

WATERMARK

COAL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

February 2013

K

Ecological Impact Assessment



WATERMARK COAL PROJECT

Ecological Impact Assessment

For:

Shenhua Watermark Coal Pty Limited

February 2013

Final



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

Report No. 9022RP1

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.

Revision	Date Issued	Reviewed by	Approved by	Date Approved	Revision Type
1	16/10/2012	D. Robertson	D. Robertson	16/10/2012	Final
2	12/02/2013	D. Robertson	D. Robertson	12/02/2013	Final

Approved by: Dr David Robertson

Position: Director

Signed: 

Date: 12 February, 2013

Table Of Contents

EXECUTIVE SUMMARY

1 INTRODUCTION

1.1	Background	1.1
1.2	The Project	1.3
1.3	Description of the Environment	1.5
1.4	Relevant Legislation and Regional Planning	1.15
1.4.1	Environment Protection and Biodiversity Conservation Act 1999	1.15
1.4.2	Environmental Planning and Assessment Act 1979	1.15
1.4.3	Threatened Species Conservation Act 1995	1.16
1.4.4	Brigalow and Nandewar Community Conservation Area Act 2005	1.16
1.4.5	SEPP 44 – Koala Habitat Protection	1.16
1.4.6	NSW State Groundwater Dependent Ecosystems Policy	1.17
1.4.7	Namoi Catchment Management Authority	1.18
1.4.8	Water Management Act 2000	1.20
1.4.9	Other Relevant Legislation and Guidelines	1.20
1.5	NSW Director Generals Requirements for the Project	1.21
1.6	Terms and Abbreviations	1.22

2 METHODOLOGY

2.1	Literature Review and Database Analysis	2.1
2.1.1	Literature Review	2.1
2.1.2	Database Analysis	2.2
2.2	Terrestrial Surveys	2.2
2.2.1	Dates of Survey by Cumberland Ecology	2.2
2.2.2	Flora Survey	2.3

Table Of Contents *(Cont'd)*

2.2.3	Fauna Surveys	2.12
2.2.4	Habitat Assessment	2.21
2.3	Aquatic Surveys	2.22
2.3.1	Aquatic Surveys	2.22
2.4	Weather Conditions During Surveys	2.27
2.5	Survey Limitations	2.30
2.5.1	Flora	2.30
2.5.2	Fauna	2.31
2.6	Investigation of Potential Offset Areas	2.33
2.6.1	Selection Criteria	2.33
2.6.2	Field Investigations	2.33
2.6.3	Limitations	2.35
3	FLORA RESULTS	
3.1	Vegetation Communities	3.1
3.1.1	Vegetation Community Nomenclature	3.6
3.1.2	Vegetation Communities Recorded from the Project Boundary	3.11
3.1.3	Condition Assessment	3.37
3.2	Groundwater Dependent Ecosystems	3.39
3.2.1	Definition of a Groundwater Dependent Ecosystem	3.39
3.2.2	Potential Groundwater Dependent Ecosystems in the Namoi Catchment and the Project Boundary	3.40
3.2.3	Assessment of the Occurrence of GDEs within the Project Boundary	3.42
3.3	Flora Species	3.42
3.3.1	Bothriochloa biloba	3.43
3.3.2	Dichanthium setosum	3.43

Table Of Contents *(Cont'd)*

3.3.3	Digitaria porrecta	3.44
3.3.4	Cadellia pentastylis	3.44
3.3.5	Swainsona murrayana	3.45
4	FAUNA RESULTS	
4.1	Terrestrial Fauna Habitat Assessment	4.1
4.1.1	Wetland and Riparian Environments	4.1
4.1.2	Rocky Outcrops and Coarse Woody Debris	4.2
4.1.3	Tree Hollows	4.2
4.1.4	Koala Habitat Assessment	4.3
4.1.5	Wildlife Corridors	4.4
4.1.6	Caves	4.4
4.1.7	Regional Distribution and Abundance of Fauna Habitat	4.5
4.2	Fauna Species	4.7
4.2.1	Birds	4.7
4.2.2	Mammals	4.12
4.2.3	Reptiles	4.15
4.2.4	Amphibians	4.16
4.3	Summary of TSC Act Listed Species	4.19
4.4	Summary of EPBC Act Listed Threatened Fauna Species	4.20
5	AQUATIC RESULTS	
5.1	Aquatic Habitat Assessment	5.1
5.1.1	Farm Dams	5.1
5.1.2	Waterways	5.3
5.1.3	Lake Goran	5.4
5.2	Aquatic Vertebrate Species	5.6
5.3	Threatened Species	5.7

Table Of Contents *(Cont'd)*

5.3.1	Olive Perchlet (<i>Ambassis agassizii</i>)	5.7
5.3.2	Silver Perch (<i>Bidyanus bidyanus</i>)	5.8
5.3.3	Eel-tail Catfish (<i>Tandanus tandanus</i>)	5.8
5.3.4	The Purple-spotted Gudgeon (<i>Mogurnda adspersa</i>)	5.9
5.3.5	Murray Cod (<i>Maccullochella peelii peelii</i>)	5.9
5.4	Endangered Ecological Communities	5.9
5.5	Site Condition and Water Quality	5.10
5.6	Macro-invertebrate Results	5.14
5.6.1	AusRivAS Analysis	5.15
5.6.2	SIGNAL Analysis	5.19
6	IMPACT ASSESSMENT	
6.1	Impacts to Vegetation Communities	6.1
6.1.1	Box Gum Woodland and Derived Native Grassland	6.5
6.1.2	Inland Grey Box Woodland	6.5
6.1.3	Weeping Myall Woodland	6.6
6.1.4	Brigalow	6.6
6.1.5	Semi-evergreen Vine Thicket	6.7
6.1.6	Fuzzy Box Woodland	6.7
6.2	Loss of Habitat Features	6.7
6.2.1	Loss of Tree Hollows	6.8
6.3	Impacts on Remaining Vegetation and Habitat	6.9
6.3.1	Habitat Fragmentation	6.9
6.3.2	Edge Effects	6.11
6.3.3	Noise	6.11
6.3.4	Light	6.12
6.3.5	Vehicle Strike	6.13

Table Of Contents *(Cont'd)*

6.3.6	Dust	6.13
6.3.7	Erosion	6.14
6.3.8	Weeds, Feral Animals and Overabundant Native Species	6.15
6.4	Impacts to Regionally Significant Vegetation and Corridors	6.15
6.5	Impacts on Threatened Flora Species	6.17
6.5.1	Bothriochloa biloba	6.17
6.5.2	Dichanthium setosum	6.18
6.5.3	Digitaria porrecta	6.18
6.5.4	Cadellia pentastylis	6.18
6.5.5	Swainsona murrayana	6.19
6.6	Impacts on Threatened Fauna Species	6.19
6.6.1	Birds	6.19
6.6.2	Mammals	6.25
6.6.3	Reptiles	6.27
6.7	Summary of Impacts to TSC Act and EPBC Act Species and Communities	6.28
6.8	Impacts to the Aquatic Environment	6.36
6.8.1	Pipeline and Pump Construction and Management	6.36
6.8.2	Impacts of Water Extraction	6.36
6.9	Impacts to Groundwater Dependent Ecosystems	6.37
6.10	Cumulative Impacts	6.37
6.11	Duration and Timing of Impacts	6.39
6.12	Permanence and Reversibility of Impacts	6.40
6.13	Summary of Impacts	6.40
7	IMPACT MITIGATION	
7.1	Measures to Avoid Impacts	7.2
7.2	Measures to Mitigate Impacts	7.3

