
Fabaceae (Faboideae)		<i>Swainsona monticola</i>				X	
Fabaceae (Mimosoideae)		<i>Acacia cheelii</i>	Motherumbah (juvenile)			X	
Fabaceae (Mimosoideae)		<i>Acacia deanei subsp. deanei</i>	Deane's Wattle			X	X
Fabaceae (Mimosoideae)		<i>Acacia decora</i>	Western Golden Wattle			X	
Fabaceae (Mimosoideae)		<i>Acacia implexa</i>	Hickory Wattle (juvenile)			X	X
Fabaceae (Mimosoideae)		<i>Acacia lineata</i>				X	
Fabaceae (Mimosoideae)		<i>Acacia montana</i>	Mallee Wattle				X
Fabaceae (Mimosoideae)		<i>Acacia oswaldii</i>	Miljee			X	
Fabaceae (Mimosoideae)		<i>Acacia pendula</i>	Weeping Myall (juvenile)			X	
Fabaceae (Mimosoideae)		<i>Acacia</i> sp.					X
Lamiaceae	*	<i>Marrubium vulgare</i>	Horehound			X	X
Ornithoglossaceae		<i>Lysiana subfalcata</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Malvaceae		<i>Abutilon leucopetalum</i>				X	
Malvaceae		<i>Abutilon otocarpum</i>	Desert Lantern				X
Malvaceae		<i>Abutilon oxycarpum</i> var. <i>oxycarpum</i>	Lantern Bush			X	
Malvaceae		<i>Abutilon</i> sp.					X
Malvaceae		<i>Hibiscus sturtii</i> var. <i>sturtii</i>				X	
Malvaceae	*	<i>Malva parviflora</i>	Small-flowered Mallow			X	
Malvaceae	*	<i>Malvastrum americanum</i>	Spiked Malvastrum			X	
Malvaceae		<i>Malvastrum coronandelianum</i>				X	
Malvaceae		<i>Sida cunninghamii</i>	Ridged Sida			X	X
Malvaceae		<i>Sida</i> sp.				X	
Malvaceae		<i>Sida spinosa</i>				X	
Malvaceae		<i>Sida subspicata</i>	Spiked Sida			X	X
Myoporaceae		<i>Eremophila mitchellii</i>	Budda			X	
Myoporaceae		<i>Myoporum montanum</i>	Western Boobialla			X	
Oleaceae		<i>Jasminum lineare</i>	Desert Jasmine			X	X
Oleaceae		<i>Jasminum suavisimum</i>				X	
Oleaceae		<i>Notelaea linearis</i>					
Oleaceae		<i>Notelaea microcarpa</i>	Native Olive			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Oleaceae		<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	Native Olive			X	
Phyllanthaceae		<i>Breynia oblongifolia</i>	Coffee Bush			X	
Pittosporaceae		<i>Bursaria spinosa</i>	Native Blackthorn			X	X
Pittosporaceae		<i>Bursaria spinosa</i> subsp. <i>spinosa</i>	Blackthorn			X	
Pittosporaceae		<i>Pittosporum angustifolium</i>	Weeping Pittosporum			X	X
Rubiaceae		<i>Psydrax oleifolia</i>				X	
Rutaceae		<i>Geijera parviflora</i>	Wilga			X	X
Sapindaceae		<i>Alectryon oleifolius</i> subsp. <i>elongatus</i>				X	
Sapindaceae		<i>Dodonaea ?triquetra</i>				X	
Sapindaceae		<i>Dodonaea boronifolia</i>	Fern-leaf Hop-bush			X	
Sapindaceae		<i>Dodonaea viscosa</i>	Sticky Hop-bush				X
Sapindaceae		<i>Dodonaea viscosa</i> ssp <i>angustifolia</i>	Sticky Hop-bush			X	
Solanaceae	*	<i>Lycium ferocissimum</i>	African Boxthorn			X	X
Solanaceae		<i>Solanum brownii</i>				X	
Solanaceae		<i>Solanum cinereum</i>	Narrawa Burr			X	
Solanaceae		<i>Solanum ellipticum</i>	Velvet Potato Bush				X
Solanaceae		<i>Solanum esuriale</i>	Quena			X	X
Solanaceae		<i>Solanum ferocissimum</i>	Spiny Potato-bush				X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Solanaceae		<i>Solanum parvifolium</i>				X	
Solanaceae		<i>Solanum parvifolium subsp. parvifolium</i>				X	
Sterculiaceae		<i>Brachychiton populneus subsp. populneus</i> (seedling)	Kurrajong			X	
Herbs – Ferns and Allies							
Adiantaceae		<i>Cheilanthes austrotenuifolia</i>	Rock Fern			X	
Adiantaceae		<i>Cheilanthes distans</i>	Bristly Cloak Fern			X	
Adiantaceae		<i>Cheilanthes sieberi subsp. sieberi</i>	Poison Rock Fern			X	
Adiantaceae		<i>Cheilanthes sp.</i>					X
Aspleniaceae		<i>Pleurosorus rufifolius</i>	Bristly Cloak Fern			X	
Herbs - Dicots							
Acanthaceae		<i>Brunoniella australis</i>	Blue Trumpet			X	X
Acanthaceae		<i>Rostellularia adscendens var. adscendens</i>				X	
Aizoaceae		<i>Zaleya galeculata subsp. australis</i>	Hogweed			X	
Amaranthaceae		<i>Alternanthera denticulata</i>	Lesser Joyweed			X	X
Amaranthaceae		<i>Alternanthera nana</i>	Hairy Joyweed			X	
Amaranthaceae	*	<i>Alternanthera pungens</i>	Khaki Weed			X	X
Amaranthaceae	*	<i>Amaranthus hybridus</i>	Slim Amaranth			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Amaranthaceae	*	<i>Gomphrena celosioides</i>	Gomphrena Weed			X	X
Amaranthaceae		<i>Ptilotus nobilis</i> var. <i>semilanatus</i>				X	
Apiaceae		<i>Ammi majus</i>				X	
Apiaceae	*	<i>Cyclospemum leptophyllum</i>	Slender Celery			X	
Apiaceae		<i>Daucus glochidiatus</i>	Native Carrot			X	
Apocynaceae		<i>Gomphocarpus elatus</i>				X	
Apocynaceae	*	<i>Gomphocarpus fruticosus</i>				X	
Asteraceae	*	<i>Arctotheca calendula</i>	Capeweed			X	
Asteraceae	*	<i>Aster subulatus</i>	Wild Aster			X	
Asteraceae	*	<i>Bidens bipinnata</i>	Bipinnate Beggar's Ticks			X	
Asteraceae	*	<i>Bidens pilosa</i>	Cobbler's Pegs			X	
Asteraceae	*	<i>Bidens subalternans</i>	Greater Beggar's Ticks			X	X
Asteraceae		<i>Brachyscome chrysoglossa</i>				X	
Asteraceae		<i>Brachyscome nova-angelica</i>				X	
Asteraceae		<i>Calotis cuneifolia</i>	Purple Burr-daisy			X	
Asteraceae		<i>Calotis hispidula</i>	Bogan Flea			X	
Asteraceae		<i>Calotis lappulacea</i>	Yellow Burr-daisy			X	
Asteraceae		<i>Calotis</i> sp.	Burr-daisy				X

Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Asteraceae	*	<i>Carthamus lanatus</i>	Saffron Thistle			X	
Asteraceae		<i>Cassinia aculeata</i>	Dolly Bush				X
Asteraceae	*	<i>Centaurea solstitialis</i>	St Barnaby's Thistle			X	
Asteraceae	*	<i>Centaurea sp.</i>					X
Asteraceae		<i>Centipeda minima subsp. minima</i>	Spreading Sneezeweed			X	
Asteraceae	*	<i>Chondrilla juncea</i>	Skeleton Weed			X	X
Asteraceae		<i>Chrysocephalum apiculatum</i>	Common Everlasting			X	
Asteraceae		<i>Chrysocephalum semipapposum</i>	Clustered Everlasting			X	
Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle			X	
Asteraceae	*	<i>Conyza albida (syn. Conyza sumatrensis)</i>	Tall Fleabane			X	
Asteraceae	*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane			X	X
Asteraceae	*	<i>Conyza sp.</i>	Fleabane			X	
Asteraceae		<i>Cotula australis</i>	Carrot Weed			X	
Asteraceae		<i>Cymbonotus lawsonianus</i>	Bears-ear			X	
Asteraceae		<i>Cymbonotus sp.</i>				X	
Asteraceae		<i>Euchiton involucreatus</i>	Star Cudweed			X	
Asteraceae		<i>Euchiton japonicus spp. complex</i>				X	
Asteraceae		<i>Euchiton sphaericus</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Asteraceae		<i>Gamochaeta americana</i>	Cud Weed			X	
Asteraceae		<i>Glossocardia bidens</i>	Cobblers Tack			X	
Asteraceae	*	<i>Hedynopsis rhagadioloides ssp. cretica</i>	Cretan Weed			X	
Asteraceae	*	<i>Helianthus annuus</i>	Common Sunflower			X	
Asteraceae	*	<i>Hypochoeris glabra</i>	Smooth Catsear			X	
Asteraceae	*	<i>Hypochoeris microcephala var. albiflora</i>	White Flatweed			X	
Asteraceae	*	<i>Hypochoeris sp.</i>				X	
Asteraceae	*	<i>Lactuca saligna</i>	Willow-leaved Lettuce			X	
Asteraceae	*	<i>Lactuca serriola</i>	Prickly Lettuce			X	
Asteraceae		<i>Lactuca sp.</i>				X	
Asteraceae		<i>Leiocarpa paneioides</i>	Woolly Buttons			X	
Asteraceae		<i>Olearia elliptica</i>	Sticky Daisy-bush			X	
Asteraceae		<i>Olearia elliptica subsp. elliptica</i>	Sticky Daisy-bush			X	
Asteraceae	*	<i>Onopordum acanthium subsp. acanthium</i>	Scotch Thistle			X	
Asteraceae		<i>Pycnosorus globosus</i>	Drumsticks				X
Asteraceae	*	<i>Schkuhria pinnata var. abrotanoides</i>				X	
Asteraceae		<i>Senecio sp.</i>				X	
Asteraceae		<i>Senecio tenuiflorus</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Asteraceae		<i>Sigesbeckia australiensis</i>				X	
Asteraceae		<i>Solenogyne bellioides</i>				X	
Asteraceae	*	<i>Soliva sessilis</i>	Bindyiii			X	
Asteraceae	*	<i>Sonchus asper</i>	Prickly Sowthistle			X	
Asteraceae		<i>Sonchus hydrophilus</i>				X	
Asteraceae	*	<i>Sonchus oleraceus</i>	Common Sowthistle			X	
Asteraceae		<i>Stuartina hamata</i>	Hooked Cudweed			X	
Asteraceae		<i>Stuartina muelleri</i>	Spoon Cudweed			X	
Asteraceae	*	<i>Taraxacum officinale</i>	Dandelion			X	
Asteraceae	*	<i>Tolpis barbata</i>	Yellow Hawkweed			X	
Asteraceae		<i>Trapogon porrifolius</i>	Oyster Plant			X	
Asteraceae		<i>Triptilodiscus pygmaeus</i>	Common Sunray			X	
Asteraceae		<i>Verbesina encelioides</i>				X	
Asteraceae		<i>Vittadinia cuneata var. cuneata</i>	Fuzzweed			X	X
Asteraceae		<i>Vittadinia dissecta var. hirta</i>				X	
Asteraceae		<i>Vittadinia muelleri</i>				X	
Asteraceae	*	<i>Xanthium spinosum</i>	Bathurst Burr			X	
Asteraceae		<i>Xerochrysium bracteatum ssp. bracteatum</i>	Golden Everlasting			X	X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Asteraceae	*	<i>Zinnia peruviana</i>					X
Boraginaceae	*	<i>Echium plantagineum</i>	Patterson's Curse			X	
Boraginaceae	*	<i>Heliotropium amplexicaule</i>				X	
Boraginaceae	*	<i>Heliotropium europaeum</i>				X	
Brassicaceae	*	<i>Capsella bursa-pastoralis</i>	Shepard's Purse			X	
Brassicaceae	*	<i>Hirschfeldia incana</i>				X	
Brassicaceae	*	<i>Lepidium africanum</i>				X	
Brassicaceae	*	<i>Lepidium bonariensis</i>				X	
Brassicaceae		<i>Lepidium sp.</i>					X
Brassicaceae		<i>Rapistrum rugosum</i>	Giant Mustard			X	
Brassicaceae	*	<i>Sinapis alba</i>	White Mustard			X	
Brassicaceae	*	<i>Sisymbrium irio</i>	London Rocket			X	
Brassicaceae	*	<i>Sisymbrium orientale</i>	Indian Hedge Mustard			X	
Campanulaceae		<i>Wahlenbergia communis</i>	Tufted Bluebell			X	
Campanulaceae		<i>Wahlenbergia gracilentia</i>				X	
Campanulaceae		<i>Wahlenbergia gracilis</i>	Australian Bluebell			X	
Campanulaceae		<i>Wahlenbergia graniticola</i>	Granite Bluebell			X	
Campanulaceae		<i>Wahlenbergia luteola</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Campanulaceae		<i>Wahlenbergia planiflora ssp. longipila</i>				X	
Campanulaceae		<i>Wahlenbergia sp.</i>	Bluebell			X	X
Caryophyllaceae		<i>Arenaria leptoclades</i>	Lesser Thyme-leaved Sand Wort			X	
Caryophyllaceae		<i>Gypsophyla tubulosa</i>	Annual Chalk Wart			X	
Caryophyllaceae		<i>Paronychia brasiliana</i>	Brasilian Witlow Wort			X	
Caryophyllaceae	*	<i>Petrorrhagia nanteuillii</i>				X	
Caryophyllaceae	*	<i>Petrorrhagia velutina</i>	Velvet Pink			X	
Caryophyllaceae	*	<i>Polycarpon tetraphyllum</i>	Four-leaved Allseed			X	
Caryophyllaceae		<i>Silene gallica</i>				X	
Caryophyllaceae		<i>Silene gallica var. gallica</i>				X	
Caryophyllaceae		<i>Spergularia rubra</i>	Sandspurry			X	
Caryophyllaceae	*	<i>Stellaria media</i>	Common Chickweed			X	
Caryophyllaceae		<i>Stellaria sp.</i>				X	
Chenopodiaceae		<i>Chenopodium auricomum</i>				X	
Chenopodiaceae		<i>Chenopodium carinatum</i>				X	
Chenopodiaceae		<i>Chenopodium desertorum subsp. anidiophyllum</i>					X
Chenopodiaceae		<i>Chenopodium pumilio</i>	Small Crumbweed			X	X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Chenopodiaceae		<i>Chenopodium sp.</i>					X
Chenopodiaceae		<i>Einadia hastata</i>	Berry Saltbush			X	
Chenopodiaceae		<i>Einadia nutans</i>	Climbing Saltbush			X	X
Chenopodiaceae		<i>Einadia nutans ssp. linifolia</i>				X	
Chenopodiaceae		<i>Einadia nutans ssp. nutans</i>				X	
Chenopodiaceae		<i>Einadia polygonoides</i>				X	
Chenopodiaceae		<i>Einadia sp.</i>				X	
Chenopodiaceae		<i>Einadia trigonos subsp. stelluata</i>	Fishweed			X	
Chenopodiaceae		<i>Enchylaena tomentosa</i>	Ruby Saltbush			X	X
Chenopodiaceae		<i>Maireana decalvans</i>				X	X
Chenopodiaceae		<i>Maireana sp.</i>					X
Chenopodiaceae		<i>Salsola tragus</i>				X	
Chenopodiaceae		<i>Sclerolaena birchii (syn. Bassia birchii)</i>	Galvanized Burr			X	
Chenopodiaceae		<i>Sclerolaena diacantha</i>	Grey Copperburr			X	
Chenopodiaceae		<i>Sclerolaena divaricata</i>	Tangled Copperburr			X	
Chenopodiaceae		<i>Sclerolaena muricata var. muricata</i>	Black Rolypoly			X	X
Chenopodiaceae		<i>Sclerolaena muricata var. semiglabra</i>	Black Rolypoly			X	
Chenopodiaceae		<i>Sclerolaena muricata var. villosa</i>	Black Rolypoly			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Chenopodiaceae		<i>Sclerolaena sp.</i>				X	X
Chenopodiaceae		<i>Sclerolaena ventricosa</i>				X	
Clusiaceae		<i>Hypericum gramineum</i>	Small St. John's Wort			X	
Colchicaceae		<i>Wurmbea dioica</i>	Early Nancy				
Convolvulaceae		<i>Convolvulus erubescens</i>	Blushing Bindweed			X	X
Convolvulaceae		<i>Dichondra repens</i>	Kidney Weed				X
Convolvulaceae		<i>Dichondra sp. A</i>				X	
Convolvulaceae		<i>Evolvulus alsinoides var. decumbens</i>				X	
Crassulaceae	*	<i>Bryophyllum delagoense</i>	Mother-of-millions			X	
Crassulaceae		<i>Crassula seiberiana</i>				X	
Dilleniaceae		<i>Hibbertia obtusifolia</i>	Hoary Guniea Flower			X	
Euphorbiaceae		<i>Chamaesyce australis</i>					X
Euphorbiaceae		<i>Chamaesyce drummondii</i>	Caustic Weed			X	
Euphorbiaceae		<i>Chamaesyce sp. A</i>				X	
Euphorbiaceae		<i>Cullen tenax</i>	Tough-scurf Pea			X	X
Euphorbiaceae		<i>Euphorbia tannensis</i>				X	
Euphorbiaceae		<i>Phyllanthus hebecarpus</i>				X	
Euphorbiaceae		<i>Phyllanthus virgatus</i>				X	X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Euphorbiaceae		<i>Poranthera microphylla</i>				X	
Fabaceae (Ceasalopinoideae)		<i>Petalostylis labichoides</i>				X	
Fabaceae (Faboideae)		<i>Cullen australasicum</i>				X	
Fabaceae (Faboideae)		<i>Desmodium brachypodium</i>	Large tick-trefoil			X	
Fabaceae (Faboideae)		<i>Desmodium sp.</i>					X
Fabaceae (Faboideae)		<i>Desmodium varians</i>	Tick-trefoil			X	
Fabaceae (Faboideae)	*	<i>Medicago minima</i>	Woolly Burr-Medic			X	
Fabaceae (Faboideae)	*	<i>Medicago sativa</i>	Lucerne			X	
Fabaceae (Faboideae)		<i>Onobrychis vicifolia</i>	Sainfoin			X	
Fabaceae (Faboideae)		<i>Trifolium angustifolium</i>	Narrow-leaved Clover			X	
Fabaceae (Faboideae)	*	<i>Trifolium arvense</i>	Haresfoot Clover			X	
Fabaceae (Faboideae)	*	<i>Trifolium campestre</i>	Hop Clover			X	
Fabaceae (Faboideae)	*	<i>Trifolium glomeratum</i>	Cluster Clover			X	
Fabaceae (Faboideae)	*	<i>Trifolium scabrum</i>				X	
Fabaceae (Faboideae)	*	<i>Trifolium sp.</i>	Clover			X	
Fabaceae (Faboideae)	*	<i>Trifolium vesiculosum</i>				X	
Fabaceae (Mimosoideae)		<i>Neptunia gracilis f. gracilis</i>	Sensitive Plant			X	
Gentianaceae		<i>Centaurium sp.</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Gentianaceae	*	<i>Centaurium spicatum</i>				X	
Geraniaceae		<i>Erodium cicutarium</i>	Blue Storksbill			X	
Geraniaceae		<i>Geranium solanderi</i> var. <i>solanderi</i>	Native Geranium			X	
Geraniaceae		<i>Geranium</i> sp.				X	
Goodeniaceae		<i>Goodenia glabra</i>				X	
Goodeniaceae		<i>Goodenia pinatifida</i>				X	
Goodeniaceae		<i>Goodenia</i> sp.				X	X
Haloragaceae		<i>Gonocarpus elatus</i>				X	
Haloragaceae		<i>Myriophyllum verrucosum</i>	Red Water-milfoil			X	
Lamiaceae		<i>Ajuga australis</i>	Austral Bugle			X	
Lamiaceae		<i>Mentha sativa</i> var. <i>mentha</i>	Native Pennyroyal			X	
Lamiaceae		<i>Oncoclype betchei</i>				X	
Lamiaceae		<i>Salvia plebeia</i>				X	
Lamiaceae	*	<i>Salvia verbenaca</i>	Wild Sage				X
Lamiaceae	*	<i>Stachys arvensis</i>	Stagger Weed			X	
Lamiaceae		<i>Teucrium</i> sp. <i>D</i>				X	
Lobeliaceae		<i>Isotoma axillaris</i>	Showy Isotome			X	
Lobeliaceae		<i>Pratia</i> sp.				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Lythraceae		<i>Lythrum hyssopifolia</i>	Hyssop Loosestrife			X	
Malvaceae	*	<i>Modiola caroliniana</i>	Red-flowered Mallow			X	
Malvaceae		<i>Sida corrugata</i>	Corrugated Sida			X	X
Malvaceae		<i>Sida sp.A</i>				X	
Malvaceae		<i>Sida trichopoda</i>	Spiked Sida			X	
Myoporaceae		<i>Eremophila debilis</i>	Winter Apple			X	X
Myrsinaceae	*	<i>Anagallis arvensis</i>	Scarlet/Blue Pimpernel			X	
Nyctaginaceae		<i>Boerhavia dominii</i>	Tarvine			X	
Onagraceae		<i>Epilobium billardierianum subsp. cinereum</i>				X	
Onagraceae		<i>Epilobium sp.</i>				X	
Onagraceae	*	<i>Oenothera affinis</i>				X	
Onagraceae	*	<i>Oenothera mollissima</i>				X	
Oxalidaceae	*	<i>Oxalis corniculata</i>	Creeping Oxalis				X
Oxalidaceae		<i>Oxalis exilis</i>				X	
Oxalidaceae		<i>Oxalis perennans</i>				X	
Oxalidaceae		<i>Oxalis radicata</i>				X	
Oxalidaceae		<i>Oxalis sp.</i>				X	X
Oxalidaceae		<i>Oxalis thompsoniae</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Papaveraceae	*	<i>Argemone ochroleuca subsp. ochroleuca</i>	Mexican Poppy			X	
Plantaginaceae		<i>Plantago cunninghamii</i>					X
Plantaginaceae		<i>Plantago debilis</i>				X	
Plantaginaceae	*	<i>Plantago lanceolata</i>	Plantain			X	X
Plantaginaceae		<i>Plantago sp.</i>				X	
Plantaginaceae	*	<i>Veronica arvensis</i>				X	
Polygonaceae		<i>Muehlenbeckia florulenta</i>	Lignum			X	
Polygonaceae	*	<i>Polygonum aviculare</i>	Wireweed			X	
Polygonaceae		<i>Polygonum patulum</i>				X	
Polygonaceae		<i>Rumex brownii</i>	Dockweed			X	X
Polygonaceae	*	<i>Rumex crispus</i>	Curled Dock			X	
Polygonaceae		<i>Rumex dumosus</i>				X	
Polygonaceae		<i>Rumex sp.</i>					X
Polygonaceae		<i>Rumex tenax</i>				X	
Portulacaceae		<i>Calandrinia eremaea</i>				X	
Portulacaceae		<i>Portulaca oleracea</i>	Pigweed			X	X
Ranunculaceae		<i>Ranunculus pentadandrus</i>				X	
Ranunculaceae		<i>Ranunculus sessilifloris var sessiliflora</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Rubiaceae		<i>Galium leptogonium</i>				X	
Rubiaceae		<i>Galium microlobum</i>				X	
Rubiaceae		<i>Galium polyanthum</i>				X	
Rubiaceae		<i>Galium sp. A</i>				X	
Rubiaceae		<i>Galium sp.</i>					X
Rubiaceae		<i>Opercularia diphylla</i>				X	
Rubiaceae		<i>Pomax umbellata</i>				X	
Scrophulariaceae	*	<i>Misopates orontium</i>	Lesser Snapdragon			X	
Scrophulariaceae		<i>Verbascum virgatum</i>	Twiggy Mullein			X	
Solanaceae		<i>Nicotiana simulans</i>				X	
Solanaceae		<i>Physalis viscosa</i>	Prairie Ground Cherry			X	
Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade			X	
Solanaceae		<i>Solanum sp.</i>					X
Solanaceae	*	<i>Solanum triflorum</i>	Three-flowered Nightshade				X
Stackhousiaceae		<i>Stackhousia viminea</i>	Slender Stackhousia			X	
Sterculiaceae		<i>Brachychiton populneus subsp. populneus</i>	Kurrajong (seedling)			X	
Urticaceae		<i>Parietaria debilis</i>	Native Pellitory			X	
Urticaceae		<i>Urtica incisa</i>	Stinging Nettle			X	

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Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Urticaceae		<i>Urtica sp.</i>				X	
Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop			X	X
Verbenaceae	*	<i>Verbena hispida</i>				X	
Verbenaceae	*	<i>Verbena officinalis</i>	Common Verbena			X	X
Verbenaceae	*	<i>Verbena tenuisecta</i>				X	
Violaceae		<i>Hybanthus monopetalus</i>	Slender Violet Bush				X
Zygophyllaceae	*	<i>Tribulus terrestris</i>	Catshead			X	
Zygophyllaceae		<i>Zygophyllum apiculatum</i>	Gallweed			X	
Herbs – Monocots (Grasses)							
Poaceae		<i>Agrostis venusta</i>				X	
Poaceae		<i>Ancistrachne uncinulata</i>				X	
Poaceae		<i>Aristida calycina var. calycina</i>				X	
Poaceae		<i>Aristida calycina var. praealta</i>				X	
Poaceae		<i>Aristida caput-medusae</i>				X	
Poaceae		<i>Aristida leptopoda</i>	White Speargrass			X	X
Poaceae		<i>Aristida personata (Syn Aristida ramosa var. speciosa)</i>	Purple Wiregrass			X	
Poaceae		<i>Aristida ramosa</i>	Purple Wiregrass			X	X

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Aristida sp.</i>	Wire Grass			X	
Poaceae		<i>Austrodanthonia bipartita</i>	Wallaby Grass			X	
Poaceae		<i>Austrodanthonia caespitosa</i>	Ringed Wallaby Grass			X	X
Poaceae		<i>Austrodanthonia fulva</i>				X	
Poaceae		<i>Austrodanthonia racemosa var. obtusata</i>	Wallaby Grass			X	
Poaceae		<i>Austrodanthonia sp.</i>	Wallaby Grass			X	X
Poaceae		<i>Austrodanthonia tenuior</i>				X	
Poaceae		<i>Austrostipa aristiglumis</i>	Plains Grass			X	
Poaceae		<i>Austrostipa densiflora</i>				X	
Poaceae		<i>Austrostipa ramosissima</i>	Stout Bamboo Grass			X	X
Poaceae		<i>Austrostipa scabra subsp. scabra</i>	Speargrass			X	X
Poaceae		<i>Austrostipa setacea</i>	Corkscrew Grass			X	
Poaceae		<i>Austrostipa sp.</i>				X	
Poaceae		<i>Austrostipa verticillata</i>	Slender Bamboo Grass			X	
Poaceae	*	<i>Avena sp.</i>	Oats			X	
Poaceae		<i>Bothriochloa biloba</i>		Vulnerable		X	
Poaceae		<i>Bothriochloa decipiens var. decipiens</i>	Red Grass			X	X
Poaceae		<i>Bothriochloa macra</i>	Red-leg Grass			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Bothriochloa sp.</i>				X	
Poaceae	*	<i>Bromus arenarius</i>				X	
Poaceae	*	<i>Bromus catharticus</i>	Prairie Grass			X	
Poaceae		<i>Bromus hordeaceus</i>				X	
Poaceae	*	<i>Cenchrus spinifex</i>	Spiny Burrgrass				X
Poaceae		<i>Chloris divaricata var. divaricata</i>	Slender Chloris				X
Poaceae	*	<i>Chloris gayana</i>	Rhodes Grass			X	
Poaceae		<i>Chloris truncata</i>	Windmill Grass			X	X
Poaceae		<i>Chloris ventricosa</i>	Plump Windmill Grass			X	X
Poaceae	*	<i>Chloris virgata</i>	Feathertop Rhodes Grass			X	X
Poaceae		<i>Cymbopogon refractus</i>	Barbed Wire Grass			X	X
Poaceae		<i>Cynodon dactylon</i>	Common Couch			X	X
Poaceae		<i>Dactyloctenium radulans</i>	Button Grass			X	X
Poaceae		<i>Dichanthium sericeum ssp. sericeum</i>	Silky Blue-grass			X	X
Poaceae		<i>Dichelachne micrantha</i>	Shorthair Plumegrass			X	
Poaceae		<i>Dichelachne sieberiana</i>				X	
Poaceae		<i>Digitaria amnophila</i>	Silky Umbrella Grass				X
Poaceae		<i>Digitaria breviglumis</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Digitaria brownii</i>	Cotton Panic Grass				X
Poaceae		<i>Digitaria diffusa</i>	Open Summer-grass			X	
Poaceae		<i>Digitaria divaricatissima</i>	Umbrella Grass			X	X
Poaceae		<i>Digitaria ramularis</i>				X	
Poaceae		<i>Echinochloa sp.</i>					X
Poaceae	*	<i>Eleusine tristachya</i>	Goose Grass			X	
Poaceae		<i>Elymus scaber var. scaber</i>	Common Wheatgrass			X	
Poaceae		<i>Elymus sp.</i>				X	
Poaceae		<i>Elymus sp. A</i>				X	
Poaceae		<i>Enneapogon gracilis</i>	Slender Bottle-washers			X	
Poaceae		<i>Enneapogon sp.</i>				X	X
Poaceae		<i>Enteropogon acicularis</i>				X	
Poaceae		<i>Eragrostis alveiformis</i>				X	
Poaceae		<i>Eragrostis australasica</i>	Cane Grass			X	
Poaceae		<i>Eragrostis brownii</i>	Lovegrass			X	
Poaceae	*	<i>Eragrostis cilianensis</i>	Stinkgrass			X	X
Poaceae	*	<i>Eragrostis curvula</i>	African Lovegrass			X	
Poaceae		<i>Eragrostis elongata</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Eragrostis lacunaria</i>	Purple Lovegrass			X	
Poaceae		<i>Eragrostis leptostachya</i>				X	X
Poaceae		<i>Eragrostis megalosperma</i>				X	
Poaceae		<i>Eragrostis parviflora</i>				X	X
Poaceae		<i>Eragrostis sp.</i>	Lovegrass			X	
Poaceae		<i>Eriochloa pseudoacrotricha</i>	Early Spring Grass			X	
Poaceae		<i>Eriochloa sp.</i>					X
Poaceae		<i>Eulalia aurea</i>				X	
Poaceae	*	<i>Hordeum leporinum</i>	Barley Grass			X	
Poaceae		<i>Lachnagrostis filiformis (syn. Agrostis avenacea)</i>				X	
Poaceae		<i>Lamarkia aurea</i>	Goldentop			X	
Poaceae		<i>Leptochloa asthenes (syn. L. decipiens subsp. asthenes)</i>				X	
Poaceae		<i>Leptochloa fusca ssp. fusca</i>				X	
Poaceae	*	<i>Lolium perenne</i>	Perennial Ryegrass			X	
Poaceae	*	<i>Lolium sp.</i>				X	
Poaceae		<i>Microlaena stipoides var. stipoides</i>	Weeping Meadow Grass			X	
Poaceae		<i>Notodanthonia longifolia</i>	Long-leaved Wallaby Grass			X	