Table Of Contents *(Cont'd)*

7.2.1	General Mitigation Measures	7.3
7.2.2	Minimising Vegetation and Habitat Loss	7.3
7.2.3	Minimising Aquatic Impacts during Water Extraction	7.4
7.3	Monitoring	7.5
7.3.1	Vegetation Monitoring	7.6
7.3.2	Threatened Species Monitoring	7.6
7.3.3	Reference Sites	7.6
7.4	Biodiversity Management Plan	7.7
8	BIODIVERSITY OFFSETTING	
8.1	Introduction	8.1
8.2	The Shenhua Watermark Biodiversity Offset Strategy	8.2
8.3	Biodiversity Offsets Package	8.4
8.3.1	Introduction	8.4
8.3.2	Components of the BOP	8.10
8.4	Onsite Offset Areas	8.13
8.4.1	Location	8.13
8.4.2	Vegetation	8.13
8.4.3	Habitat for Threatened Species	8.18
8.5	Offsite Offset Areas	8.21
8.5.1	Description	8.21
8.5.2	Vegetation	8.21
8.5.3	Habitat for Threatened Species	8.32
8.6	Proposed Management of Offset Areas	8.36
8.6.1	Conservation and Ongoing Management of Existing Vegetation	8.36
8.6.2	Revegetation	8.37
8.6.3	Mining Area Rehabilitation	8.42

Table Of Contents *(Cont'd)*

8.6.4	Likely Success of Rehabilitation/Revegetation	8.43
8.6.5	Wildlife Corridor Management	8.43
8.6.6	Securing the Offsets	8.44
8.7	Summary of the Onsite and Offsite Offset Areas	8.45
8.7.1	Vegetation	8.45
8.7.2	Vegetation/Habitat Condition Assessment	8.47
8.7.3	Habitat for Threatened Species	8.50
8.7.4	Strategic Values	8.52
8.8	Indirect Offsets	8.53
8.9	Adequacy of the BOP	8.53
8.9.1	Vegetation Removal and Offset Ratios	8.54
8.9.2	BioBanking Assessment	8.59
8.9.3	Compliance with OEH and SEWPaC Offsetting Principles	8.62

9 CONCLUSION

REFERENCES

Table Of Appendices

A.	COMPLIANCE WITH ASSESSMENT REQUIREMENTS	
B.	IDENTIFICATION GUIDELINES FROM THE EPBC ACT POLICY STATEMENT FOR BOX GUM GRASSY WOODLAND AND DERIVED NATIVE GRASSLAND	
C.	FLORA QUADRAT DATA	
D.	FLORA SPECIES LIST	
E.	FLORA LIKELIHOOD OF OCCURRENCE	
F.	FAUNA SPECIES LIST	
G.	FAUNA LIKELIHOOD OF OCCURRENCE	
H.	THREATENED FLORA AND FAUNA OF BOX GUM WOODLAND	
I.	ASSESSMENTS OF SIGNIFICANCE	
I.1	Introduction	I.1
I.2	Ecological Communities	I.1
I.2.1	White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland and Derived Native Grassland)	I.1
I.2.2	Inland Grey Box Woodland	I.4
I.2.3	Weeping Myall Woodland	I.7
I.2.4	Brigalow	I.9
I.2.5	Semi-evergreen Vine Thicket	I.12
I.2.6	Fuzzy Box Woodland	I.14
I.3	Flora	I.17
I.3.1	Bothriochloa biloba (Lobed Blue-grass)	I.17
I.3.2	Dichanthium setosum (Bluegrass)	I.19
I.3.3	Digitaria porrecta (Finger Panic Grass)	I.21
I.3.4	Cadellia pentastylis (Ooline)	I.24
I.3.5	Swainsona murrayana (Slender Darling Pea)	I.27
I.4	Birds	I.29
I.4.1	Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)	I.29

Table Of Appendices

I.4.2	Hooded Robin (<i>Melanodryas cucullata cucullata</i>)	I.32
I.4.3	Speckled Warbler (<i>Chthonicola saggitatus</i>)	I.34
I.4.4	Diamond Firetail (<i>Stagonopleura guttata</i>)	I.37
I.4.5	Grey-crowned Babbler (eastern subspecies) (<i>Pomatostomus temporalis temporalis</i>)	I.40
I.4.6	Varied Sittella (<i>Daphoenositta chrysoptera</i>)	I.43
I.4.7	Turquoise Parrot (<i>Neophema pulchella</i>)	I.45
I.4.8	Superb Parrot (<i>Polytelis swainsonii</i>)	I.48
I.4.9	Painted Honeyeater (<i>Grantiella picta</i>)	I.51
I.4.10	Black-chinned Honeyeater (eastern subspecies) (<i>Melithreptus gularis gularis</i>)	I.53
I.4.11	Little Lorikeet (<i>Glossopsitta pusilla</i>)	I.56
I.4.12	Regent Honeyeater (<i>Anthochaera phrygia</i>) and Swift Parrot (<i>Lathamus discolor</i>)	I.59
I.4.13	Spotted Harrier (<i>Circus assimilis</i>)	I.62
I.4.14	Little Eagle (<i>Hieraaetus morphinoides</i>)	I.65
I.4.15	Square-tailed Kite (<i>Lophoictinia isura</i>)	I.67
I.4.16	Black-breasted Buzzard (<i>Hamirostra melanosternon</i>)	I.70
I.4.17	Barking Owl (<i>Ninox connivens</i>) and Masked Owl (<i>Tyto novaehollandiae</i>)	I.72
I.5	Mammals	I.75
I.5.1	Hollow-roosting Microbat Species	I.75
I.5.2	Cave-roosting Microbat Species	I.79
I.5.3	Koala (<i>Phascolarctos cinereus</i>)	I.81
I.5.4	Spotted-tailed Quoll (<i>Dasyurus maculatus</i>)	I.84
I.5.5	Squirrel Glider (<i>Petaurus norfolcensis</i>)	I.86
I.6	Reptiles	I.89

Table Of Appendices

I.6.1	Pale-headed Snake (<i>Hoplocephalus bitorquatus</i>)	I.89
I.6.2	Border Thick-tailed Gecko (<i>Underwoodisaurus sphyrurus</i>);	I.91
I.6.3	Five-clawed Worm-skink (<i>Anomalopus mackayi</i>)	I.94
I.6.4	Pink-tailed Legless Lizard (<i>Aprasia parapulchella</i>)	I.96

List of Figures

1.1	Regional Locality	1.2
1.2	Conceptual Project Layout	1.4
1.3	1954 Aerial Photograph of the Project Boundary	1.6
1.4	1967 Aerial photograph of the Project Boundary	1.7
1.5	1976 Aerial Photograph of the Project Boundary	1.8
1.6	1989 Aerial Photograph of the Project Boundary	1.9
1.7	1998 Aerial Photograph of the Project Boundary	1.10
1.8	Conservation and Forest Reserves in the Area	1.14
2.1	Flora Quadrat Locations	2.11
2.2	Fauna Survey Locations	2.13
2.3	Aquatic Survey Locations	2.26
2.4	Survey Locations within the Onsite Offset Areas	2.37
2.5	Survey Locations within the Offsite Offset Areas	2.38
3.1	Vegetation Communities within the Project Boundary	3.5
3.2	Vegetation/Habitat Condition Assessment of the Project Boundary and Disturbance Area	3.38
3.3	Locations of Threatened Flora Species Recorded within the Project Boundary	3.46
4.1	Grassland and Woodland Habitats in the Surrounding Areas	4.6
4.2	Locations of Threatened Fauna Species Recorded within the Project Boundary	4.17
4.3	Survey Results Indicating Koala Activity within the Project Boundary	4.18
5.1	MDS Plot of Invertebrate Diversity and Abundance	5.15
5.2	Quadrant Diagram of Signal Scores	5.20
6.1	Vegetation Communities within the Disturbance Area	6.4

List of Figures

8.1	Location of the Onsite and Offsite Offset Areas	8.12
8.2	Vegetation communities recorded within the Onsite Offset Areas	8.19
8.3	Threatened Species Recorded within the Onsite Offset Areas	8.20
8.4	Vegetation Communities Recorded within the Offsite Offset Areas	8.34
8.5	Threatened Species Recorded within the Offsite Offset Areas	8.35
8.6	Location of Revegetation and Rehabilitation Areas within the Onsite Offset Areas	8.40
8.7	Location of Revegetation Areas within the Offsite Offset Areas	8.41
8.8	Vegetation/Habitat Condition Assessment of the Onsite Offset Areas	8.48
8.9	Vegetation/Habitat Condition Assessment of the Offsite Offset Areas	8.49