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Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Notodanthonia semicanularis</i>				X	
Poaceae		<i>Panicum brunei</i>				X	
Poaceae		<i>Panicum decompositum</i>	Native Millet			X	
Poaceae		<i>Panicum effusum</i>	Hairy Panic			X	X
Poaceae		<i>Panicum queenslandicum</i>	Yadbila Grass			X	
Poaceae	*	<i>Panicum maximum</i>	Guinea Grass				X
Poaceae	*	<i>Panicum maximum var. trichoglume</i>	Green Panic			X	
Poaceae		<i>Paspalidium constrictum</i>	Knobbybutt Grass			X	
Poaceae		<i>Paspalidium criniforme</i>					X
Poaceae		<i>Paspalidium distans</i>				X	
Poaceae		<i>Paspalidium gracile</i>	Slender Panic			X	
Poaceae		<i>Paspalidium jubiflorum</i>				X	
Poaceae		<i>Paspalidium sp.</i>				X	
Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum			X	X
Poaceae	*	<i>Paspalum notatum</i>	Bahia Grass			X	
Poaceae	*	<i>Phalaris paradoxa</i>				X	
Poaceae		<i>Poa sieberiana var. hirtella</i>	Snowgrass			X	
Poaceae		<i>Poa sieberiana var. sieberiana</i>	Snowgrass			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Poaceae		<i>Polypogon monspeliensis</i>				X	
Poaceae	*	<i>Rostraria cristata</i>	Annual Cat's Tail			X	
Poaceae	*	<i>Sorghum halepense</i>	Johnson Grass			X	X
Poaceae		<i>Sporobolus caroli</i>	Fairy Grass			X	
Poaceae		<i>Sporobolus creber</i>	Western Rat-tail Grass			X	X
Poaceae		<i>Sporobolus sp.</i>				X	
Poaceae		<i>Themeda triandra</i>				X	
Poaceae	*	<i>Thinopyrum elongatum</i>				X	
Poaceae		<i>Triodia scariosa subsp. scariosa</i>	Porcupine Grass			X	
Poaceae	*	<i>Triticum aestivum</i>	Common Wheat			X	
Poaceae	*	<i>Triticum sp.</i>	Wheat			X	
Poaceae		<i>Unknown sp.</i>	Unknown Grass Species			X	
Poaceae	*	<i>Urochloa panicoides</i>	Urochloa Grass			X	
Poaceae	*	<i>Vulpia muralis</i>				X	
Poaceae	*	<i>Vulpia sp.</i>				X	
Poaceae		<i>Walwhalleya proluta</i>				X	
Herbs – Monocots (Other)							
Amaryllidaceae		<i>Crinum flaccidum</i>	Darling Lily			X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Anthericaceae		<i>Arthropodium milleflorum</i>	Pale Vanilla-lily			X	
Anthericaceae		<i>Arthropodium minus</i>	Small Vanilla Lily			X	
Anthericaceae		<i>Arthropodium sp. B</i>				X	
Anthericaceae		<i>Dichopogon strictus</i>	Chocolate Lily			X	
Anthericaceae		<i>Laxmannia gracilis</i>	Slender Wire-lily			X	
Anthericaceae		<i>Tricoryne elatior</i>				X	
Asparagaceae	*	<i>Asparagus asparagoides</i>	Bridal Creeper				X
Asphodelaceae		<i>Bulbine bulbosa</i>	Native Leek				
Asphodelaceae		<i>Bulbine semibarbata</i>				X	
Commelinaceae		<i>Commelina cyanea</i>	Native Wandering Jew			X	
Cyperaceae		<i>Bolboschoenus sp.</i>				X	
Cyperaceae		<i>Carex inversa</i>				X	X
Cyperaceae		<i>Cyperus bifax</i>				X	
Cyperaceae	*	<i>Cyperus eragrostis</i>	Mullumbimby Couch				X
Cyperaceae		<i>Cyperus fulvus</i>	Sticky Sedge			X	
Cyperaceae		<i>Cyperus gracilis</i>	Slender Flat-sedge			X	
Cyperaceae		<i>Cyperus sp.</i>				X	X
Cyperaceae		<i>Fimbristylis dichotoma</i>				X	

Table E.1 Flora Species Recorded within the Project Boundary							
Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Cyperaceae		<i>Gahnia aspera</i>	Rough Saw-sedge			X	
Hypoxidaceae		<i>Hypoxis hygrometrica</i> var. <i>villosisepala</i>				X	
Hypoxidaceae		<i>Hypoxis pratensis</i> var. <i>pratensis</i>	Golden-weather Grass			X	
Juncaceae		<i>Juncus ?australis</i>				X	
Juncaceae		<i>Juncus ochrocoleus</i>				X	
Juncaceae		<i>Juncus remotiflorus</i>				X	
Juncaceae		<i>Juncus</i> sp.				X	X
Juncaceae		<i>Juncus subsecundus</i>				X	
Lomandraceae		<i>Lomandra bracteata</i>				X	
Lomandraceae		<i>Lomandra filiformis</i> ssp. <i>filiformis</i>	Wattle Mat-rush			X	
Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			X	
Lomandraceae		<i>Lomandra multiflora</i> ssp. <i>multiflora</i>	Many-flowered Mat-rush			X	
Lomandraceae		<i>Lomandra</i> sp.				X	X
Orchidaceae		<i>Cymbidium canaliculatum</i>	Tiger Orchid			X	
Orchidaceae		<i>Microtis unifolia</i>				X	
Phormiaceae		<i>Dianella longifolia</i> var. <i>longifolia</i>				X	X
Phormiaceae		<i>Dianella revoluta</i> var. <i>revoluta</i>	Blue Flax-lily			X	
Phormiaceae		<i>Dianella</i> sp.				X	

Table E.1 Flora Species Recorded within the Project Boundary

Family	*	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Vines							
Marsileaceae		<i>Marsilea drumondii</i>	Common Nardoo			X	
Apocynaceae		<i>Parsonsia eucalyptophylla</i>	Gargaloo			X	X
Araliaceae	*	<i>Hedera helix</i>	English Ivy			X	
Bignoniaceae		<i>Pandorea pandorana subsp. pandorana</i>	Wonga Wonga Vine			X	
Fabaceae (Faboideae)		<i>Glycine clandestina</i>				X	X
Fabaceae (Faboideae)		<i>Glycine sp.</i>				X	
Fabaceae (Faboideae)		<i>Glycine tabacina</i>				X	X
Polygonaceae	*	<i>Fallopia convulvulus</i>	Black Bindweed			X	
Ranunculaceae		<i>Clematis microphylla</i>	Small-leaved Clematis			X	

* denotes exotic species

Appendix F

Flora Likelihood of Occurrence

Table F.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence	
Artesian Springs Ecological Community	EEC	The springs occur where artesian water emerges at the surface through fault-lines in the overlying rock and produce mounds from the salts and sediments as the water evaporates. Occurs at the edges of the Great Artesian Basin. Mostly found in Queensland and South Australia, however, a few occur in the Mulga Lands, Darling Riverine Plains and Cobar Peneplain Bioregions of New South Wales.	Not likely to occur. No suitable habitat. Not known in the Brigalow Belt South Bioregion or detected within the Project Boundary during surveys.	
Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	EEC	The Brigalow community is a low woodland or forest community dominated by Brigalow <i>Acacia harpophylla</i> , with pockets of Belah <i>Casuarina cristata</i> and Poplar Box <i>Eucalyptus populnea subsp. bimbil</i> . Scattered remnants on the North West Slopes and Plains and Darling River Plains in New South Wales; also in Queensland. Usually occurs on heavy clay soils.	Present. Detected during surveys within the Project Boundary (see Figure 4.1)	
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	EEC	A woodland community of flora and fauna is found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees. The structure of the community may vary from tall riparian woodlands to very open 'savanna like' grassy woodlands with a sparse midstorey of shrubs and saplings. Typically these woodlands form mosaics with grasslands and wetlands, and are characterised by Coolibah (<i>Eucalyptus coolabah</i>) and, in some areas, Black Box (<i>E. largiflorens</i>). Other tree species may be present including River Cooba (<i>Acacia stenophylla</i>), Cooba (<i>A. salicina</i>), Belah (<i>Casuarina cristata</i>) and Eurah (<i>Eremophila bignoniiflora</i>). Northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions.	Potential to occur. Not detected during surveys within the Project Boundary.	

Table F.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence	
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Penepplain, Nandewar and Brigalow Belt South Bioregions	EEC	Inland Grey Box Woodland includes those woodlands in which the most characteristic tree species, <i>Eucalyptus microcarpa</i> (Inland Grey Box), is often found in association with <i>E. populnea subsp. bimbil</i> (Bimble or Poplar Box), <i>Callitris glaucophylla</i> (White Cypress Pine), <i>Brachychiton populneus</i> (Kurrajong), <i>Allocasuarina luehmannii</i> (Bullock) or <i>E. melliodora</i> (Yellow Box), and sometimes with <i>E. albens</i> (White Box). Inland Grey Box Woodland occurs predominately within the Riverina and South West Slopes regions of New South Wales down to the Victorian border. Inland Grey Box Woodland occurs on fertile soils of the western slopes and plains of New South Wales.	Present. Detected during surveys within the Project Boundary (see Figure 4.1)	
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penepplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions	EEC	This ecological community is scattered across the eastern parts of the alluvial plains of the Murray-Darling river system. Typically, it occurs on red-brown earths and heavy textured grey and brown alluvial soils within a climatic belt receiving between 375 and 500 mm mean annual rainfall. The structure of the community varies from low woodland and low open woodland to low sparse woodland or open shrubland, depending on site quality and disturbance history. The tree layer grows up to a height of about 10 metres and invariably includes <i>Acacia pendula</i> (Weeping Myall or Boree) as one of the dominant species or the only tree species present.	Present. Detected during surveys within the Project Boundary (see Figure 4.1)	
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	CEEC	Native Vegetation on Cracking Clay Soils of the Liverpool Plains is mainly a native grassland community which includes a range of small forb and herb species. The main grass species include Plains Grass (<i>Austrostipa aristiglumis</i>), Queensland Bluegrass (<i>Dichanthium sericeum</i>) and Coolibah Grass (<i>Panicum queenslandicum</i>). It also contains scattered and patchy shrubs and trees, including Boree (<i>Acacia pendula</i>), Rough-barked Apple (<i>Angophora floribunda</i>), Fuzzy Box (<i>Eucalyptus conica</i>), Bimble Box (<i>E. populnea</i>) and Yellow Box (<i>E. melliodora</i>). This community is located around Coonabarabran, Gunnedah, Murrumbidgee, Narrabri, Tamworth and Quirindi, on the North West Slopes and Plains of New South Wales. Occurs on the highly fertile cracking clay	Potential to occur within pipeline easements to the Mooki River.	

Table F.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence	
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions	EEC	soils of the Liverpool Plains. A low, dense form of dry rainforest generally less than 10 m high, made up of vines and rainforest trees as well as some shrubs. This community often stands out as a bright green against surrounding woodland due to many species having bright-coloured leaves. The main canopy is dominated by rainforest species such as Red Olive Plum (<i>Cassine australis</i> var. <i>angustifolia</i>), Wilga (<i>Geijera parvifolia</i>) Native Olive (<i>Notelaea microcarpa</i> var. <i>microcarpa</i>) and Peach Bush (<i>Ehretia membranifolia</i>), with taller eucalypts and cypress pines from surrounding woodland vegetation emerging above the main canopy. A scattered distribution near Gunnedah, Barraba, Bingara and north of Wyalda on the New South Wales North West Slopes and Plains, and also in Queensland. This community often occurs on rocky hills, in deep, loam, high nutrient soils derived from basalt or other volcanic rocks, in areas which are sheltered from frequent fire.	Present. Small area recorded from Mt Watermark in an area outside of the Disturbance Area (see Figure 4.1).	
White Box Yellow Box Blakely's Red Gum Woodland	CEEC	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box Gum Woodland) is an open woodland community (sometimes occurring as a forest formation). The main canopy is dominated by one or more of the following: White Box (<i>Eucalyptus albens</i>), Yellow Box (<i>E. melliodora</i>) and Blakely's Red Gum (<i>E. blakelyi</i>). Box Gum Woodland and Derived Native Grassland is found from the Queensland border in the north, to the Victorian border in the south. It occurs in the tablelands and western slopes of New South Wales.	Present. Detected during surveys within the Project Boundary (see Figure 4.1)	

Table F.2 Likelihood of Occurrence of Threatened Plants Known to Occur within the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur within the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Asclepiadaceae	<i>Tylophora linearis</i>		E	2	Tylophora linearis has rarely been collected and is known from eight localities in the Dubbo area and Mt Crow near Barraba in New South Wales, and "Myall Park" near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. Grows in dry scrub, open forest and woodlands associated with <i>Melaleuca uncinata</i> , <i>Eucalyptus fibrosa</i> , <i>E. sideroxylon</i> , <i>E. albens</i> , <i>Callitris endlicheri</i> , <i>C. glaucophylla</i> , <i>Allocasuarina luehmannii</i> , <i>Acacia hakeoides</i> , <i>A. lineata</i> , <i>Myoporum spp.</i> , and <i>Casuarina spp.</i>	Not likely to occur. Not known within the Gunnedah LGA. Project Boundary is situated beyond known populations. Not detected during surveys.
Fabaceae - Faboideae	<i>Swainsona murrayana</i>	Slender Darling Pea	V	0	Often grows with Maireana species on heavy soils, especially in depression. Found throughout New South Wales, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. It grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated. The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams.	Not likely to occur. Species is not known within the Gunnedah LGA or the wider Namoi Catchment Management Area. Not recorded during surveys.

Table F.2 Likelihood of Occurrence of Threatened Plants Known to Occur within the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur within the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Orchidaceae	<i>Prasophyllum</i> sp. <i>Wybong</i>		CE	0	The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated.	Not likely to occur. Not known within the Gunnedah LGA. Project Boundary is situated beyond known populations. Not detected during surveys.
Orchidaceae	<i>Pterostylis cobarensis</i>	Greenhood Orchid / Cobar Rustyhood	V	0	Grows among rocks on low hills and on slopes above streams; chiefly from Nyngan to Bourke district of the Western plains of New South Wales and favours stony ridges, often growing under <i>Eucalyptus morrisii</i> (Grey Mallee). Habitats are eucalypt woodlands, open mallee or Callitris shrublands on low stony ridges and slopes in skeletal sandy-loam soils. It has been recorded from ridge tops as well as steep exposed slopes and sheltered east slopes. Soils include shallow red clay-loam, skeletal red loam on metaquartzite, shallow sandy-loam on conglomerate and sandstone, and skeletal gritty organic loam on microgranite. Associated species include <i>Eucalyptus morrisii</i> , <i>E. viridis</i> , <i>E. intertexta</i> , <i>E. vicina</i> , <i>Callitris glaucophylla</i> , <i>Geijera parviflora</i> , <i>Casuarina cristata</i> , <i>Acacia doratoxylon</i> , <i>Senna</i> sp. and <i>Eremophila</i> sp.	Potential to occur though not likely. No suitable habitat was recorded during surveys of the Project Boundary. Not recorded within the Gunnedah LGA.
Poaceae	<i>Bothriochloa</i>	Lobed Blue Grass	V	21	Commonly found on clay soils in woodlands and grasslands in the	Recorded along Court Lane

Table F.2 Likelihood of Occurrence of Threatened Plants Known to Occur within the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur within the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act Status	LGA Count	Habitat	Likelihood of Occurrence
	<i>biloba</i>				following NSW botanical regions: North Coast, Central Coast, Northern Tablelands, North West Slopes, Central West Slopes, North West Plains, South West Plains	and The Dip Road within the Project boundary.
Poaceae	<i>Dichanthium setosum</i>	Bluegrass	V	9	Grows in woodland. NSW botanical regions: Northern Tablelands, North West Slopes, Central West Slopes, North West Plains	Present. Atlas of NSW Wildlife records occur within Project Boundary along Court Road
Poaceae	<i>Digitaria porrecta</i>	Finger Panic Grass	E	8	In New South Wales it occurs in north western slopes and north western plains subdivisions where it grows in native grassland, woodlands or open forest with a grassy understorey, on richer soils. It is often found along roadsides and travelling stock routes where there is light grazing and occasional fire.	Potential to occur on valley floors on richer soils. Known within the Gunnedah LGA. Not recorded during surveys.
Proteaceae	<i>Hakea pulvinifera</i>	Lake Keepit Hakea	E	11	Recorded from a single population on a hard rocky hillside below a dam. The site is also recorded as being hot and dry and well drained.	Not likely to occur. Lake Keepit Hakea is confined to a single population near Lake Keepit, north-east of Gunnedah.
Rutaceae	<i>Philotheca ericifolia</i>		V	0	Known only from the upper Hunter Valley and Pilliga to Peak Hill districts of New South Wales. The records are scattered over a range of over 400 km between West Wyalong and the Pilliga Scrub. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been	Not likely to occur. Not known within the Gunnedah LGA. No suitable habitat of vegetation type recorded

Table F.2 Likelihood of Occurrence of Threatened Plants Known to Occur within the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur within the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act Status	LGA Count	Habitat	Likelihood of Occurrence
					collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include <i>Melaleuca uncinata</i> , <i>Eucalyptus crebra</i> , <i>E. rossii</i> , <i>E. punctata</i> , <i>Corymbia trachyphloia</i> , <i>Acacia triptera</i> , <i>A. burrowii</i> , <i>Beyeria viscosa</i> , <i>Philotheca australis</i> , <i>Leucopogon muticus</i> and <i>Calytrix tetragona</i> .	during surveys.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax	V	0	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be <i>Themeda australis</i> and <i>Poa spp.</i> On the tablelands it occurs with <i>Eucalyptus pauciflora</i> , <i>E. dalrympleana</i> or <i>E. viminalis</i> .	Not likely to occur. Not known within the Gunnedah LGA. Not detected during surveys.
Scrophulariaceae	<i>Euphrasia arguta</i>		CE	0	Grows in grassy areas near rivers, recorded from Bathurst to Walcha area	Not likely to occur. Not known within the Gunnedah LGA. No suitable habitat detected during surveys.
Surianaceae	<i>Cadellia pentastylis</i>	Ooline	V	2	Occurs west from near Tenterfield and north from Terry Hie Hie. Grows mainly in vine thickets or dry rainforest, and more rarely occurs in woodlands. It is a relict rainforest species and tends to favour upper and mid slope positions, often with a northerly aspect. It commonly occurs on sandy-loam to clay soils of low to medium fertility. It can occur in pure stands or in a mixed community on the slopes of residual sandstone ranges and scarps.	Potential to occur within Whitewood Woodland and other remnants. Known within the Gunnedah LGA. Not detected during surveys.

Notes: V = Vulnerable; E = Endangered; CE = Critically Endangered

Appendix G

Fauna Species List

Table G.1 Fauna Species Recorded within the Project Boundary

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Amphibians						
Hylidae	<i>Cyclorana verrucosa</i>	Rough Collared Frog			X	
Hylidae	<i>Litoria caerulea</i>	Green Tree Frog			X	
Hylidae	<i>Litoria latopalmata</i>	Broad-palmed Frog			X	
Hylidae	<i>Litoria peronii</i>	Peron's Tree Frog			X	
Myobatrachidae	<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog			X	
Reptiles						
Agamidae	<i>Amphibolurus muricatus</i>	Jacky Lizard				X
Agamidae	<i>Pogona barbata</i>	Eastern Bearded Dragon			X	X
Elapidae	<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake			X	
Elapidae	<i>Pseudonaja textilis</i>	Eastern Brown Snake			X	
Gekkonidae	<i>Diplodactylus vittatus</i>	Eastern Stone Gecko			X	
Gekkonidae	<i>Gehyra dubia</i>	Dubious Drella			X	
Gekkonidae	<i>Oedura lesueurii</i>	Lesueur's Velvet Gecko			X	
Gekkonidae	<i>Oedura robusta</i>	Robust Velvet Gecko			X	
Gekkonidae	<i>Underwoodisaurus milii</i>	Thick-tailed Gecko			X	
Pygopodidae	<i>Lialis burtonis</i>	Burton's Legless Lizard			X	

Table G.1 Fauna Species Recorded within the Project Boundary						
Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Scincidae	<i>Anomalopus leuckartii</i>	Two-clawed Worm-skink			X	
Scincidae	<i>Ctenotus robustus</i>	Robust Ctenotus			X	
Scincidae	<i>Egernia striolata</i>	Tree Skink			X	
Scincidae	<i>Lerista muelleri</i>	Three-toed Lerista			X	
Scincidae	<i>Menetia greyii</i>				X	
Scincidae	<i>Morethia boulengeri</i>	Boulenger's Morethia			X	
Varanidae	<i>Varanus varius</i>	Lace Monitor			X	
Birds						
Phasianidae	<i>Coturnix pectoralis</i>	Stubble Quail			X	
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail			X	
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck			X	X
Anatidae	<i>Anhinga melanogaster</i>	Darter				X
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe			X	X
Columbidae	<i>Columba livia</i>	Rock Dove*				X
Columbidae	<i>Streptopelia chinensis</i>	Spotted Dove*			X	
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing			X	X
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon			X	X
Columbidae	<i>Geopelia striata</i>	Peaceful Dove			X	X

Table G.1 Fauna Species Recorded within the Project Boundary

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Columbidae	<i>Geopelia humeralis</i>	Bar-shouldered Dove			X	
Podargidae	<i>Podargus strigoides</i>	Tawny Frogmouth			X	X
Aegothelidae	<i>Aegothales cristatus</i>	Australian Owllet-nightjar			X	X
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant				X
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant				X
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron			X	X
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron				X
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis				X
Threskiornithidae	<i>Platalea flavipes</i>	Yellow-billed Spoonbill				X
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite			X	X
Accipitridae	<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	Migratory		X	
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk			X	
Accipitridae	<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk			X	
Accipitridae	<i>Circus assimilis</i>	Spotted Harrier		Vulnerable	X	
Accipitridae	<i>Circus approximans</i>	Swamp Harrier			X	
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle			X	X
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle		Vulnerable	X	
Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel			X	X
Falconidae	<i>Falco berigora</i>	Brown Falcon			X	X

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Falconidae	<i>Falco longipennis</i>	Australian Hobby			X	X
Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon			X	
Charadriidae	<i>Elsemyornis melanops</i>	Black-fronted Dotterel			X	
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing			X	
Cacatuidae	<i>Eolophus roseicapillus</i>	Galah			X	X
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo			X	X
Cacatuidae	<i>Nymphicus hollandicus</i>	Cockatiel			X	X
Psittacidae	<i>Glossopsitta concinna</i>	Musk Lorikeet			X	X
Psittacidae	<i>Glossopsitta pusilla</i>	Little Lorikeet		Vulnerable	X	
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot			X	X
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella			X	X
Psittacidae	<i>Barnardius zonarius</i>	Australian Ringneck			X	X
Psittacidae	<i>Psephotus haematotus</i>	Red-rumped Parrot			X	X
Strigidae	<i>Ninox connivens</i>	Barking Owl		Vulnerable		X
Strigidae	<i>Ninox novaeseelandiae</i>	Southern Boobook			X	X
Tytonidae	<i>Tyto javanica</i>	Eastern Barn Owl			x	x
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra			x	x
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher			x	
Climacteridae	<i>Cormobates leucophaea</i>	White-throated Treecreeper			x	

Table G.1 Fauna Species Recorded within the Project Boundary

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Climacteridae	<i>Climacteris picumnus victorae</i>	Brown Treecreeper		Vulnerable	x	
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren			x	x
Acanthizidae	<i>Chthonicola sagittata</i>	Speckled Warbler		Vulnerable	x	
Acanthizidae	<i>Smicromis brevirostris</i>	Weebill			x	x
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill			x	x
Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill			x	x
Acanthizidae	<i>Acanthiza reguloides</i>	Buff-rumped Thornbill			x	x
Acanthizidae	<i>Acanthiza apicalis</i>	Inland Thornbill			x	
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill				x
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote			x	x
Pardalotidae	<i>Pardalotus striatus</i>	Striated Pardalote			x	x
Meliphagidae	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater			x	x
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner			x	x
Meliphagidae	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater			x	x
Meliphagidae	<i>Philemon corniculatus</i>	Noisy Friarbird			x	
Meliphagidae	<i>Philemon citreogularis</i>	Little Friarbird				x
Pomatostomidae	<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler		Vulnerable	x	x
Campephagidae	<i>Coracina maxima</i>	Ground Cuckoo-shrike				x
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			x	x

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler			X	X
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush				X
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole			X	
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow			X	X
Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow			X	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird			X	X
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird			X	X
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie			X	X
Artamidae	<i>Strepera graculina</i>	Pied Currawong			X	X
Dicruridae	<i>Grallina cyanoleuca</i>	Magpie-lark			X	X
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail			X	X
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail			X	X
Corvidae	<i>Corvus coronoides</i>	Australian Raven			X	X
Corvidae	<i>Corvus mellori</i>	Little Raven			X	X
Corvidae	<i>Corvus orru</i>	Torresian Crow				X
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark			X	
Corcoracidae	<i>Corcorax melanorhamphos</i>	White-winged Chough			X	X
Corcoracidae	<i>Struthidea cinerea</i>	Apostlebird			X	X
Petroicidae	<i>Microeca fascians</i>	Jacky Winter				X

Table G.1 Fauna Species Recorded within the Project Boundary

Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Petroicidae	<i>Petroica goodenovii</i>	Red-capped Robin				X
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin			X	X
Megaluridae	<i>Cincloramphus cruralis</i>	Brown Songlark			X	
Timaliidae	<i>Zosterops lateralis</i>	Silvereye			X	
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow			X	X
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin				X
Hirundinidae	<i>Petrochelidon nigricans</i>	Tree Martin			X	
Sturnidae	<i>Sturnus vulgaris</i>	Common Starling*			X	X
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird			X	
Estrildidae	<i>Taeniopygia guttata</i>	Zebra Finch			X	X
Estrildidae	<i>Taeniopygia bichenovii</i>	Double-barred Finch			X	X
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch				X
Estrildidae	<i>Stagonopleura guttata</i>	Diamond Firetail		Vulnerable	X	
Motacillidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit			X	
Mammals						
Tachyglossidae	<i>Tachyglossus aculeatus</i>	Short-beaked Echidna			X	X
Phascoglossidae	<i>Phascoglossus cinereus</i>	Koala	Vulnerable	Vulnerable	X	X
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum			X	X

Table G.1 Fauna Species Recorded within the Project Boundary						
Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Petauridae	<i>Petaurus breviceps</i>	Sugar Glider			X	
Macropodidae	<i>Macropus giganteus</i>	Eastern Grey Kangaroo			X	X
Macropodidae	<i>Macropus robustus</i>	Euro			X	X
Macropodidae	<i>Macropus rufogriseus</i>	Red-necked Wallaby			X	X
Macropodidae	<i>Wallabia bicolor</i>	Swamp Wallaby			X	X
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Shearwater		Vulnerable	X	X
Molossidae	<i>Mormopterus "species 2"</i>					X
Molossidae	<i>Mormopterus "species 4"</i>				X	X
Molossidae	<i>Austronomus australis</i>	White-striped Freetail-bat			X	X
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat			X	X
Vespertilionidae	<i>Chalinolobus morio</i>	Chocolate Wattled Bat			X	X
Vespertilionidae	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat			X	
Vespertilionidae	<i>Scotorepens bairstoni</i>	Inland Broad-nosed Bat			X	X
Vespertilionidae	<i>Vespadelus vulturinus</i>	Little Forest Bat			X	X
Muridae	<i>Mus musculus</i>	House Mouse*			X	X
Muridae	<i>Rattus rattus</i>	Black Rat*			X	
Canidae	<i>Canis familiaris</i>	Dog/Dingo			X	X
Canidae	<i>Vulpes vulpes</i>	Red Fox*			X	X
Felidae	<i>Felis catus</i>	Cat*			X	

Table G.1 Fauna Species Recorded within the Project Boundary						
Family	Scientific Name	Common Name	EPBC Act Status	TSC Act Status	CE (2010 / 2011 / 2012)	GHD (2009)
Bovidae	<i>Bos taurus</i>	European Cattle*			X	X
Leporidae	<i>Lepus capensis</i>	Brown Hare*			X	X
Leporidae	<i>Oryctolagus cuniculus</i>	European Rabbit*			X	X

* denotes exotic species

Appendix H

Fauna Likelihood of Occurrence

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
Amphibians						
Hylidae	<i>Litoria booroolongensis</i>	Booroolong Frog	E	0	Confined to mountain streams of the Great Dividing Range. Usually found on or under boulders and debris in and beside the rocky beds of mountain streams; breeds in summer.	Not likely to occur. Not detected during surveys No suitable habitat detected during surveys.
Fish						
Percichthyidae	<i>Maccullochella peelii</i>	Murray Cod	V	0	The Murray Cod occurs in lower reaches of the Murray-Darling Basin, where the water temperature is warm. The diverse range of habitats frequented by the Murray Cod includes slow moving rivers, murky billabongs and clear, rocky rivers.	Not likely to occur. Not detected during surveys No suitable habitat detected during surveys. Present in the Namoi River and likely in the Mooki River.
Birds						
Accipitridae	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M	2	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs.	Present. This species was recorded within the Project Boundary, and from a large farm dam immediately to the north of the Project Boundary.

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
						Farm dams within the Project Boundary are small and would provide only occasional forage habitat for this species.
Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift	M	1	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks.	Potential to occur. Suitable forage habitat available for this species within the Project Boundary. This species was not recorded during field surveys.
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail	M	9	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April.	Likely to occur. Suitable forage habitat available for this species within the Project Boundary. This species was not recorded during field surveys.
Ardeidae	<i>Ardea alba</i>	Great Egret	M	0	Great Egrets occur throughout most of the world. They are common throughout Australia, with the	Likely to occur. Suitable habitats are available

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. In Australia, the breeding season of the Great Egret is normally October to December in the south and March to May in the north. This species breeds in colonies, and often in association with cormorants, ibises and other egrets.	for this species within the Project Boundary in the form of farm dams. Extensive suitable habitat at nearby Lake Goran. This species was not recorded during field surveys.
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	M	0	Subspecies A. i. coromanda is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia.	Likely to occur. Suitable habitats are available for this species. This species was not recorded during field surveys.
Dicruridae	<i>Myiagra cyanoleuca</i>	Satin Flycatcher	M	1	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens.	Unlikely to occur. This species was not recorded during field surveys. No suitable habitat within the

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
						Project Boundary.
Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater	E,M	1	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Important food trees include <i>Eucalyptus sideroxylon</i> (Mugga Ironbark), <i>E. albens</i> (White Box) , <i>E. melliodora</i> (Yellow Box) and <i>E. leucoxylon</i> (Yellow Gum).	Potential to occur. Suitable habitats are available for this species. This species was not recorded during field surveys.
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	M	12	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings.	Likely to occur. This species was not recorded within the Project Boundary during field surveys. Suitable forage habitat present within the Project Boundary.
Psittacidae	<i>Lathamus discolor</i>	Swift Parrot	E	1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland. Swift	Potential to occur. Suitable habitats are available for this species. This species

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					parrots forage in the western slopes region along the inland slopes of the Great Dividing Range and the forests on the coastal plains from southern to northern NSW. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants. Sites used vary from year to year.	was not recorded during field surveys.
Psittacidae	<i>Neophema pulchella</i>	Turquoise Parrot	-	26	Occurs in the foothills of the great dividing range in eucalypt woodlands and forests with a grassy or sparsely shrubby understorey. Nests in hollows in trees, stumps or even fence posts. It feeds on seeds of both native and introduced grass and herb species.	Potential to occur. This species was not recorded during field surveys. Suitable habitat present within the Project Boundary and the adjacent Breeza State Forest.
Psittacidae	<i>Polytelis swainsonii</i>	Superb Parrot	V	0	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both	Potential to occur. Suitable habitats are available for this

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					forage and feed within box woodland, mostly nesting in dead trees.	species. This species was not recorded during field surveys. There are no records from the Gunnedah LGA. Records for this species occur to the west of the Project.
Rostratulidae	<i>Rostratula australis</i>	Australian Painted Snipe	V,M	0	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as <i>Eucalyptus camaldulensis</i> (River Red Gum), <i>E. populnea</i> (Poplar Box) or shrubs such as <i>Muehlenbeckia florulenta</i> (Lignum) or <i>Sarcocornia quinqueflora</i> (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, mollusks and crustaceans. Males incubate eggs in a shallow scrape nest.	Unlikely to occur. There is no preferred habitat available for this species in the Project Boundary. This species was not recorded during field surveys.
Scolopacidae	<i>Gallinago hardwickii</i>	Latham's Snipe	M	0	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere	Unlikely to occur. There is no preferred habitat available for this species in the Project

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					to breed.	Boundary. This species was not recorded during field surveys.
Mammals						
Dasyuridae	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	E	11	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold. Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods.	Potential to occur. Suitable habitats are available for this species within the Project Boundary. This species was not recorded during field surveys.
Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	0	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a	Unlikely to occur. There is only marginal habitat available for this

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres.	species within the Project Boundary. . This species was not recorded during field surveys.
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V	720	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum <i>Eucalyptus tereticornis</i> , Grey Gum <i>E. punctata</i> , Monkey Gum <i>E. cypellocarpa</i> and Ribbon Gum <i>E. viminalis</i> . In coastal areas, Tallowwood <i>E. microcorys</i> and Swamp Mahogany <i>E. robusta</i> are important food species, while in inland areas White Box <i>E. albens</i> , Bimble Box <i>E. populnea</i> and River Red Gum <i>E. camaldulensis</i> are favoured.	Present. Recorded during field surveys within the Project Boundary.
Muridae	<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	4	Restricted to unique habitat known as Pilliga scrub, which occurs on deep, low nutrient sand in the	Unlikely to occur. There is no preferred habitat

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					Pilliga region of NSW (south of Narrabri). Specifically, Pilliga mouse has been found in areas dominated by broombush, or with Acacia burrowii shrub layer and Corymbia trachyphloia overstorey. Both of these habitats had relatively high species richness with moist groundcover and medium to high shrub cover. An additional habitat for the Pilliga Mouse is recently burnt moist gullies with high cover of low grasses and sedges, yet low cover of shrubs.	available for this species within the Project Boundary. This species was not recorded during field surveys.
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	6	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottleshaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects.	Potential to occur. Suitable forage and roosting habitat available for this species within the Project Boundary. This species was not recorded during field surveys.
Vespertilionidae	<i>Nyctophilus corbeni</i> (formerly <i>timoriensis</i>)	South-eastern Long-eared Bat	V	2	Roosts in tree hollows and under loose bark in arid and semi-arid Australia and forages in the understorey of woodlands and open savanna and	Potential to occur. Suitable forage and roosting habitat

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)							
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence	
					swamps.	available for this species within the Project Boundary. This species was not recorded during field surveys.	
Reptiles							
Chelidae	<i>Eiseya belli</i>	Bell's Turtle	V	0	Found in upper reaches of rivers overlying granite, on the western slopes of the Northern NSW Tablelands, specifically in the Namoi, Gwydir and MacDonal Rivers and major tributaries. Often occurs in shallow or deep pools or in narrow (30 - 40 m wide) river stretches along grazing land.	Unlikely to occur. There is no preferred habitat available for this species within the Project Boundary. This species was not recorded during field surveys.	
Gekkonidae	<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	V	2	Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. It is found on rocky hills with dry open eucalypt forest or woodland. It favours forest and woodland areas with boulders, rock slabs, fallen	Potential to occur. Suitable habitats for this species are present in the higher rocky outcrops within the Project Boundary. This species was not	

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
Scincidae	<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	V	0	timber and deep leaf litter. The Five-clawed Worm-skink's preferred habitat is open woodland. It often occurs on the lower slopes of slight rises in grassy White Box Woodland. It is also known to occur in River Red Gum and Coolibah-Bimble Box woodland. Both types of woodland occur on red-black to black clay-loam soils. The species lives in permanent tunnel-like burrows and deep cracks within the soil. On the surface the species utilises fallen logs and timber for shelter.	recorded during field surveys within the Project Boundary. Potential to occur. Suitable habitat for this species occurs within the Project Boundary. This species was not recorded within the Project Boundary during field surveys.
Scincidae	<i>Aprasia parapulchella</i>	Pink-tailed Legless Lizard	V	1	Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (<i>Themeda australis</i>). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks and appears to spend considerable time in burrows below these rocks; the burrows have been constructed by and are	Potential to occur. Suitable habitat for this species occurs within the Project Boundary. This species was not recorded within the Project Boundary during field surveys.