List of Tables

S.1.1	Summary of Vegetation Clearance within the Project Boundary	5
1.1	Terms and Abbreviations Used in this Report	1.22
2.1	Dates of Field Survey	2.2
2.2	Flora Survey Effort	2.9
2.3	Koala Feed Trees for the Western Slopes and Plain KMA (DECC (NSW) 2008)	2.15
2.4	Fauna Survey Effort	2.19
2.5	Tree Hollow Class Size	2.22
2.6	Survey Weather Conditions	2.28
2.7	Summary of Additional Surveys Undertaken within the Onsite and Offsite Offset Areas	2.34
3.1	Vegetation Communities Recorded within the Project Boundary	3.3
3.2	Nomenclature of Vegetation Communities Recorded Within the Project Boundary	3.7
3.3	Potential Groundwater Dependent Ecosystems in the Namoi Catchment	3.40
4.1	Size and Abundance of Tree Hollows Within the Project Boundary, Averaged from 31 Sample Plots	4.3
4.2	Flowering Periods For Dominant Tree Species	4.8
4.3	Summary of TSC Act Listed Species Known or Potentially Occurring within the Project Boundary	4.19
4.4	Summary of EPBC Act Listed Species Known or Potentially Occurring	

List of Tables

	within the Project Boundary	4.20
5.1	Aquatic Habitat Assessment	5.5
5.2	Physical and Chemical Data Recorded at 2011 Aquatic Survey Sampling Locations	5.12
5.3	AusRivAS Ecological Integrity Bands	5.17
5.4	Ecological Integrity of 2011 Aquatic Survey Sampling Locations	5.18
6.1	Summary of Vegetation Clearance within the Project Boundary	6.2
6.2	Summary of Project Impacts on TSC Act Listed Ecological Communities and Threatened Species	6.29
6.3	Summary of Project Impacts on EPBC Act Listed Ecological Communities and Threatened Species	6.33
7.1	Summary of Proposed General Mitigation Measures at Watermark	7.3
8.1	Total Offset Areas Required for the Project	8.6
8.2	Total BioBanking Ecosystem Credits Required for the Project	8.8
8.3	Vegetation Communities Occurring within the Onsite Offset Areas	8.15
8.4	Vegetation Communities Occurring within the Offsite Offset Areas	8.21
8.5	Summary of Vegetation Clearance and Offsetting	8.46
8.6	Threatened Species Occurrence within the Onsite and Offsite Offset Areas	8.50
8.7	Summary of Offset Ratios for Retained Vegetation	8.54
8.8	Summary of Offset Ratios for the Project	8.56
8.9	Total BioBanking Ecosystem Credits Generated by the Project	8.60
8.10	Compliance with OEH Offsetting Principles	8.62
8.11	Compliance with the EPBC Act Environmental Offset Policy	8.67
A.1	Compliance with Assessment Requirements	A.1
C.1	Flora Quadrat Data (Quadrats 1-45)	C.1
C.2	Flora Quadrat Data (Quadrats 46-90)	C.12
D.1	Flora Species Recorded within the Project Boundary	D.1
E.1	Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region	E.1
E.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)	E.5
F.1	Fauna Species Recorded within the Project Boundary	F.1
G.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)	G.1

List of Tables

H.1	Threatened Species that May Occur in Box Gum Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List ¹	H.1

List of Photographs

3.1	White Box Grassy Woodland	3.13
3.2	Blakely's Red Gum Grassy Woodland	3.15
3.3	Yellow Box Grassy Woodland	3.17
3.4	Inland Grey Box Grassy Woodland	3.19
3.5	Weeping Myall Woodland	3.20
3.6	Brigalow	3.22
3.7	Fuzzy Box Woodland	3.24
3.8	Poplar Box Woodland	3.25
3.9	Belah Woodland	3.26
3.10	Whitewood Woodland	3.27
3.11	Tumbledown Red Gum Open Grassy Woodland	3.28
3.12	White Box Shrubby Woodland	3.30
3.13	Blakely's Red Gum Shrubby Woodland	3.32
3.14	Blakely's Red Gum Motherumbah Shrubby Woodland	3.33
3.15	Derived Native Grassland	3.35
3.16	Low Diversity Grasslands, Plantings and Exotic Pastures	3.36
5.1	Aquatic Survey Location - SWM15	5.2
5.2	Aquatic Survey Location - SWM12	5.2
5.3	Aquatic Survey Location - FD07	5.3
5.4	Aquatic Survey Location - Lake Goran	5.6
8.1	Dwyer's Red Gum Woodland	8.17
8.2	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland (Clonmeen Offset Area)	8.23
8.3	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland (Aandra Offset Area)	8.23
8.4	Red Stringybark/Blakely's Red Gum Woodland	8.24
8.5	Red Stringybark/Rough-barked Apple Woodland	8.25
8.6	New England Blackbutt Woodland	8.26

List of Photographs

8.7	Orange Gum Woodland	8.27
8.8	Manna Gum Riparian Woodland	8.28
8.9	River Oak Riparian Woodland	8.29
8.10	Derived Native Grassland	8.31
8.11	Low Diversity Grassland	8.32

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 purpose of this report is to document the findings of an ecological investigation of the Project and to assess the impacts of the Project on biodiversity values present within the Project Boundary, including threatened species, populations and ecological communities protected under State and Commonwealth legislation. This report examines the terrestrial and aquatic flora and fauna assemblages and their habitats within the Project Boundary (see **Figure 1.2**) and considers the ecological impacts of the construction and operation of the Project.

The specific objectives of the report are as follows:

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

Director-General's Environmental Assessment Requirements (DGRs) were issued by the NSW Department of Planning and Infrastructure (DP&I) on 19 April 2012 for the Project. This EIA has addressed relevant biodiversity requirements outlined in the DGRs.

The Project also requires the approval of the Commonwealth Minister for the Environment. A Referral was submitted to the Commonwealth Department of the Sustainability, Environment, Water, Population and Communities (SEWPaC) in November 2011, and the Project was deemed a Controlled Action under the EPBC Act on 22 December 2011. Accordingly a separate SEWPaC Report focussing on Matters of National Environmental Significance (MNES) listed under the EPBC Act is being prepared for submission to SEWPaC, which will also form part of the EIS being prepared by Hansen Bailey. It is expected that SEWPaC will utilise DP&I's assessment process to assess the Project.

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, where possible, 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 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. It is considered that the fauna species of conservation value have been adequately targeted to enable a comprehensive EIA to be prepared.

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 Onsite and Offsite Offset Areas

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) (see **Figure 2.4** and **Figure 2.5**). 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. A number of 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, and an Endangered Ecological Community (EEC) under the TSC Act. Another four communities identified within the Project Boundary conform to EECs listed under both the EPBC Act and the TSC Act; Inland Grey Box Woodland, Weeping Myall Woodland, Semi-evergreen Vine Thicket and Brigalow. One community identified within the Project Boundary, Fuzzy Box Woodland, is listed as an EEC under the TSC Act only. The remaining suite of vegetation communities recorded within the Project Boundary do not conform to an EEC listed under either the EPBC Act or the TSC Act.

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 TSC Act or 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 historical NSW Atlas of Wildlife records, this species was not recorded.

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 both the EPBC Act and TSC Act (the Koala) was recorded within the Project Boundary. An additional nine threatened fauna species listed under only the TSC Act, and one Migratory EPBC Act species, were also recorded within the Project Boundary during surveys, mostly birds and microbats. Although not recorded during field surveys, a suite of other fauna species listed as threatened or migratory

under the TSC Act and/or the EPBC Act are considered to have potential to occur. These are species that were not recorded, but due to the presence of suitable habitat have potential to occur. The Koala was frequently recorded within the Project Boundary during surveys. 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 4,084 ha within the Project Area (see **Figure 1.2**). This area consists of approximately 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** 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	TSC Act Status	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
White Box Grassy Woodland	EEC	CEEC	988	517	52
Regenerating White Box Grassy Woodland	EEC	CEEC	28	28	100
Blakely's Red Gum Grassy Woodland	EEC	CEEC	90	89	99
Regenerating Blakely's Red Gum Grassy Woodland	EEC	CEEC	17	17	100
Yellow Box Grassy Woodland	EEC	CEEC	69	14	20
Derived Native Grassland	EEC	CEEC	73	73	100
Subtotal Box Gum Woodland (C/EEC)			1,265	738	58
Inland Grey Box Grassy Woodland	EEC	EEC	55	30	55
Weeping Myall Woodland	EEC	EEC	22	3	14
Brigalow	EEC	EEC	9	0	0
Semi-evergreen Vine Thicket	EEC	EEC	n/a*	0	0
Fuzzy Box Woodland	EEC		36	18	50
Subtotal Other EEC			122	51	42
Poplar Box Woodland			223	45	20

Table S.1.1 Summary of Vegetation Clearance within the Project Boundary

Vegetation Community	TSC Act Status	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
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
Subtotal Other Woodland			683	148	22
Low Diversity Grassland, Planted & Exotic Pasture			7,290	3,084	42
Cleared Areas (roads, dams, buildings, etc.)			141	63	45
Subtotal Other			7,431	3,147	42
TOTAL TSC Act EEC			1,387	789	57
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 789 ha of vegetation communities listed under the EPBC Act and / or the TSC Act;
- Removal of approximately 864 ha of woodland (this includes 847 ha of preferred Koala habitat), providing known and potential habitat for a suite of 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 follows the NSW Government principles for the use of biodiversity offsets in NSW (DECC 2008b), and the Commonwealth *Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999* (DEWR 2007), which is based upon the following hierarchy of principles:

- 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 should 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 (Cumberland Ecology 2013) (Appendix L of the EIS).

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.

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, 33.7:1 for other EECs and 31.9:1 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 51 ha of other threatened ecological communities.

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 TSC Act and/or 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 and should be implemented. 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, 1,759 ha of other listed EECs and 4,890 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

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). The Project is a 30 year open cut coal mining operation and associated infrastructure.

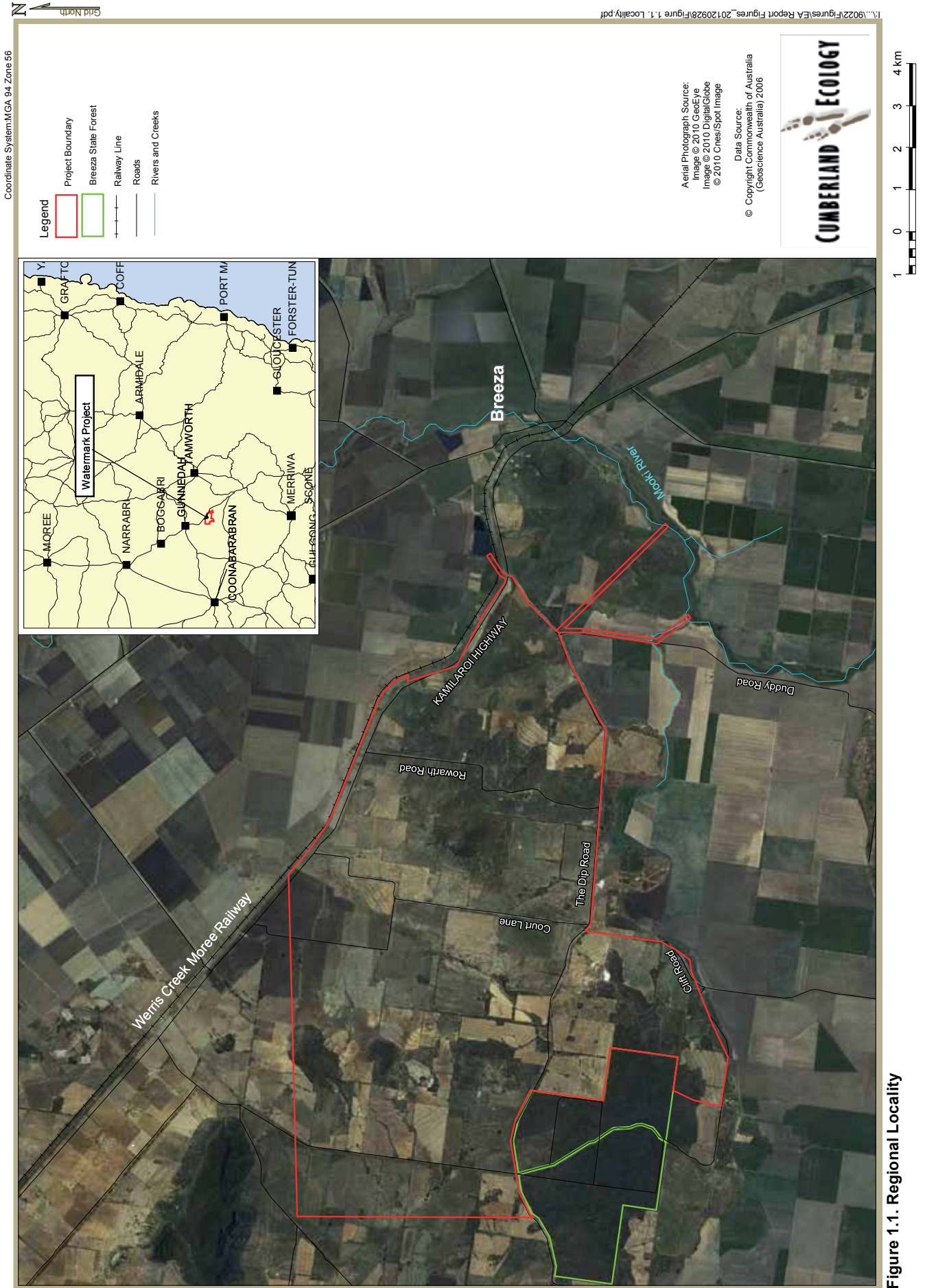
This EIA will form part of the Environmental Impact Statement (EIS) being prepared by Hansen Bailey to support an application for State Significant Development Consent under Division 4.1 of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The purpose of this report is to document the findings of an ecological investigation of the Project and to assess the impacts of the Project on the biodiversity values present within the Project Application Boundary (Project Boundary). The main objective of this report is to determine whether the Project is likely to significantly affect threatened biodiversity. Biodiversity values include threatened species, populations and ecological communities protected under State and Commonwealth legislation.

1.1 Background

In October 2008, Shenhua Watermark was granted Exploration Licence (EL) 7223. Shenhua Watermark is a subsidiary of the Shenhua Group.

The Project is located within 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 Project is approximately 282 km by rail from the export Port of Newcastle. **Figure 1.1** illustrates the regional locality of the Project in relation to the nearest town centres of Breeza and Gunnedah.