Table H.1 Likelihood of Occurrence of Threatened Fauna Species Known from the Gunnedah LGA (Atlas of NSW Wildlife) or Predicted to Occur in the Locality (Protected Matters Search Tool)						
Family	Scientific Name	Common Name	EPBC Act	LGA Count	Preferred Habitat	Likelihood of Occurrence
					often still inhabited by small black ants and termites. Feeds on the larvae and eggs of the ants with which it shares its burrows.	

Notes: V = Vulnerable; E = Endangered; CE = Critically Endangered; M = Migratory

Appendix I

Threatened Flora and Fauna of Box Gum
Woodland

Table I.1 Threatened Species Listed Under the EPBC Act that May Occur in Box Gum Grassy Woodland		
Species	Common Name	EPBC Act Listing
Flora		
<i>Ammobium craspedioides</i>	Yass Daisy	Vulnerable
<i>Bothriochloa biloba</i>	Lobed Redgrass	Vulnerable
<i>Dichanthium setosum</i>	Bluegrass	Vulnerable
<i>Digitaria porrecta</i>	Finger Panic Grass	Endangered
<i>Diuris pedunculata</i>	Small Snake Orchid	Endangered
<i>Hibbertia humifusa ssp. erigens</i>	Euroa Guinea-flower	Vulnerable
<i>Homopholis belsonii</i>	Belson's Panic	Vulnerable
<i>Leucochrysum albicans var. tricolor</i>	Hoary Sunray (white form)	Endangered
<i>Picris evae</i>	a hawkweed	Vulnerable
<i>Prasophyllum petilum</i>	Tarengo Leek Orchid	Endangered
<i>Rutidosia leptorrhynchoidea</i>	Button Wrinklewort	Endangered
<i>Senecio garlandii</i>	Woolly Ragwort	Vulnerable
<i>Swainsona recta</i>	Small Purple Pea	Endangered
<i>Thesium australe</i>	Austral Toadflax	Vulnerable
Fauna		
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	Vulnerable
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard	Vulnerable
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	Endangered
<i>Delma impar</i>	Striped Legless Lizard	Vulnerable
<i>Geophaps scripta</i>	Squatter Pigeon	Vulnerable
<i>Lathamus discolor</i>	Swift Parrot	Endangered
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	Vulnerable
<i>Pedionomus torquatus</i>	Plains Wanderer	Vulnerable
<i>Phascolarctos cinereus</i>	Koala	Vulnerable
<i>Polytelis swainsonii</i>	Superb Parrot	Vulnerable
<i>Synemon plana</i>	Golden Sun Moth	Critically Endangered
<i>Tympanocryptis pinguicollis</i>	Grassland Earless Dragon	Endangered
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	Vulnerable
<i>Anthochaera phrygia</i>	Regent Honeyeater	Endangered

Appendix J

Assessments of Significance

J.1 Introduction

This Appendix contains assessments of significance according to the *Matters of National Environmental Significance Significant Impact Guidelines 1.1* (DEWHA 2009). They are intended to assist in determining whether the impacts of the Project on any Matter of National Environmental Significance are likely to be significant. They provide a means by which to gauge the significance of predicted impacts to threatened species, populations and ecological communities and have been prepared to examine the magnitude of impacts to threatened biota.

Both direct and indirect impacts are taken into account within these assessments. Direct impacts have been quantified within the assessments, while indirect impacts are considered generally. An important consideration in these assessments is that the direct and indirect impacts are not proposed to take place at one time; rather they will take place progressively over a period of 30 years.

Each assessment of significance reproduces the Significant Impact Criteria in italicised text, beneath which a response is supplied in plain text. The responses have been prepared under the scenario that no mitigation or compensatory measures are applied. That is, to determine the significance of impacts, the assessments of significance consider the impacts without amelioration. The Project now includes substantial amelioration measures including on-site mitigation measures, such as rehabilitation and erosion control, and off-site compensatory habitat. The ultimate conclusions to this ecological assessment report take such measures into consideration when assessing the long term implications for flora and fauna.

J.2 Ecological Communities

J.2.1 White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland and Derived Native Grassland)

White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland and Derived Native Grassland) is listed as a Critically Endangered Ecological Community (CEEC) under the EPBC Act. Approximately 1,265 ha of this community is found within the Project Boundary, of which 738 ha is proposed to be cleared.

Box Gum Woodland and Derived Native Grassland was once a widespread and floristically diverse community that extended from Victoria to Queensland. In NSW the community is found on relatively fertile soils on the tablelands and western slopes which are preferred landscapes for agriculture; as a result, most of the community was historically cleared. It now exists as isolated and fragmented remnant paddock trees or patches with reduced structural complexity and little evidence of regeneration (DECCW (NSW) 2010). This community now supports a low diversity of flora and fauna species.

Historically, the community was a floristically diverse complex of communities that occupied 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 pure or intergrade tree species: *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). The understorey is characterised by native grasses and wild flowers.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

reduce the extent of an ecological community

The Project will result in the clearing of 738 ha of Box Gum Woodland and Derived Native Grassland. In the absence of appropriate mitigation measures, this will reduce the extent of this community in the locality.

fragment or increase fragmentation of an ecological community

The Project will result in the fragmentation of Box Gum Woodland and Derived Native Grassland as some existing large areas of this community will be split, with some areas being cleared and some areas being retained. The areas of retained vegetation will be more isolated from other remnants of vegetation than currently. However, The Box Gum Woodland and Derived Native Grasslands in the locality of the Project Boundary are already highly fragmented and surrounded by agricultural lands. Although the Project will increase the amount of overall fragmentation, it will not result in the isolation of important areas of habitat.

adversely affect habitat critical to the survival of an ecological community

The area of Box Gum Woodland and Derived Native Grassland to be cleared is not considered to be critical for the survival of this community. There are extensive areas in the locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction.

modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

Within the Disturbance Area, the extent of Box Gum Woodland and Derived Native Grassland will be entirely removed; however this area is not necessary for the survival of this community. There are extensive areas of this community in the locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction. The Project is unlikely to reduce groundwater levels or alter surface water drainage patterns such that other occurrences of this community outside the Project Boundary will be deleteriously affected.

cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

Within the Disturbance Area, a substantial change will occur to the species composition of Box Gum Woodland and Derived Native Grassland, as it will be entirely removed. However, there are large areas of this community in the locality that go to make up the “occurrence” of this species, and these areas will not be affected by the Project. Accordingly, the Project is not considered likely to cause a substantial change in the species composition of an occurrence of this community.

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

-- assisting invasive species, that are harmful to the listed ecological community, to become established, or

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species harmful to Box Gum Woodland and Derived Native Grassland will become established.

-- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The Project will not result in the regular mobilisation of chemicals that kill or inhibit the growth of plant species into Box Gum Woodland and Derived Native Grassland.

interfere with the recovery of an ecological community.

The Project will remove approximately 738 ha of Box Gum Woodland and Derived Native Grassland, and in the absence of mitigation measures, would be likely to interfere with the recovery of this community. However, a Biodiversity Offset Package, which is proposed to compensate for the Project impacts, will avoid this, as it will result in:

- An increase in the area of this community and under conservation management agreements and/or within the formal reserve system;
- An increase in areas which meet the minimum condition criteria for the nationally listed ecological community;
- Maintenance of floristic diversity, structural complexity and ecological function of the ecological community across its distribution;
- A reduction in the level of specific threats; and
- An improvement in the landscape connectivity for remnants of the listed ecological community.

Accordingly, with the implementation of the proposed Biodiversity Offset Package, it is not considered that the Project will interfere with the recovery of this community.

Conclusion

The Project will result in the direct loss of 738 ha of Box Gum Woodland and Derived Native Grassland, which will impact on this community, the extent of which has already been significantly reduced due to past clearing.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project including the retention of woodland and revegetation/rehabilitation. With the implementation of the proposed avoidance, mitigation, and offset measures, the Project is not expected to result in a significant impact to the Box Gum Woodland and Derived Native Grassland community.

J.2.2 Grey Box Grassy Woodland and Derived Native Grassland

Grey Box Grassy Woodland and Derived Native Grasslands an EEC listed under the EPBC Act. Approximately 55 ha of this community is found within the Project Boundary, which has been mapped as Inland Grey Box Woodland, of which 30 ha is proposed to be cleared.

Grey Box Grassy Woodland and Derived Native Grasslands is open woodland that occurs on relatively fertile soils of the western slopes and plains of NSW. Grey Box (*E. microcarpa*) is the characteristic canopy species, although codominants include Bimbil Box, White Cypress Pine, Kurrajong, Yellow Box and Bulloak. The community generally has a sparse or absent shrub layer and variable ground layer. Floristic composition relates to climatic differences such as rainfall levels and temperature. The community is estimated to have experienced a decline of 85% since pre-settlement, primarily as a result of clearing for agriculture.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

reduce the extent of an ecological community

The Project will result in the clearing of 30 ha of Grey Box Grassy Woodland and Derived Native Grasslands. In the absence of appropriate mitigation measures, this will reduce the extent of this community in the locality.

fragment or increase fragmentation of an ecological community

The Project will not result in the fragmentation of Grey Box Grassy Woodland and Derived Native Grasslands as the areas of this community to be removed are currently isolated from other remnants of this community. No connectivity between areas of this community will be reduced.

adversely affect habitat critical to the survival of an ecological community

The area of Grey Box Grassy Woodland and Derived Native Grasslands to be cleared is not considered to be critical for the survival of this community. There are extensive areas in the

locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction.

modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

Within the Disturbance Area, the extent of Grey Box Grassy Woodland and Derived Native Grasslands will be entirely removed, however this area is not necessary for the survival of this community. There are extensive areas in the locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction. The Project is unlikely to reduce groundwater levels or alter surface water drainage patterns such that other occurrences of this community outside the Project Boundary will be deleteriously affected.

cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

Within the Disturbance Area, a substantial change will occur to the species composition of Grey Box Grassy Woodland and Derived Native Grasslands, as it will be entirely removed within this area. However, there are large areas of this community in the locality that go to make up the "occurrence" of this species, and these areas will not be affected by the Project. Accordingly, the Project is not considered likely to cause a substantial change in the species composition of an occurrence of this community.

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

-- assisting invasive species, that are harmful to the listed ecological community, to become established, or

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species harmful to Grey Box Grassy Woodland and Derived Native Grasslands will become established.

-- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The Project will not result in the regular mobilisation of chemicals that kill or inhibit the growth of plant species into Grey Box Grassy Woodland and Derived Native Grasslands.

interfere with the recovery of an ecological community.

The Project will remove approximately 30 ha of Grey Box Grassy Woodland and Derived Native Grasslands, and in the absence of mitigation measures, would be likely to interfere

with the recovery of this community. However, a Biodiversity Offset Package, which is proposed to compensate for the Project impacts, will avoid this, as it will result in:

- An increase in the area of this community and under conservation management agreements and/or within the formal reserve system;
- An increase in areas which meet the minimum condition criteria for the nationally listed ecological community;
- Maintenance of floristic diversity, structural complexity and ecological function of the ecological community across its distribution;
- A reduction in the level of specific threats; and
- An improvement in the landscape connectivity for remnants of the listed ecological community.

Accordingly, with the implementation of the proposed Biodiversity Offset Package, it is not considered that the Project will interfere with the recovery of this community.

Conclusion

The Project will result in the direct loss of 30 ha of Grey Box Grassy Woodland and Derived Native Grasslands. The community is recognised to have suffered a large reduction in extent through past clearing.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project including the retention of woodland and revegetation/rehabilitation. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the Project will result in a significant impact to Grey Box Grassy Woodland and Derived Native Grasslands.

J.2.3 Weeping Myall Woodland

Weeping Myall Woodland is listed as an EEC under the EPBC Act. Approximately 22 ha of this community is found within the Project Boundary, of which 3 ha is proposed to be cleared.

This community occurs across the eastern parts of the alluvial plains of the Murray-Darling river system. Depending on disturbance history, this community ranges from open or sparse woodland to open shrubland on earths and heavy alluvial soils. The tree layer is dominated by *Acacia pendula* (Weeping Myall) and it can occur as the only tree species present. The understorey is typically comprised of an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of herbs and grasses.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

reduce the extent of an ecological community

The Project will result in the clearing of 3 ha of Weeping Myall Woodland. In the absence of appropriate mitigation measures, this will reduce the extent of this community in the locality.

fragment or increase fragmentation of an ecological community

The Project will not result in the fragmentation of Weeping Myall Woodland as the areas of this community to be removed are currently isolated from other remnants of this community. No connectivity between areas of this community will be reduced.

adversely affect habitat critical to the survival of an ecological community

The area of Weeping Myall Woodland to be cleared is not considered to be critical for the survival of this community. There are extensive areas in the locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction.

modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

Within the Disturbance Area, the extent of Weeping Myall Woodland will be entirely removed, however this area is not necessary for the survival of this community. There are other areas in the locality that will remain, and the local occurrence of this community is unlikely to be placed at risk of extinction. The Project is unlikely to reduce groundwater levels or alter surface water drainage patterns such that other occurrences of this community outside the Project Boundary will be deleteriously affected.

cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

Within the Disturbance Area, a substantial change will occur to the species composition of Weeping Myall Woodland, as it will be entirely removed. However, there are large areas of this community in the locality that go to make up the "occurrence" of this species, and these areas will not be affected by the Project. Accordingly, the Project is not considered likely to cause a substantial change in the species composition of an occurrence of this community.

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

-- assisting invasive species, that are harmful to the listed ecological community, to become established, or

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species harmful to Weeping Myall Woodland will become established.

-- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The Project will not result in the regular mobilisation of chemicals that kill or inhibit the growth of plant species into Weeping Myall Woodland.

interfere with the recovery of an ecological community.

The Project will remove approximately 3 ha of Weeping Myall Woodland, and in the absence of mitigation measures, would be likely to interfere with the recovery of this community. However, a Biodiversity Offset Package, which is proposed to compensate for the Project impacts, will avoid this, as it will result in:

- An increase in the area of this community and under conservation management agreements and/or within the formal reserve system;
- An increase in areas which meet the minimum condition criteria for the nationally listed ecological community;
- Maintenance of floristic diversity, structural complexity and ecological function of the ecological community across its distribution;
- A reduction in the level of specific threats; and
- An improvement in the landscape connectivity for remnants of the listed ecological community.

Accordingly, with the implementation of the proposed Biodiversity Offset Package, it is not considered that the Project will interfere with the recovery of this community.

Conclusion

The Project is expected to result in the removal of approximately 3 ha of Weeping Myall Woodland. The community is recognised to have suffered a large decline in geographic distribution since European settlement, with an estimated 82-94% reduction of the community. A range of impact avoidance, mitigation and compensation measures have been developed for the Project including the retention of woodland and revegetation/rehabilitation. With the implementation of the proposed avoidance, mitigation, and offset measures, it is not expected that the Project will result in a significant impact to this community.