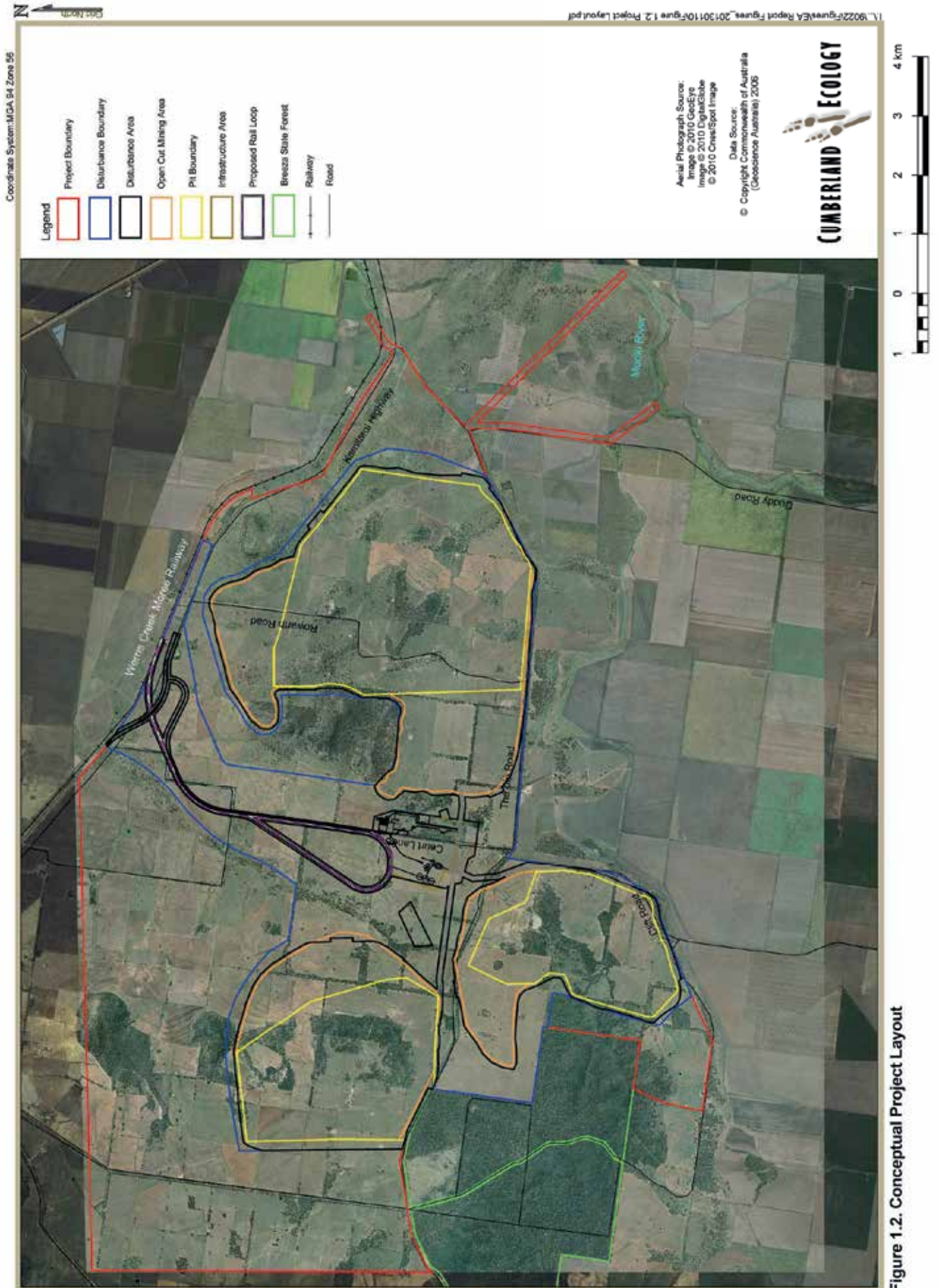


1.2 The Project

Shenhua Watermark is seeking State Significant Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project. The Project generally comprises:

- The construction and operation of an open cut mining operation extracting up to 10 Million tonnes per annum (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 1.2**. 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 1.2**.



1.3 Description of the Environment

i. Bioregional Context

The Project is located within the Gunnedah LGA on the Liverpool Plains of the Namoi River Valley. This area forms part of the Brigalow Belt South bioregion, which is one of the largest recognised bioregions in Australia. The Brigalow Belt South bioregion is an area of 27,196,933 ha that extends from southern Queensland to northern New South Wales (NSW). As such, the Brigalow Belt South bioregion is characterised by high environmental heterogeneity and ecological diversity (RACAC 2000).

ii. Vegetation

The vegetation of the NSW 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). In the Liverpool Plains sub-bioregion, where the Project Boundary is located, the extensive black soil plains, undulating volcanic hills and alluvial floodplains once supported large tracts of closed grasslands dominated by *Austrostipa aristiglumis* (Plains Grass) together with an array of sub-dominant grasses (*Panicum* spp., *Austrodanthonia* spp., *Dichanthium* spp., *Bothriochloa* spp. and *Chloris* spp.). The heavier black soils also provide habitat for Belah-Wilga woodland thickets (*Casuarina cristata-Geijera parviflora*), within which a number of other canopy trees could commonly be found (*E. albens*, *Callitris* spp., *Allocasuarina luehmanna*, *E. melliodora* and *E. blakelyi*). Although the Brigalow-Belah association of plant communities and species is more frequently encountered in the portions of the Brigalow Belt bioregion situated in Queensland, *Acacia harpophylla* (Brigalow) is rarely encountered in the southern extent.

The Brigalow Belt South bioregion is one of the most intensively cleared areas in Australia. While some of the riparian areas in the upland areas are in reasonable condition, much of the riparian areas on the plains have been significantly degraded due to broad scale vegetation clearing and intensive agricultural and pastoral development. This is due to the high fertility of the land 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. Decades of stock grazing has resulted in a variety of ecological impacts including weed invasion, nutrient enrichment and soil erosion.

These patterns are evident within the Project Boundary, where the majority has been cleared for agriculture and only higher elevation areas and fence lines support woodland vegetation. The Project Boundary has obviously had a long history of agricultural development and associated degradation and land clearing. Historical photographs indicate that the majority of the clearing that has taken place within the Project Boundary was undertaken prior to 1954, and that levels of native vegetation have not changed significantly since then, either in configuration or overall amount (see **Figures 1.3 to 1.7**).