J.2.4 Brigalow

Brigalow is listed as an EEC under the EPBC Act. Approximately 9 ha of this community is found within the Project Boundary, of which none is proposed to be cleared.

Brigalow is a low woodland or forest community dominated by Brigalow (*Acacia harpophylla*), with pockets of Belah (*Casuarina cristata*) and Poplar Box (*Eucalyptus*

populnea subsp. Bimbil). The canopy of this community tends to be quite dense while the understorey and ground strata are generally sparse. Due to extensive clearing for agriculture, the community mainly occurs as scattered remnants along roadsides and paddock edges on heavy clay soils or sand plains of the North West Slopes and Plains and Darling River Plains in NSW and in Queensland. Regeneration of this community is limited in natural environments as seedlings are often grazed and as seeds remain viable for less than a year and require particular conditions to germinate, i.e. dry conditions to set seed followed by heavy rainfall.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

reduce the extent of an ecological community

The Project will not reduce the extent of this community as none will be cleared.

fragment or increase fragmentation of an ecological community

The Project will not fragment or increase fragmentation of this community as none will be cleared.

adversely affect habitat critical to the survival of an ecological community

As no areas of this community will be removed, the Project is considered unlikely to affect habitat critical to the survival of this community.

modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns

As no areas of this community will be removed, the Project is considered unlikely to affect abiotic factors necessary to the survival of this community. The Project is unlikely to reduce groundwater levels or alter surface water drainage patterns such that other occurrences of this community outside the Project Boundary will be deleteriously affected.

cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

Within the Disturbance Area, a substantial change will occur to the species composition of Weeping Myall Woodland, as it will be entirely removed. However, there are large areas of this community in the locality that go to make up the "occurrence" of this species, and these areas will not be affected by the Project. Accordingly, the Project is not considered likely to cause a substantial change in the species composition of an occurrence of this community.

cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

-- assisting invasive species, that are harmful to the listed ecological community, to become established, or

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species harmful to Brigalow will become established.

-- causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or

The Project will not result in the regular mobilisation of chemicals that kill or inhibit the growth of plant species in Brigalow.

interfere with the recovery of an ecological community

The Project will not remove or modify any areas of Brigalow. No areas of Brigalow will become fragmented or isolated from other areas of habitat as a result of the Project. The area of Brigalow within the Project Boundary is not considered to be important for the survival of this community in the locality as it is only a very small area (9 ha) and a small proportion of its original distribution. No areas of this community will be cleared and the overall extent of the community in the locality will not therefore be reduced. Thus, the Project will not interfere with the recovery of this community.

Conclusion

The Project not result in the loss of any of the Brigalow community. The community is recognised to have suffered a large decline in geographic distribution since European settlement, with an estimated 82-94% reduction of the community. A range of impact avoidance, mitigation and compensation measures have been developed for the Project including the retention of woodland and revegetation/rehabilitation. The Project is unlikely to result in a significant impact on this community.

J.3 Flora

J.3.1 *Bothriochloa biloba* (Lobed Blue-grass)

Bothriochloa biloba (Lobed Blue-grass) is listed as Vulnerable under the EPBC Act. The species has been recorded within the Project Boundary along The Dip and Court Roads, and potential habitat exists in other areas within the Project Boundary, and adjacent Breeza State Forest. This species is intolerant of heavy grazing and as a result is often found along roadsides, as is the case within the Project Boundary. This indicates that the majority of the Project Boundary is unlikely to provide important habitat for this species due to the long history of grazing.

Bothriochloa bilobais known from the Darling Downs district in Queensland, south along the western slopes of the Great Dividing Range to North Star, Warialda, Bingara and Merriwa in New South Wales (NSW Scientific Committee 2004a). It also occurs west to Dubbo and around the Hunter Valley (Quinn et al. 1995).

Bothriochloa biloba grows in cleared eucalypt forests and relict grassland, often dominated by *Aristida ramosa* (Purple Wiregrass), *Bothriochloa macra* (Red-leg Grass), *B. decipiens* (Red Grass), *Dichanthium sericeum* (Queensland Bluegrass) or *Austrostipa aristiglumis*. *Bothriochloa biloba* prefers heavier-textured soils such as brown or black clay soils.

According to the Significant Impact Guidelines (DEWHA 2009), the concept of an 'important population' is central to assessing the potential for an action to have a significant impact on a Vulnerable species. According to the guidelines:

... 'an important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

Each of these points is addressed below.

Key source population either for breeding or dispersal

The population of *Bothriochloa biloba* that occurs within the Project Boundary is unlikely to be part of a key source population for breeding or dispersal. This species is known to be widespread in NSW, and similar habitats to those within the Project Boundary are widespread in the locality. Over 204,000 ha of woodland and 260,000 ha of grassland has been mapped by the Namoi CMA as occurring in a 50 km radius of the Project Boundary. The species is only known from roadsides within the Project Boundary and it is likely that due to a long history of grazing, the remainder of the Project Boundary is unlikely to provide high quality habitat for this species. Many areas of roadside occur in the region that are not impacted by grazing, and the population within the Project Boundary is not considered to comprise a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species, it is unlikely that the population of *Bothriochloa biloba* within the Project Boundary is genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Project Boundary is not located near the limit of the range of *Bothriochloa biloba*. It has a wide distribution throughout NSW.

For the reasons outlined above, the population of *Bothriochloa biloba* that occurs within the Project Boundary is not considered to be important for the long term survival and recovery of this species and is not considered to comprise an 'important population' as defined by the EPBC Act.

Significant Impact Assessment

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The population of *Bothriochloa biloba* within the Project Boundary is not considered to comprise an important population. The Project will remove areas of habitat for this species, however large areas of suitable habitat for this species will remain in the locality and a comprehensive offsetting strategy has been prepared that will result in the rehabilitation and protection of large areas of suitable habitat. Over 204,000 ha of woodland and 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary that is likely to provide suitable habitat for this species. The offsetting strategy will result in the revegetation, rehabilitation and protection of approximately 13,015 ha of similar habitat. No long term decrease in the size of an important population of *Bothriochloa biloba* is considered likely to occur.

reduce the area of occupancy of an important population

The population of *Bothriochloa biloba* within the Project Boundary is not considered to comprise an important population. The Project will temporarily reduce the area of occupancy of *Bothriochloa biloba*, however large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland and 260,000 ha of grassland vegetation has been mapped within a 50 km radius of the Project Boundary that is likely to provide suitable habitat for this species. A comprehensive offsetting strategy has been prepared that will result in the revegetation, rehabilitation and protection of approximately 13,015 ha of similar habitat. Accordingly, it is not considered that the Project will reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

The population of *Bothriochloa biloba* within the Project Boundary is not considered to comprise an important population. As *Bothriochloa biloba* is known to be widespread in NSW, the Project is considered unlikely to fragment the population of *Bothriochloa biloba* into two or more populations. Large areas of suitable habitat for this species will remain in the locality and a comprehensive offsetting strategy has been prepared that will result in the rehabilitation and protection of large areas of suitable habitat including the creation of habitat corridors linking habitat areas.

adversely affect habitat critical to the survival of a species

The potential woodland habitat to be removed is not considered to be critical to the survival of *Bothriochloa biloba*. Over 204,000 ha of woodland and 260,000 ha of grassland vegetation has been mapped within a 50 km radius of the Project Boundary that will continue to provide suitable habitat for this species.

disrupt the breeding cycle of an important population

The population of *Bothriochloa biloba* within the Project Boundary is not considered to comprise an important population. Large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Bothriochloa biloba is widespread throughout NSW, and therefore the removal of some habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality and a result in the rehabilitation and protection of large areas of suitable habitat. Over 204,000 ha of woodland and 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary that is likely to provide suitable habitat for this species. A comprehensive offsetting strategy has been prepared that will result in the revegetation, rehabilitation and protection of approximately 13,015 ha of habitat.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of habitat for *Bothriochloa biloba*.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Bothriochloa biloba* to decline.

interfere substantially with the recovery of the species.

It is unlikely that the Project will interfere substantially with the recovery of *Bothriochloa biloba*. Over 204,000 ha of woodland and 260,000 ha of grassland vegetation has been mapped within a 50 km radius of the Project Boundary that is likely to provide suitable habitat for this species. A comprehensive offsetting strategy has been prepared that will result in the revegetation, rehabilitation and protection of approximately 13,015 ha of habitat. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to *Bothriochloa biloba* as a result of the Project.

J.3.2 *Dichanthium setosum* (Bluegrass)

Dichanthium setosum (Bluegrass) is listed as Vulnerable under the EPBC Act. There are nine Atlas of NSW Wildlife records of this species within the Gunnedah LGA, including from within the Project Boundary. Suitable habitat exists for this species in most areas of the Project Boundary.

Dichanthium setosum is an erect, perennial grass with limited distribution in NSW and Queensland. In NSW the species occurs within the Border Rivers–Gwydir, Central West, Northern Rivers and Namoi regions (NSW Scientific Committee 2004b). The species is most commonly found in habitat with heavy basaltic black soils or hard setting loam with clay subsoil (SEWPaC 2011c). *Dichanthium setosum* grows in grassland and open woodland but is also commonly found in disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The species flowers in summer.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

Dichanthium setosum has not been recorded from within the Project Boundary during numerous field surveys conducted by Cumberland Ecology and therefore it is unlikely that large numbers are present or that an important population occurs. Large areas of similar habitat for this species will remain in the locality; Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary and no long term decrease in the size of an important population of *Dichanthium setosum* is considered likely to occur.

reduce the area of occupancy of an important population

As *Dichanthium setosum* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

As *Dichanthium setosum* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary.

adversely affect habitat critical to the survival of a species

Dichanthium setosum has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival.

Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary.

disrupt the breeding cycle of an important population

Dichanthium setosum has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Dichanthium setosum has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Dichanthium setosum*.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Dichanthium setosum* to decline.

interfere substantially with the recovery of the species.

Dichanthium setosum has not been recorded within the Project Boundary and therefore no known populations will be affected. The Project is expected to impact on approximately 4,021 ha of potential habitat for this species, however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to impact on approximately 4,021 ha of potential habitat for this species. However, this species has not been recorded from the Project Boundary by Cumberland Ecology and therefore it is not likely that significant populations exist. Large areas of similar habitat will remain in the locality that will not be disturbed by the Project; over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. The Project is not considered likely to have a significant impact on *Dichanthium setosum*.

J.3.3 *Digitaria porrecta* (Finger Panic Grass)

Digitaria porrecta (Finger Panic Grass) is listed as Endangered under the EPBC Act. There are eight Atlas of NSW Wildlife records of this species within the Gunnedah LGA. The species has not been recorded during targeted field surveys; however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur, particularly as it has previously been recorded along roadsides to the north-west and south-west of the Project Boundary.

Digitaria porrecta is a perennial grass that occurs over an area of approximately 1,000km in four disjunct areas in Queensland and NSW. In NSW, the population is estimated to be 200,000 individuals and occurs within the Border Rivers–Gwydir, Namoi and Central West regions (SEWPaC 2011d).

The species prefers grasslands on extensive basaltic plains, and in undulating woodlands and open forests with an underlying rich, basaltic geology. It usually occurs on dark and fine textured soils with some degree of seasonal cracking (SEWPaC 2011d).

Digitaria porrecta is commonly found in disturbed environments including road verges and stock routes surrounded by beef cattle grazing or cultivation and where there are occasional fire events (DEC (NSW) 2005c). The species seeds from March to April but also reproduces vegetatively by dying back to the tussock base, from which it resprouts in summer (Halford 1995, DEC (NSW) 2005c).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

Digitaria porrecta has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar habitat occur in the locality that will not be disturbed by the Project. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. No long term decrease in the size of the population is considered likely to occur.

Reduce the area of occupancy of the species

Digitaria porrecta is not known to occupy habitat within the Project Boundary and therefore the Project is considered unlikely to reduce the area of occupancy of this species. The

Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary.

Fragment an existing population into two or more populations

Digitaria porrecta has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar vegetation occur in the locality and it is not expected that the Project will fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project. However, *Digitaria porrecta* has not been recorded within the Project Boundary and therefore the potential habitat for this species to be removed is not considered to be critical to the survival of this species.

Disrupt the breeding cycle of a population

Digitaria porrecta has not been recorded within the Project Boundary and therefore no known population will be affected. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project. However, *Digitaria porrecta* has not been recorded within the Project Boundary and therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Digitaria porrecta*.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Digitaria porrecta* to decline.

Interfere with the recovery of the species

Digitaria porrecta has not been recorded within the Project Boundary and therefore no known population will be affected. Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project, however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to *Digitaria porrecta* as a result of the Project.

J.3.4 *Cadellia pentastylis* (Ooline)

Cadellia pentastylis (Ooline) is listed as Vulnerable under the EPBC Act. There are two Atlas of NSW Wildlife records of this species within the Gunnedah LGA. The species has not been recorded within the Project Boundary during targeted field surveys; however suitable habitat exists within the Project Boundary, and adjacent Breeza State Forest. The species is considered to have potential to occur.

Cadellia pentastylis occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnedah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Threatened Species Scientific Committee 2008a).

Cadellia pentastylis grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent (Threatened Species Scientific Committee 2008a) and its distribution is known to overlap Box Gum Woodland and Brigalow, which occur within the Project Boundary.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

Cadellia pentastylis has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland vegetation similar to that present in the Project Boundary has been mapped by the Namoi CMA within a 50 km radius. No long term decrease in the size of the population is considered likely to occur.

Reduce the area of occupancy of the species

Cadellia pentastylis is not known to occupy habitat within the Project Boundary and therefore the Project is considered unlikely to reduce the area of occupancy of this species. The Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland

vegetation similar to that present in the Project Boundary has been mapped by the Namoi CMA within a 50 km radius.

Fragment an existing population into two or more populations

Cadellia pentastylis has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar vegetation occur in the locality and it is not expected that the Project will fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Approximately 864 ha of potential woodland habitat will be removed as part of the Project. However, *Cadellia pentastylis* has not been recorded within the Project Boundary and therefore the potential habitat for this species to be removed is not considered to be critical to the survival of this species.

Disrupt the breeding cycle of a population

Cadellia pentastylis has not been recorded within the Project Boundary and therefore no known population will be affected. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Approximately 864 ha of potential woodland habitat will be removed as part of the Project. However, *Cadellia pentastylis* has not been recorded within the Project Boundary and therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Cadellia pentastylis*.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Cadellia pentastylis* to decline.

Interfere with the recovery of the species

Cadellia pentastylis has not been recorded within the Project Boundary and therefore no known population will be affected. Approximately 864 ha of potential woodland habitat will

be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation similar to that present in the Project Boundary has been mapped by the Namoi CMA within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to *Cadellia pentastylis* as a result of the Project.

J.3.5 *Swainsona murrayana* (Slender Darling Pea)

Swainsona murrayana (Slender Darling Pea) is listed as Vulnerable under the EPBC Act. There are no Atlas of NSW Wildlife records of this species within the Gunnedah LGA. The species has not been recorded during targeted field surveys; however potential habitat exists within the Project Boundary, particularly in areas of grassland and woodland, and adjacent Breeza State Forest.

This species is found throughout NSW and has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree (DEC (NSW) 2005g). The species grows in numerous vegetation types including black box, bladder saltbush and grassland communities on level plains, floodplains and depressions. The species has been detected within previously grazed grasslands and grassy woodland that have been intermittently grazed or cultivated (DEC (NSW) 2005g).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

Swainsona murrayana has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Large areas of suitable habitat for this species will remain in the locality, and over 204,000 ha of woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. No long term decrease in the size of an important population of *Swainsona murrayana* is considered likely to occur.

reduce the area of occupancy of an important population

As *Swainsona murrayana* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

As *Swainsona murrayana* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Large areas of suitable habitat for this species will remain in the locality. Over

204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

adversely affect habitat critical to the survival of a species

Swainsona murrayana has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

disrupt the breeding cycle of an important population

Swainsona murrayana has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Swainsona murrayana has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Swainsona murrayana*.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Swainsona murrayana* to decline.

interfere substantially with the recovery of the species.

Swainsona murrayana has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 4,021 ha of woodland and grassland will be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been

mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to remove on approximately 4,021 ha of potential habitat for *Swainsona murrayana*. However, no known populations of the species occur within the LGA, and Breeza State Forest will continue to provide a large area of suitable habitat for the species. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Accordingly, the Project is not considered likely to have a significant impact on the *Swainsona murrayana*.