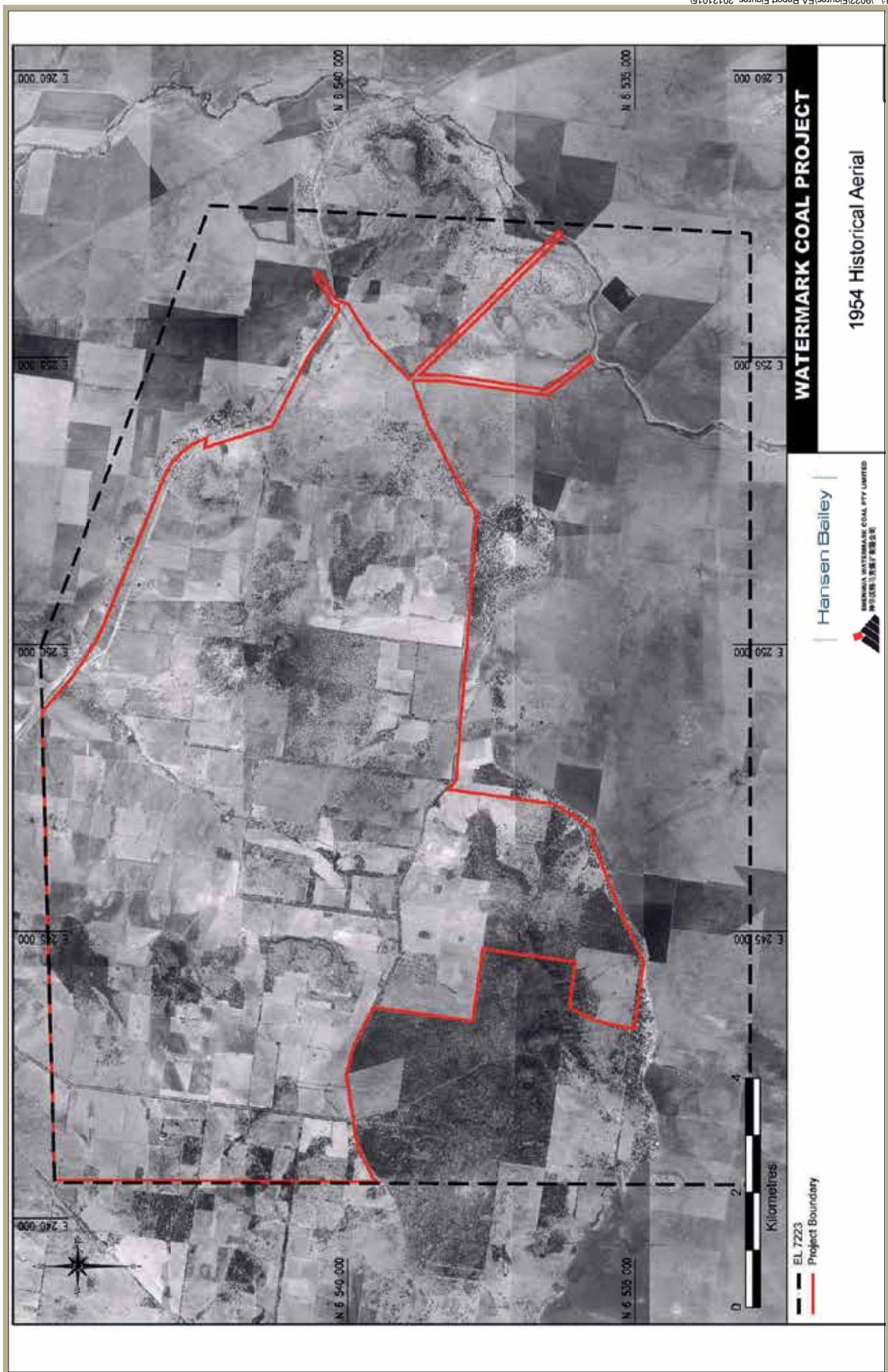


Figure 1.3. 1954 Aerial Photograph of the Project Boundary

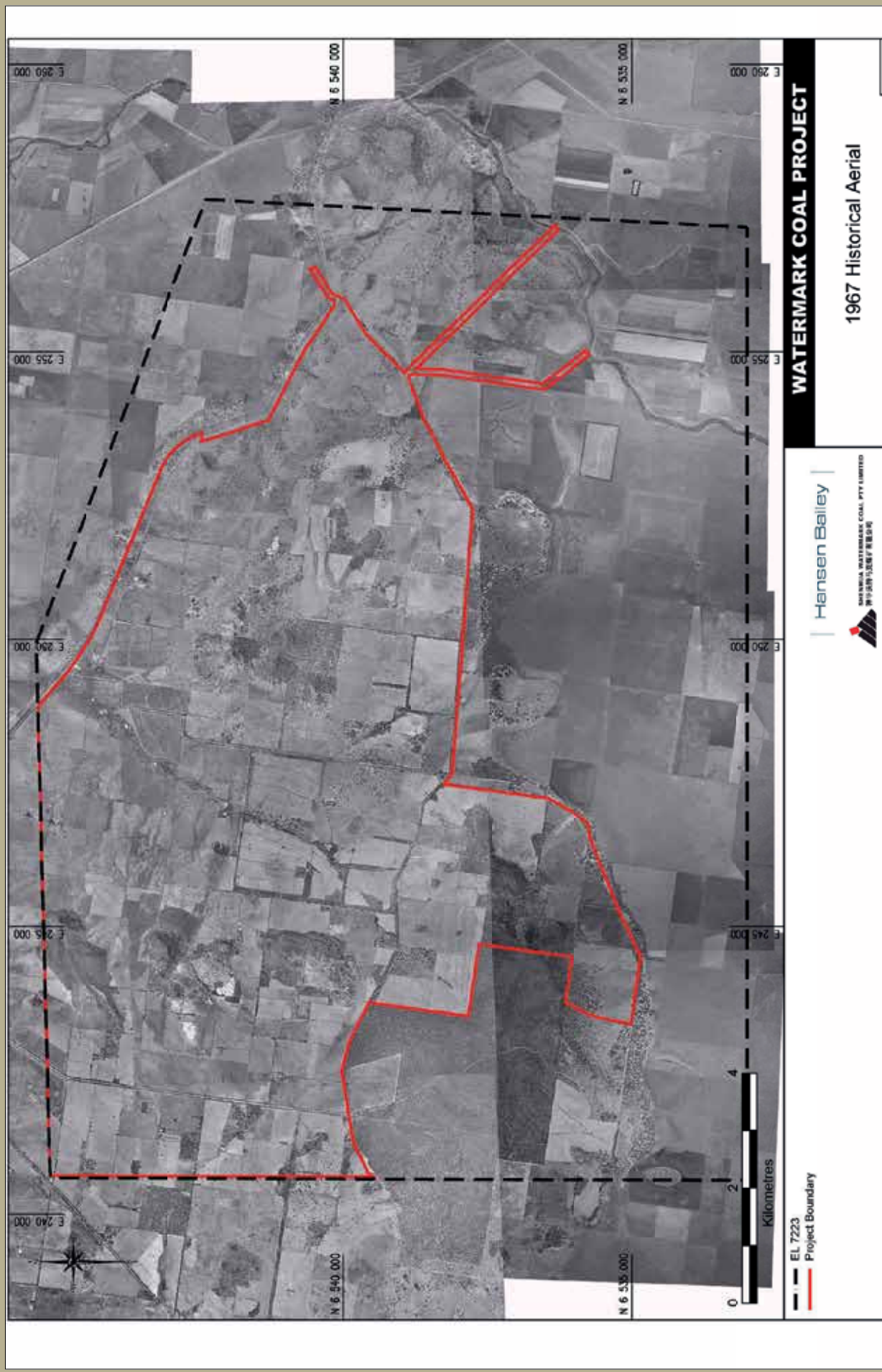


Figure 1.4. 1967 Aerial Photograph of the Project Boundary

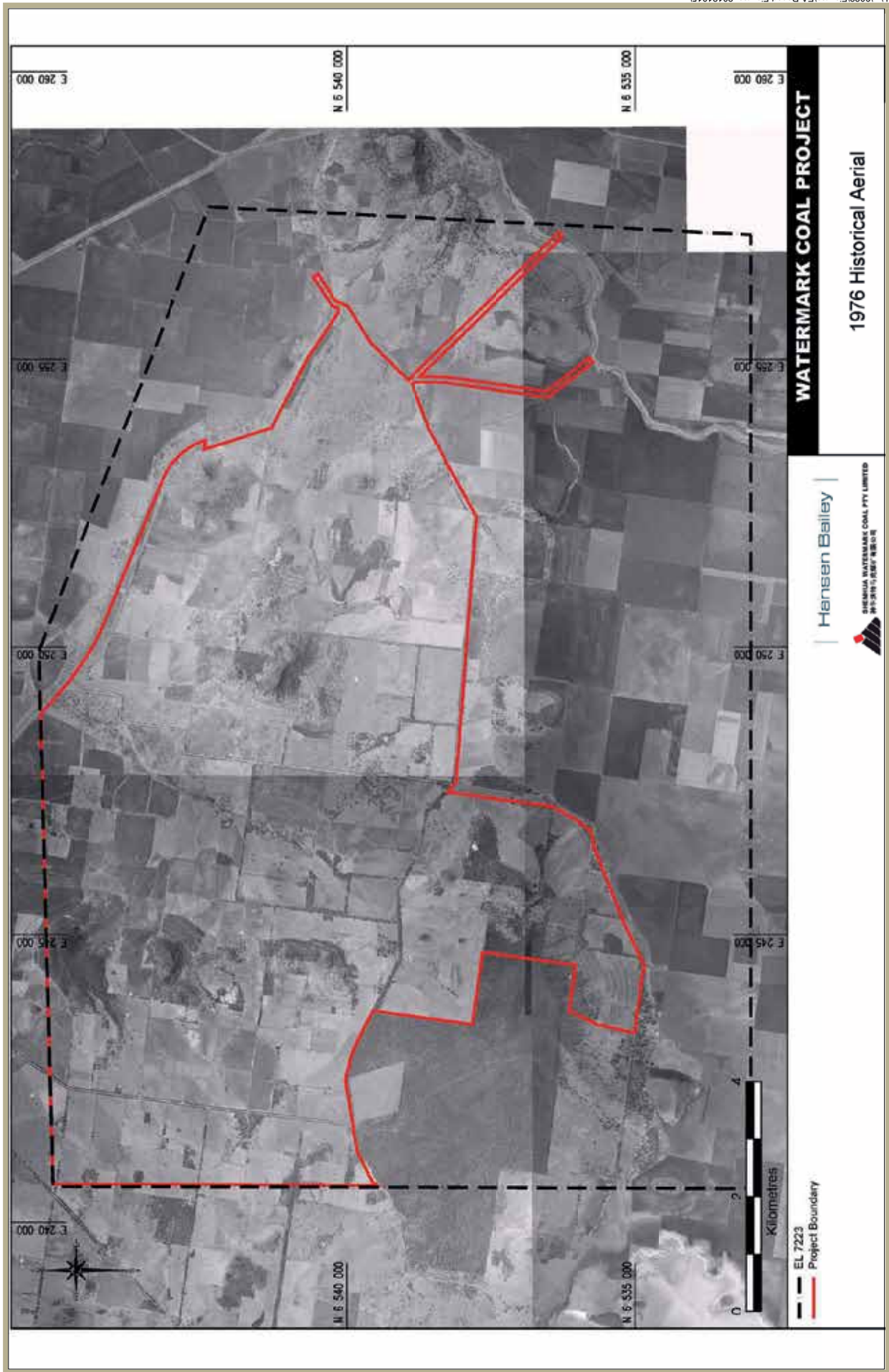


Figure 1.5. 1976 Aerial Photograph of the Project Boundary

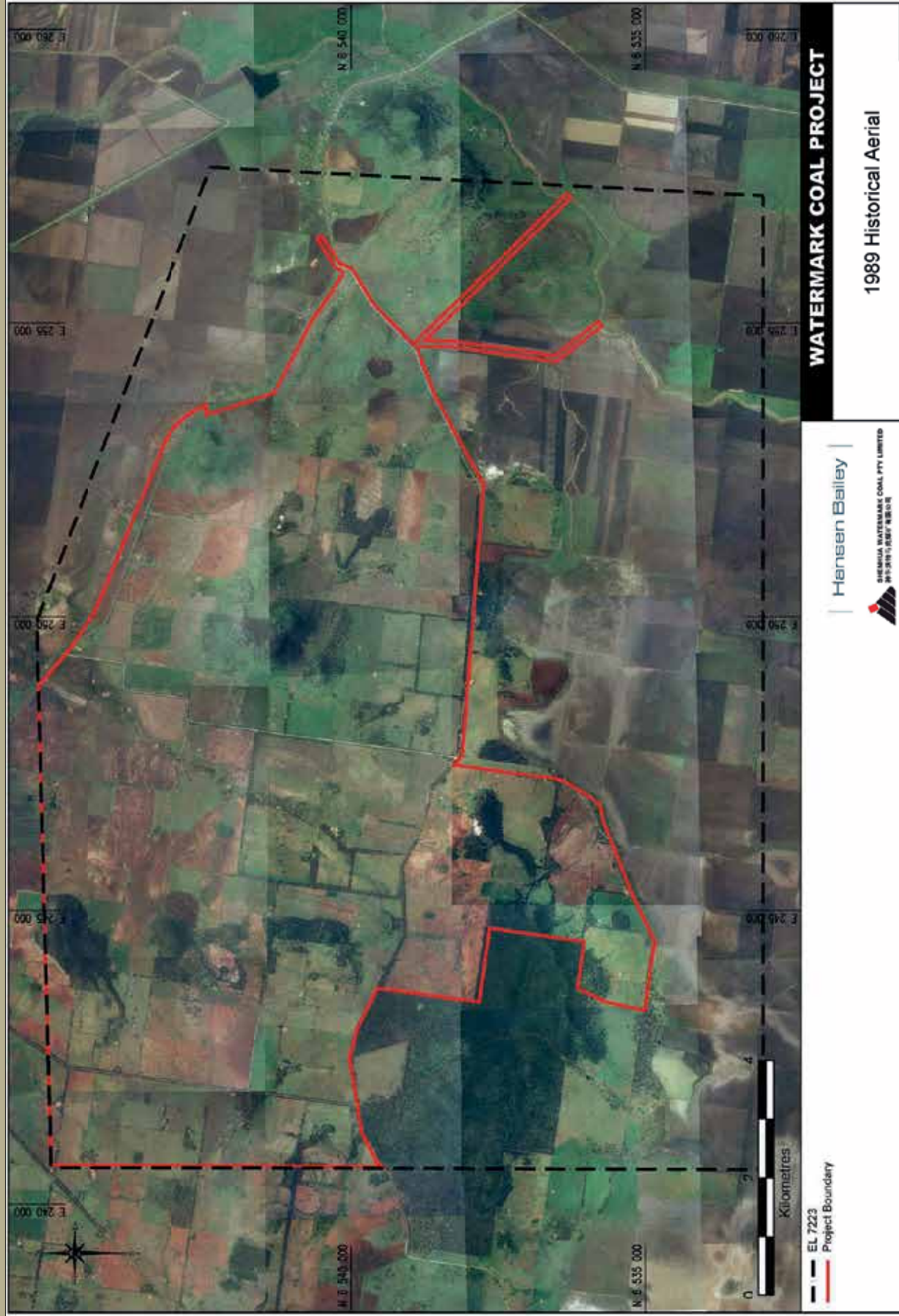


Figure 1.6. 1989 Aerial Photograph of the Project Boundary



Figure 1.7. 1998 Aerial Photograph of the Project Boundary

iii. Topography, Geology and Soils

The Gunnedah LGA is located on the Liverpool Plains within the Namoi River valley. The region is generally flat with land slopes greater than 15 degrees recorded in only 1% of the Gunnedah LGA.

Topography is variable across the Project Boundary, ranging from topographic highs associated with Mt Watermark (512 m AHD) and Smokey Point (447 m AHD) through to the black soil plains to the south and south-east of the Project Boundary. Gently undulating cleared grasslands (approximately 310 m AHD) dominate the central and western portions of the Project Boundary.

The Project Boundary is located within the Gunnedah Basin which is one of the main coal basins within NSW. The Project Boundary is located in an area referred to as the Breeza Shelf, where the Permian sediments outcrop on the eastern margin of the basin. Geological maps show the superficial geology of the site to be comprised of Quaternary aged sediments on the alluvial plains overlying Permian and Triassic aged Gunnedah Basin Sequence, which outcrops in the central and western areas. Minor areas of Tertiary aged volcanic deposits are also present to the east of the site near Breeza.

The stratigraphy of the area generally includes:

- Quaternary Alluvium;
- Tertiary Basalt and Dolerite of the Liverpool Range Beds;
- Gunnedah Basin Sequence; and
- Early Permian Watermark and Porcupine Formations and underlying Maules Creek Formation.

The early Permian to Triassic strata within the Project Boundary has a thickness of approximately 700 m and comprises predominately alluvial, deltaic and marine shelf sediments. These strata are, in places, overlain by Jurassic volcanic and sedimentary sequences of the Surat Basin.

Coal resources within the Project Boundary are from the Late Permian strata (Black Jack Group) and include the Hoskissons, Melville and associated minor coal seams.

iv. Water Catchments, Drainage and Aquifers

The Project is located within the Liverpool Plains catchment, which is self-contained and geologically bounded by the edge of the Liverpool Plains to the south and the east-dipping Hunter-Mooki Thrust to the east (SEWPaC 2009). The Liverpool Plains catchment is generally flat, with extensive floodplains and depressions which can often remain waterlogged months after heavy rains and flood events, forming small wetland areas, lagoons and chains of ponds and billabongs. The catchment is drained on the northern slopes by the Namoi River and its tributaries, the Mooki River, Cox's Creek and Peel River.

The Liverpool Plains catchment is subject to a number of water management issues that affect river flow, surface and groundwater recharge and water and habitat quality. These include excessive quantities of river water and groundwater extracted for domestic and industrial purposes, the removal of important riparian communities and bank stabilisation vegetation, the threat of fish kills, algal blooms and eutrophication as a result of increased nutrients from agricultural runoff and chemical use, and increased turbidity due to higher levels of suspended particulate matter and soil (SEWPaC 2009) (Gehrke and H. 2001).

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 significant rainfall.

A larger, permanent river, the Mooki River, is located outside of the Project Boundary near the eastern boundary. The Mooki River is a meandering inland river that joins the Namoi River, which is part of major Darling River system that extends across northern NSW (Thoms et al. 1999). The Mooki has variable water flow (median flow 10 ML/day) and is fed by numerous watercourses upstream of Gunnedah. The 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 (DIPNR 2004).