J.3.6 *Tylophora linearis*

Tylophora linearis is a small twiner that is listed as Endangered under the EPBC Act. It occurs in dry scrub and open forest, and has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *Eucalyptus sideroxylon*, *Eucalyptus albens*, *Callitris endlicheri*, *Callitris glaucophylla* and *Allocasuarina luehmannii*. There are two Atlas of NSW Wildlife records of this species within the Gunnedah LGA and the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Tylophora linearis* has not been recorded from the Project Boundary, although potential habitat for this species does occur and will be removed by the Project.

Tylophora linearis has rarely been collected and is known from eight localities in the Dubbo area and Mt Crow near Barraba in NSW, and “Myall Park” near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

Tylophora linearis has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however this species is considered unlikely to occur. Large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius. No long term decrease in the size of the population is considered likely to occur.

Reduce the area of occupancy of the species

Tylophora linearis is not known to occupy habitat within the Project Boundary and therefore the Project is considered unlikely to reduce the area of occupancy of this species. The Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland

vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

Fragment an existing population into two or more populations

Tylophora linearis has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar vegetation occur in the locality and it is not expected that the Project will fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Approximately 864 ha of potential woodland habitat will be removed as part of the Project, however this species is unlikely to utilise this habitat. *Tylophora linearis* has not been recorded within the Project Boundary and therefore the potential habitat for this species to be removed is not considered to be critical to the survival of this species.

Disrupt the breeding cycle of a population

Tylophora linearis has not been recorded within the Project Boundary and therefore no known population will be affected. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Approximately 864 ha of potential woodland habitat will be removed as part of the Project. However, *Tylophora linearis* has not been recorded within the Project Boundary and therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Tylophora linearis*.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Tylophora linearis* to decline.

Interfere with the recovery of the species

Tylophora linearis has not been recorded within the Project Boundary and therefore no known population will be affected. Approximately 864 ha of potential woodland habitat will

be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to *Tylophora linearis* as a result of the Project.

J.3.7 *Thesium australe* (Austral Toadflax)

Thesium australe (Austral toadflax) is a small straggling herb that is listed as Vulnerable under the EPBC Act. It occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo Grass (*Themeda australis*). It is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Thesium australe* has not been recorded from the Project Boundary, and although potential habitat for this species is present, it is considered unlikely to occur.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

Thesium australe has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Accordingly, no long term decrease in the size of an important population of *Thesium australe* is considered likely to occur.

reduce the area of occupancy of an important population

As *Thesium australe* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

As *Thesium australe* is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

adversely affect habitat critical to the survival of a species

Thesium australe has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

disrupt the breeding cycle of an important population

Thesium australe has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Thesium australe has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Thesium australe*.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Thesium australe* to decline.

interfere substantially with the recovery of the species.

Thesium australe has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to remove on approximately 864 ha of potential habitat for *Thesium australe*. However, no known populations of the species occur within the LGA or the Project Boundary, and it is considered unlikely to occur. Similar habitats to those within the Project Boundary will remain in the locality. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary has been mapped within a 50 km radius. The Project is not considered likely to have a significant impact on *Thesium australe*.

J.3.8 *Pterostylis cobarensis* (Greenhood Orchid)

Pterostylis cobarensis (Greenhood orchid) is a small terrestrial orchid that is listed as Vulnerable under the EPBC Act. It occurs in eucalypt woodlands, open mallee or *Callitris* shrublands on low stony ridges and slopes in skeletal sandy-loam soils. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Pterostylis cobarensis* has not been recorded from the Project Boundary and it is considered unlikely to occur, although potential habitat for this species does occur.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

Pterostylis cobarensis has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Large areas of suitable habitat for this species will remain in the locality; Over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius. No long term decrease in the size of an important population of *Pterostylis cobarensis* considered likely to occur.

reduce the area of occupancy of an important population

As *Pterostylis cobarensis* is not known to occupy habitat within the Project Boundary, no important population is considered to occur and the Project is therefore considered unlikely to reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

As *Pterostylis cobarensis* is not known to occupy habitat within the Project Boundary, no important population is considered to occur and the Project is considered unlikely to fragment an existing important population into two or more populations. Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

adversely affect habitat critical to the survival of a species

Pterostylis cobarensis has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

disrupt the breeding cycle of an important population

Pterostylis cobarensis has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Pterostylis cobarensis has not been recorded from within the Project Boundary, and therefore the removal of approximately 864 ha of potential woodland habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Pterostylis cobarensis*.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Pterostylis cobarensis* to decline.

interfere substantially with the recovery of the species.

Pterostylis cobarensis has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of eucalypt woodland vegetation similar to that recorded from the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to remove approximately 864 ha of potential habitat for *Pterostylis cobarensis*. However, no known populations of the species occur within the LGA, and it has not been recorded from the Project Boundary. The Project is not considered likely to have a significant impact on *Pterostylis cobarensis*.

J.3.9 Prasophyllum sp. Wybong (C. Phelps ORG 5269)

Prasophyllum sp. Wybong is a perennial orchid endemic to NSW that is listed as Critically Endangered under the EPBC Act. It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. *Prasophyllum* sp. Wybong is known to occur in open eucalypt woodland and grassland. This species has not been recorded from the Gunnedah LGA, however the Protected Matters Search Tool indicates that potential habitat for this species may occur in the locality. *Prasophyllum* sp. Wybong has not been recorded from the Project Boundary, although potential habitat for this species does occur in the form of eucalypt woodland and grassland. It is considered unlikely to occur however as this species is known from a closely defined range and the Project Boundary falls outside of this range.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

Prasophyllum sp. Wybong has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of eucalypt woodland vegetation and over 260,000 ha of grassland has been mapped within a 50 km radius of the Project Boundary. No long term decrease in the size of the population is considered likely to occur.

Reduce the area of occupancy of the species

Prasophyllum sp. Wybong is not known to occupy habitat within the Project Boundary and therefore the Project is considered unlikely to reduce the area of occupancy of this species. The Project will remove potential habitat for this species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

Fragment an existing population into two or more populations

Prasophyllum sp. Wybong has not been recorded within the Project Boundary and therefore no known population will be affected. The Project will remove potential habitat for this species, however large areas of similar vegetation occur in the locality and it is not expected that the Project will fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project. However, *Prasophyllum* sp. Wybong has not been recorded within the Project Boundary and therefore the potential habitat for this species to be removed is not considered to be critical to the survival of this species.

Disrupt the breeding cycle of a population

Prasophyllum sp. Wybong has not been recorded within the Project Boundary and therefore no known population will be affected. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project. However, *Prasophyllum* sp. Wybong has not been recorded within the Project Boundary and therefore the removal of this area of habitat is not expected to result in the decline of this species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for *Prasophyllum* sp. Wybong.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause *Prasophyllum* sp. Wybong to decline.

Interfere with the recovery of the species

Prasophyllum sp. Wybong has not been recorded within the Project Boundary and therefore no known population will be affected. Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project, however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that occurring in the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to *Prasophyllum* sp. Wybong as a result of the Project.

J.4 Birds

J.4.1 Superb Parrot (*Polytelis swainsonii*)

The Superb Parrot (*Polytelis swainsonii*) is listed as Vulnerable under the EPBC Act. There are no Atlas of NSW Wildlife records of the species within the Gunnedah LGA. This species has not been recorded during field surveys; however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur during migrations.

The Superb Parrot is a woodland species endemic to eastern inland Australia. The species typically inhabits Box-Gum, Box-Cypress pine and River Red Gum forest and woodlands, and scattered paddock trees. The species' core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round (DEC (NSW) 2005i). The species breeds between September and January and nests in small colonies sometimes in the same tree. Superb Parrots feed on grass seeds, herbaceous plants, fruits, berries and flowers and may forage up to 10km from nesting sites, primarily in grassy box woodland. The Superb Parrot is a non-breeding winter migrant to the upper Namoi and Gwydir Rivers. It is estimated that there are less than 5,000 breeding pairs left in the wild.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Superb Parrot has not been recorded from within the Project Boundary or from the locality and therefore it is unlikely that an important population occurs. No long term decrease in the size of an important population of the Superb Parrot is considered likely to occur.

reduce the area of occupancy of an important population

As the Superb Parrot is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species.

fragment an existing important population into two or more populations

As the Superb Parrot is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations.

adversely affect habitat critical to the survival of a species

The Superb Parrot has not been recorded from within the Project Boundary or the locality and therefore the potential woodland habitat to be removed is not considered to be critical to their survival.

disrupt the breeding cycle of an important population

The Superb Parrot has not been recorded from within the Project Boundary or the locality and therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Superb Parrot has not been recorded from within the Project Boundary or the locality, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Superb Parrot.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Superb Parrot to decline.

interfere substantially with the recovery of the species.

The Superb Parrot has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Superb Parrot as a result of the Project.

J.4.2 Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*)

This test assesses the Regent Honeyeater and Swift Parrot together as the species have similar habitat requirements and are affected by the same potential threats as a result of the

Project. These species have not been detected during field surveys but are considered to have moderate potential to forage in the area during winter migrations, as the Project Boundary and Breeza State Forest are within the historic range of both bird species.

The Regent Honeyeater (*Anthochaera phrygia*) is listed as Endangered and Migratory under the EPBC Act. There is one record of the species within the Gunnedah LGA. The Regent Honeyeater is a nectivorous migratory species endemic to south-eastern Australia where it is widespread but sparsely scattered in temperate woodlands and open forests. In NSW the species mainly occurs around the Great Dividing Range, but has been recorded in the Hunter Valley and Pilliga regions (Pizzey and Knight 2003, Birds Australia 2011). They prefer box-ironbark associations in wet, fertile sites along creek lines and river valleys. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region (DEC (NSW) 2005j). Numbers fluctuate greatly between years and sites, and movement outside of breeding season is poorly understood. Only 1500 individuals are thought to make up the single subpopulation of this species. Regent Honeyeaters forage in the canopy tops of mature feed trees, but roost in saplings (Oliver D. L. 1998). This suggests that the species requires a more extensive area of habitat than other similar nectivorous species.

The Swift Parrot (*Lathamus discolor*) is listed as Endangered and Marine under the EPBC Act. There is one record of the species within the Gunnedah LGA. The Swift Parrot only breeds in Tasmania and migrates to south-eastern Australia from March to October (Pizzey and Knight 2003). In NSW they are found in dry sclerophyll eucalypt forests and woodlands such as box-gum woodlands (SEWPaC 2011e). The species is semi nomadic in winter and generally found in Victoria and New South Wales with other populations found in south-eastern Queensland. The timing of their migration causes a heavy reliance on winter flowering eucalypts: *Eucalyptus robusta*, *Corymbia maculata*, *C. gummifera*, *E. sideroxylon*, and *E. albens* (Kennedy and Tzaros 2005, Saunders and Heinsohn 2008). This species has high site fidelity and returns to sites on a cyclic basis. However, this site fidelity depends on availability of foraging resources.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary and therefore no known population will be affected. There is no current evidence that either species regularly visits the locality. Both species are unlikely to make significant recurrent use of habitat available within the Project Boundary, but have potential to forage during migrations. The Project will remove potential habitat for these species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. No long term decrease in the size of a population of either the Swift Parrot or the Regent Honeyeater is considered likely to occur.

Reduce the area of occupancy of the species

As the Swift Parrot and Regent Honeyeater are not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of these species. The Project will remove potential habitat for these species, however large areas of similar habitat occur in locality that will not be disturbed by the Project. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

Fragment an existing population into two or more populations

The Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary and therefore no known population will be affected. These are highly mobile species that forage over large areas, and therefore the Project will not fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

The Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary, and are not likely to breed there. Some potential foraging habitat will be removed that these species may utilise periodically, however this habitat is not considered to be critical to their survival.

Disrupt the breeding cycle of a population

The Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary, and are not likely to breed there. Accordingly, it is not considered likely that the Project will disrupt the breeding cycle of a population of these species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Approximately 864 ha of potential woodland habitat will be removed as part of the Project. However, the Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary and large areas of similar habitat will remain in the locality that may be used by these species. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. These birds are highly mobile and make use of resources from across a very large area. Therefore the removal of this area of habitat is not expected to result in the decline of these species.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Swift Parrot and Regent Honeyeater.

Introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Swift Parrot and Regent Honeyeater to decline.

Interfere with the recovery of the species

The Swift Parrot and Regent Honeyeater have not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project; however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. These birds are highly mobile and are able to access resources from a wide area. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Swift Parrot or Regent Honeyeater as a result of the Project.

J.4.3 Migratory Birds

One migratory species, White-bellied Sea Eagle (*Haliaeetus leucogaster*), listed under the EPBC Act has been recorded within the Project Boundary. The following migratory species listed under the EPBC Act also have the potential to occur:

- White-throated Needletail (*Hirundapus caudacutus*);
- Fork-tailed Swift (*Apus pacificus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Cattle Egret (*Bubulcus ibis*); and
- Great Egret (*Ardea alba*).

The White-bellied Sea Eagle is usually associated with large bodies of water, where it forages for fish and aquatic animals. It can occur inland, particularly along large waterways. As a large raptor, it can fly large distances to access resources. Although it is often recorded flying overhead, important habitat for these species is restricted to large bodies of water.

The White-throated Needletail and the Fork-tailed Swift were not recorded during field surveys, however the Project Boundary provides suitable forage habitat for these species and they are considered to have potential to occur, particularly during the summer months. Both the White-throated Needletail and Fork-tailed Swift are common non-breeding summer migrants to Australia. These species are exclusively aerial hunters and forage over the canopy of a wide range of grassland, forest and woodland communities for insects.

Although not recorded during recent field surveys, the Project Boundary provides suitable foraging and breeding habitat for the Rainbow Bee-eater, and this species has potential to occur within the Project Boundary, particularly during the summer months. The Rainbow Bee-eater is known to be a summer breeding migrant to the locality of the Project Boundary.

The Cattle Egret and the Great Egret are both wetland birds that have a wide distribution throughout the world and occur in many habitat types including agricultural lands and flooded grasslands. The Cattle Egret in particular is known to have a close association with domestic stock. These two species have potential to occur within the Project Boundary periodically, most likely following rainfall when the lower-lying areas are wet and boggy.

These migratory species are not listed as threatened species and they are considered to be relatively abundant.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The habitat within the Project Boundary is not considered to be important habitat for these migratory species. They are known to forage among and over many kinds of habitats and large areas of similar, suitable woodland habitat occur in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The Project Boundary is not considered to comprise important habitat for migratory species. That notwithstanding, the Project is unlikely to result in an invasive species becoming established. A BMP will be prepared that will contain appropriate weed and feral animal management measures to be implemented for the Project that will minimise these risks.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

There is no evidence to suggest that the Project Boundary supports an ecologically significant proportion of the population of any of these migratory species. No breeding has been observed of these species within the Project Boundary.

Conclusion

The Project is considered unlikely to result in a significant impact to any of the listed the migratory species considered to have potential to occur within the Project Boundary.

J.5 Mammals

J.5.1 *South-eastern Long-eared Bat (Nyctophilus corbeni)*

The South-eastern Long-eared Bat (*Nyctophilus corbeni*) (Also known as the Greater Long-eared bat (*Nyctophilus timoriensis*)) is listed as Vulnerable under the EPBC Act. There are 2 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during field surveys, but suitable forage and roosting habitat is available within woodland areas in the Project Boundary and the adjacent Breeza State Forest. The species is considered to have moderate potential to occur.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The South-eastern Long-eared Bat has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Large areas of suitable habitat for this species will remain in the locality; over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. No long term decrease in the size of an important population of the South-eastern Long-eared Bat is considered likely to occur.

reduce the area of occupancy of an important population

As the South-eastern Long-eared Bat is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Large areas of potential habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

fragment an existing important population into two or more populations

As the South-eastern Long-eared Bat is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. This is a mobile species that is able to fly over disturbed areas to access resources from a large area. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

adversely affect habitat critical to the survival of a species

The South-eastern Long-eared Bat has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

disrupt the breeding cycle of an important population

The South-eastern Long-eared Bat has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The South-eastern Long-eared Bat has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the South-eastern Long-eared Bat.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the South-eastern Long-eared Bat to decline.

interfere substantially with the recovery of the species.

The South-eastern Long-eared Bat has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project, however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the South-eastern Long-eared Bat as a result of the Project.

J.5.2 Large-eared Pied Bat (*Chalinobus dwyeri*)

One threatened cave-roosting microbat species has potential to occur within the Project Boundary; the Large-eared Pied Bat (*Chalinolobus dwyeri*), which is listed as Vulnerable

under the EPBC Act. This species has not been recorded during field surveys; however there are two Atlas of NSW Wildlife records of the species within the Gunnedah LGA and suitable foraging habitat exists in woodland areas in both the Project Boundary and adjacent Breeza State Forest. Rocky areas occur on Mt Watermark that may provide potential roosting habitat for this species. Accordingly, the species is considered to have potential to occur within the Project Boundary. The Large-eared Pied Bat is an insectivorous species with poorly known population densities and distribution. It is considered to be patchily distributed from mid-Queensland to southern NSW (DEC (NSW) 2005d). Little is known about the habitat requirements of the species, but natural roosts are typically dependent on extensive sandstone outcrops, cliffs and caves, and old mine workings. The species appears to prefer low to mid-elevation dry open forest and woodland close to these roost features, particularly areas containing gullies. They typically exist in small colonies consisting of less than 50 individuals and use the same cave over many years.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Large-eared Pied Bat has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Large areas of suitable foraging habitat for this species will remain in the locality; over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. The potential roosting habitat for this species on the Project Boundary is associated with rocky areas on Mt Watermark, which will not be disturbed. Accordingly, no long term decrease in the size of an important population of the Large-eared Pied Bat is considered likely to occur.

reduce the area of occupancy of an important population

As the Large-eared Pied Bat is not known to occupy habitat within the Project Boundary, an important population is unlikely to be present and therefore the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Large areas of potential foraging habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius.

fragment an existing important population into two or more populations

As the Large-eared Pied Bat is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. This is a mobile species that is able to fly over disturbed areas to access resources from a large area. Large areas of suitable foraging habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. The potential roosting habitat for this species on the Project Boundary is associated with rocky areas on Mt Watermark, which will not be disturbed.

adversely affect habitat critical to the survival of a species

The Large-eared Pied Bat has not been recorded from within the Project Boundary and therefore the potential woodland foraging habitat to be removed is not considered to be critical to its survival. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. The potential roosting habitat for this species on the Project Boundary is associated with rocky areas on Mt Watermark, which will not be disturbed.

disrupt the breeding cycle of an important population

The Large-eared Pied Bat has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality and in rocky areas near Mt Watermark. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Large-eared Pied Bat has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland foraging habitat is not considered likely to result in the decline of this species. Large areas of suitable habitat for this species will remain in the locality. Over 204,000 ha of woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. The potential roosting habitat for this species on the Project Boundary is associated with Mt Watermark, which will not be disturbed.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Large-eared Pied Bat.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Large-eared Pied Bat to decline.

interfere substantially with the recovery of the species.

The Large-eared Pied Bat has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project, however large areas of similar habitat will remain in the locality outside of the Project Boundary. Over 204,000 ha of eucalypt woodland

vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius. The potential roosting habitat for this species on the Project Boundary is associated with Mt Watermark, which will not be disturbed. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Large-eared Pied Bat as a result of the Project.

J.5.3 Koala (*Phascolarctos cinereus*)

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the EPBC Act. There are 720 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has been recorded during surveys of the Project Boundary.

Koalas are large arboreal mammals with wide but fragmented distribution in eastern Australia ranging from the temperate south to the tropical north. The species is most commonly found in eucalypt forests, on the foliage of which the species feeds almost exclusively (Department of Planning NSW 1995, Strahan 1995). They are a solitary, sedentary and largely nocturnal species that spend most of the day sleeping in a low fork and climbing into the canopy to feed at dusk (DECC 2008). They often change trees at night and, as favoured trees may be several hundred metres away, they spend a considerable amount of time on the ground. Koala home ranges can vary in size depending on the abundance of local feed trees; in quality habitat, individual home ranges may be as small as 1-2 ha and overlap, while in semi-arid country they are generally discrete and around 100 ha (Van Dyck and Strahan 2008). The species is vulnerable to a lack of suitable food and fragmentation which can make them more susceptible to disease and predation (DECC 2008).

According to the Significant Impact Guidelines (DEWHA 2009), the concept of an 'important population' is central to assessing the potential for an action to have a significant impact on a Vulnerable species. According to the guidelines...*'an important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *key source populations either for breeding or dispersal*
- *populations that are necessary for maintaining genetic diversity, and/or*
- *populations that are near the limit of the species range.*

Each of these points is addressed below.

Key source population either for breeding or dispersal

The population of the Koala that occurs in and near the Project Boundary is likely to be part of a key source population for breeding or dispersal. Breeza State Forest is likely to be a

local stronghold of the Koala and this population also utilises vegetation within the Project Boundary. As such the Koalas that occur within the Project Boundary are likely to be a key source population.

Populations that are necessary for maintaining genetic diversity

Due to the widespread occurrence of this species within the Project Boundary and in the surrounding locality, it is unlikely that the Koalas within the Project Boundary are genetically distinct. It is therefore not considered that this population is necessary for maintaining genetic diversity.

Populations that are near the limit of the species range

The Project Boundary is not located near the limit of the range of the Koala. It has a wide distribution and occurs from north of Townsville to Victoria.

For the reasons outlined above, the population of the Koala that occurs within the Project Boundary is considered to be important for the long term survival and recovery of this species and is considered to comprise an 'important population' as defined by the EPBC Act.

Significance Impact Assessment

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Project will not lead to a long term decrease in the size of the Koala population within the Project Boundary. The most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package has been prepared which includes the protection of large areas of suitable habitat for the Koala and the recreation of large areas of habitat. These will be managed for conservation according to a BMP. In addition, a Koala Plan of Management (KPoM) has been prepared for the Project to outline a suite of mitigation measures to avoid and minimise impacts to this species. As a result, no long term decrease in the size of an important population of the Koala is considered likely to occur.

reduce the area of occupancy of an important population

The Project will not reduce the area of occupancy of the Koala. The most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package and a KPoM has been prepared which includes the protection of large areas of suitable habitat for the Koala and the recreation of large areas of habitat. Approximately 8,104 ha of suitable habitat for the Koala will be protected and recreated within the Onsite Offset Areas which will be managed for conservation according to a Biodiversity Management Plan (BMP).

fragment an existing important population into two or more populations

The Project will not fragment an existing important population into two or more populations. Connectivity between areas of remaining habitat will be retained, and linkages will be created between existing habitat and areas of recreated habitat as specified in the BMP.

adversely affect habitat critical to the survival of a species

The Koala is widely distributed along the eastern coast of Australia and the habitat to be affected is not considered to be critical to its survival. The most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package and KPoM has been prepared which includes the protection of large areas of suitable habitat for the Koala and the recreation of large areas of habitat. Approximately 8,104 ha of suitable habitat for the Koala will be protected and recreated within the Onsite Offset Areas.

disrupt the breeding cycle of an important population

The Project will not disrupt the breeding cycle of an important population of the Koala. The most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package and KPoM has been prepared which includes the protection of large areas of suitable habitat for the Koala and the recreation of large areas of habitat. Approximately 8,104 ha of habitat for the Koala will be protected and recreated within the Onsite Offset Areas. It is expected that the Koala will be able to continue to breed and persist in these areas.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Removal of habitat for the Project will not affect habitat for the Koala such that it is likely to decline. The most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package and KPoM has been prepared which includes the protection of large areas of suitable habitat for the Koala and the recreation of large areas of habitat. Approximately 8,104 ha of habitat for the Koala will be protected and recreated within the Onsite Offset Areas which will be managed for conservation according to the BMP.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The BMP will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Koala.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause Koala to decline. It is likely that the Koalas within the Project Boundary are infected with Chlamydia, however the Project is unlikely to exacerbate the incidence of this disease.

interfere substantially with the recovery of the species.

The Project will not interfere substantially with the recovery of the Koala. The most significant areas of vegetation within the Project Boundary will be retained, revegetated and rehabilitated to contain suitable habitat for this species. A comprehensive biodiversity offsets package has been prepared which includes the protection of large areas of suitable habitat for the Koala and the re-creation of large areas of habitat. A total of approximately 8,104 ha of habitat for the Koala will be protected and recreated within the Onsite Offset Areas.

Conclusion

The Project is expected to impact on approximately 847 ha of preferred eucalypt-dominated habitat for this species including the removal of forage and breeding habitat. However, the most significant areas of vegetation within the Project Boundary will be retained, and large areas nearby will be revegetated to contain suitable habitat. A comprehensive biodiversity offsets package has been prepared which includes the protection and the recreation of 8,104 ha of habitat suitable for the Koala within the Onsite Offset Areas. Substantial areas of suitable habitat are present in Breeza Forest and a detailed KPOM has been prepared to manage impacts to this species. With the implementation of the proposed mitigation measures outlined in the KPOM and the Biodiversity Offset Package, no significant impact is considered likely to the Koala.

J.5.4 Spotted-tailed Quoll (*Dasyurus maculatus*)

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act. There are 11 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during field surveys; however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Spotted-tailed Quoll is rare across its range in south-eastern Australia. It has been recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest (Van Dyck and Strahan 2008). They require forest with suitable den site features including rock crevices, caves, large hollow logs, burrows and tree hollows (NSW NPWS 1999). The Spotted-tailed Quoll is a nocturnal, solitary species with a large home range. Females occupy home ranges up to about 750 ha and males up to 3,500 ha, and they have been known to travel more than 6 km a night, usually traversing their ranges along densely vegetated creeklines (DEC (NSW) 2005h). The species hunts medium-sized reptiles and mammals including possums and rabbits, and carrion.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Spotted-tailed Quoll has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary has been mapped within a 50 km radius of the Project Boundary and no long term decrease in the size of an important population of the Spotted-tailed Quoll is considered likely to occur.

reduce the area of occupancy of an important population

As the Spotted-tailed Quoll is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

fragment an existing important population into two or more populations

As the Spotted-tailed Quoll is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. This is a mobile species that is able to access resources from a large area. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary..

adversely affect habitat critical to the survival of a species

The Spotted-tailed Quoll has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

disrupt the breeding cycle of an important population

The Spotted-tailed Quoll has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Spotted-tailed Quoll has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral

animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Spotted-tailed Quoll.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Spotted-tailed Quoll to decline.

interfere substantially with the recovery of the species.

The Spotted-tailed Quoll has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project, however over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Spotted-tailed Quoll as a result of the Project.

J.6 Reptiles

J.6.1 *Border Thick-tailed Gecko (Underwoodisaurus sphyrurus)*

The Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) is listed as Vulnerable under the EPBC Act. There are 2 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during field surveys; however suitable habitat exists in the higher rocky outcrops within the Project Boundary and adjacent Breeza State Forest. The species is considered to have moderate potential to occur.

The Border Thick-tailed Gecko is an insectivorous lizard restricted to the granite belt and other rock outcrops of the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. It is found on rocky hills with dry open eucalypt forest or woodland. It favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (DEC (NSW) 2005b).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Border Thick-tailed Gecko has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50

km radius of the Project Boundary and no long term decrease in the size of an important population of the Border Thick-tailed Gecko is considered likely to occur.

reduce the area of occupancy of an important population

As the Border Thick-tailed Gecko is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

fragment an existing important population into two or more populations

As the Border Thick-tailed Gecko is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

adversely affect habitat critical to the survival of a species

The Border Thick-tailed Gecko has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

disrupt the breeding cycle of an important population

The Border Thick-tailed Gecko has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Border Thick-tailed Gecko has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Border Thick-tailed Gecko.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Border Thick-tailed Gecko to decline.

interfere substantially with the recovery of the species.

The Border Thick-tailed Gecko has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland habitat will be removed as part of the Project, however over 204,000 ha of eucalypt woodland vegetation similar to that occurring in the Project Boundary will remain within a 50 km radius of the Project Boundary. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

No significant impact is predicted to occur to the Border Thick-tailed Gecko as a result of the Project.

J.6.2 Five-clawed Worm-skink (*Anomalopus mackayi*)

The Five-clawed Worm-skink (*Anomalopus mackayi*) is listed as Vulnerable under the EPBC Act. There are no Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during field surveys; however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Five-clawed Worm-skink has patchy distribution on the north-west slopes and plains of north-east NSW and south-eastern Queensland. It is restricted to the Namoi River and Gwydir River floodplains and lower slopes of the Great Dividing Range. The Five-clawed Worm-skink's preferred habitat is open woodland and grasslands on heavy alluvial clay soils. It often occurs on the lower slopes of slight rises in grassy White Box Woodland. It is also known to occur in River Red Gum and Coolibah-Bimble Box woodland. Both types of woodland occur on red-black to black clay-loam soils. The species lives in permanent tunnel-like burrows and deep cracks within the soil. On the surface the species utilises fallen logs and timber for shelter (SEWPaC 2011a).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Five-clawed Worm-skink has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary and no long term decrease in the size of an important population of the Five-clawed Worm-skink is considered likely to occur.

reduce the area of occupancy of an important population

As the Five-clawed Worm-skink is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

fragment an existing important population into two or more populations

As the Five-clawed Worm-skink is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

adversely affect habitat critical to the survival of a species

The Five-clawed Worm-skink has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

disrupt the breeding cycle of an important population

The Five-clawed Worm-skink has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Five-clawed Worm-skink has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Five-clawed Worm-skink.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Five-clawed Worm-skink to decline.

interfere substantially with the recovery of the species.

The Five-clawed Worm-skink has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of woodland and 3,157 ha of grassland habitat will be removed as part of the Project; however over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to impact on approximately 864 ha of woodland and 3,137 ha of grassland habitat for the Five-clawed Worm-skink. This includes the removal of potential forage and shelter habitat in the form of ground debris and woodland. The species has not been recorded from the Gunnedah LGA, and it has not been recorded from the Project Boundary. Over 204,000 ha of woodland vegetation and over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

J.6.3 *Pink-tailed Legless Lizard (Aprasia parapulchella)*

The Pink-tailed Legless Lizard (*Aprasia parapulchella*) is listed as Vulnerable under the EPBC Act. There is one Atlas of NSW Wildlife record of the species within the Gunnedah LGA. The species has not been recorded during field surveys; however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have moderate potential to occur.

The species is known from four sites in eastern Australia: near Canberra in the ACT, Tarcutta and Bathurst in NSW, and near Bendigo in Vic. Typically the species occurs in open grassland habitats that have a substantial cover of small rocks. The majority of species detections occur in relatively open vegetation, with some specimens being collected in exotic grasslands. Low densities of the species occur in relatively open areas such as stands of *Casuarina stricta* with a *Themeda* sp. understorey. Populations may extend further into woodland but remain undetected. The species commonly shelters under small rocks (150 - 600 mm basal area) (SEWPaC 2011b).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

lead to a long-term decrease in the size of an important population of a species

The Pink-tailed Legless Lizard has not been recorded from within the Project Boundary and therefore it is unlikely that an important population occurs. Over 260,000 ha of grassland

similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species and no long term decrease in the size of an important population of the Pink-tailed Legless Lizard is considered likely to occur.

reduce the area of occupancy of an important population

As the Pink-tailed Legless Lizard is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to reduce the area of occupancy of an important population of this species. Over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species..

fragment an existing important population into two or more populations

As the Pink-tailed Legless Lizard is not known to occupy habitat within the Project Boundary, the Project is considered unlikely to fragment an existing important population into two or more populations. Over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

adversely affect habitat critical to the survival of a species

The Pink-tailed Legless Lizard has not been recorded from within the Project Boundary and therefore the potential woodland habitat to be removed is not considered to be critical to its survival. Over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species..

disrupt the breeding cycle of an important population

The Pink-tailed Legless Lizard has not been recorded from within the Project Boundary, and large areas of suitable habitat for this species will remain in the locality. Therefore it is not considered likely that the Project will disrupt the breeding cycle of an important population of this species.

modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Pink-tailed Legless Lizard has not been recorded from within the Project Boundary, and therefore the removal of some potential woodland habitat is not considered likely to result in the decline of this species. Over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species.

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

A Biodiversity Management Plan will be prepared for the Project that contains detailed specifications for the control of invasive species, including both exotic plants and feral animals. With the implementation of the control measures outlined in the BMP, it is considered unlikely that any invasive species will become established in areas of potential habitat for the Pink-tailed Legless Lizard.

introduce disease that may cause the species to decline, or

The Project is considered unlikely to introduce disease that may cause the Pink-tailed Legless Lizard to decline.

interfere substantially with the recovery of the species.

The Pink-tailed Legless Lizard has not been recorded within the Project Boundary and therefore no known populations will be affected. Approximately 864 ha of potential woodland and 3,157 ha of potential grassland habitat will be removed as part of the Project; however over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary. Accordingly the Project is not expected to interfere with the recovery of this species.

Conclusion

The Project is expected to impact on approximately 864 ha of woodland and 3,157 ha of grassland providing potential habitat for the Pink-tailed Legless Lizard. This includes the removal of potential forage and shelter habitat in the form of ground debris and woodland. The species is only known from one record in the Gunnedah LGA, and it has not been recorded within the Project Boundary. Over 260,000 ha of grassland similar to that recorded from the Project Boundary will remain within a 50 km radius of the Project Boundary that provides potential habitat for this species. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.