The Mooki River is classified as a 'stressed' river as the potential demand for water extraction by various users is disproportionately high relative to natural flows. It is highly dependent on flows from feeder water sources such as the Werris, Phillips, Warrah and Quirindi Creeks, as well as overflow from Lake Goran during high rainfall and flood events. 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. Water extraction and allocation on the Mooki River is controlled by the Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources (DIPNR 2005).

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 then fed by 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. Water drains primarily via seepage from the lake bed into the underlying alluvial aquifer (Zhang et al. 1997). During times of flood and high rainfall it also drains from west to east into Native Dog Gully which discharges into the Mooki River. As a result of Lake Goran's shallow topography on the plains and the typically warm climatic conditions of the region, water can rapidly recede in summer leaving the lake susceptible to intermittent drying events and salinisation. During past drought events the black soil lake-bed has been subject to intensive cropping by surrounding farms.

Flooding is primarily limited to the southern portion of the Project Boundary and is a result of off flows from the Coomoo Coomoo and Yarraman Creeks as well as Lake Goran. Overflows from Coomoo Coomoo Creek and Lake Goran occur in moderate to high flow events while overflows from Yarraman Creek flood out into the low lying floodplain during all

flow events. 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.

v. *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 are shown in **Figure 1.8**. These 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.

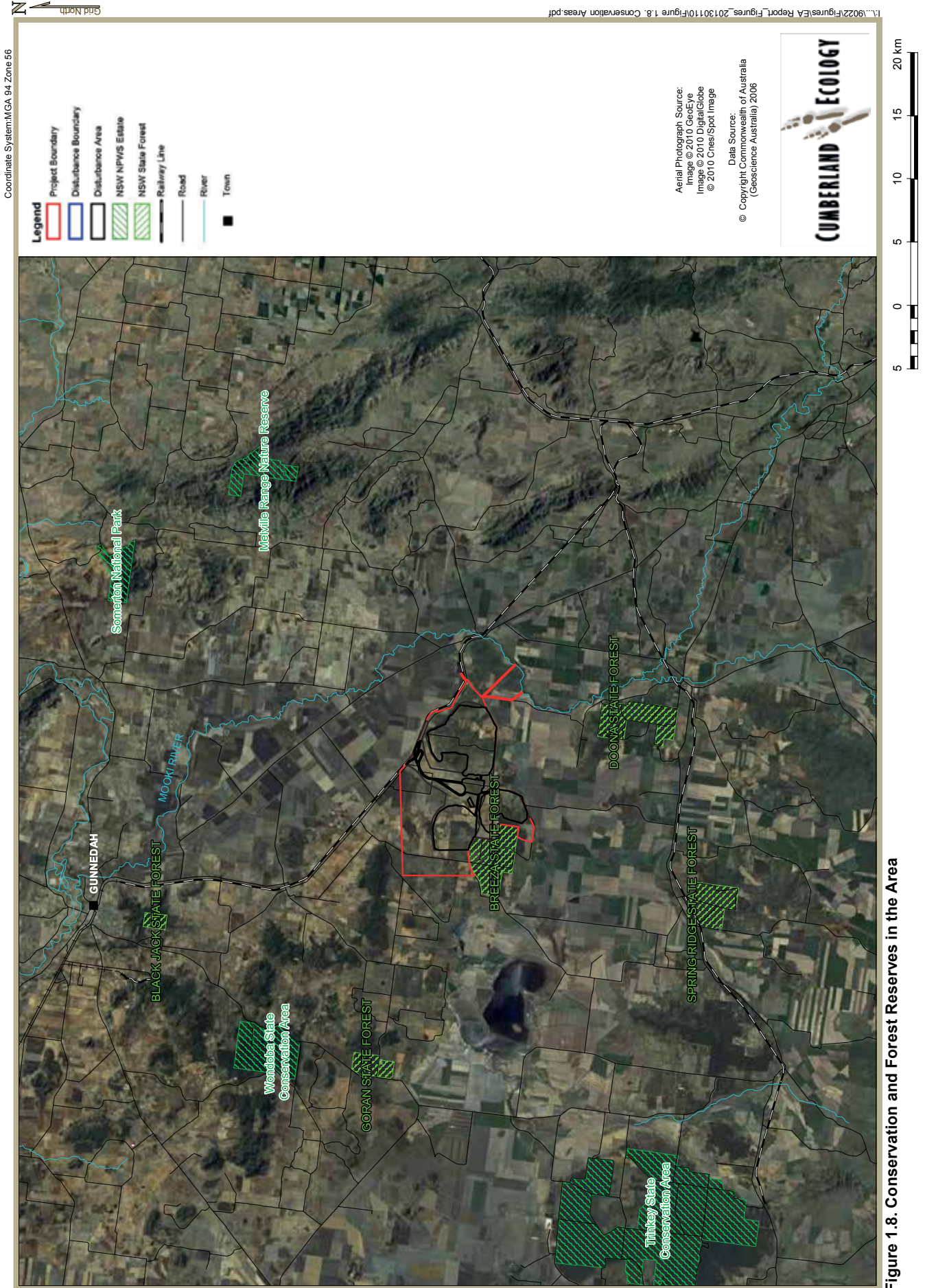


Figure 1.8. Conservation and Forest Reserves in the Area

1.4 Relevant Legislation and Regional Planning

1.4.1 *Environment Protection and Biodiversity Conservation Act 1999*

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

Any action that is considered likely to have a significant impact on MNES must be “referred” to the Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC) to obtain confirmation of whether or not a Project constitutes a “Controlled Action”. If an action is declared a Controlled Action, then Commonwealth approval is required.

SEWPaC determined that the Project is a Controlled Action under the EPBC Act and issued environmental assessment requirements for the Project that are to be integrated into the assessment requirements of the EP&A Act. These are reproduced verbatim below.

A Referral was submitted to SEWPaC in November 2011, and the Project was deemed a Controlled Action under the EPBC Act on 22 December 2011. Accordingly a separate report focussing on matters listed under the EPBC Act is being prepared for submission to SEWPaC. It is expected that SEWPaC will utilise DP&I’s assessment process to assess the Project.

1.4.2 *Environmental Planning and Assessment Act 1979*

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

i. Division 4.1 of Part 4 of the EP&A Act

Upon the repeal of Part 3A of the EP&A Act on 1 October 2011, the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* inserted a new Division 4.1 in Part 4 of the EP&A Act. This Division provides for a new planning assessment and determination regime for State Significant Developments (SSDs). A SSD is a development declared by a State Environmental Planning Policy (SEPP) or Regional Environmental

Planning Policy to be a SSD, or development which the Minister for Planning has called in for determination. The Minister for Planning is the consent authority for SSD. The Project is considered to be a SSD and therefore Shenhua Watermark will seek Project Approval from the Minister for Planning under Division 4.1 of Part 4 of the EP&A Act.

Director-General's Environmental Assessment Requirements (DGRs) were issued by the NSW Department of Planning and Infrastructure (DP&I) on 19 April 2012 for the Project and the provisions that are relevant to this EIA are provided in **Section 1.5**.

1.4.3 Threatened Species Conservation Act 1995

The TSC Act is the key piece of legislation in NSW relating to the protection and management of biodiversity and threatened species. The TSC Act aims to protect and encourage the recovery of threatened species, populations and communities that are listed under the Act through threat abatement and species recovery programs. The TSC Act requires consideration of whether a development (Part 4) or an activity (Part 5) is likely to significantly impact threatened species, populations, communities or their habitat. The potential impacts of any developments, land use changes or activities would need to undergo an "Assessment of Significance" under Section 5A of the EP&A Act.

1.4.4 Brigalow and Nandewar Community Conservation Area Act 2005

The Project Boundary is located adjacent to the Breeza State Forest which falls under the *Brigalow and Nandewar Community Conservation Area Act 2005* (BNC Act). The BNC Act was created with the following objectives:

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

Under the BNC Act, three Community Conservation Areas (BNC Conservation Areas) (Border/Gwydir, Namoi, Central West) were established in the Brigalow and Nandewar bioregions, with four management zone levels within which the BNC Conservation Areas would be managed. Under the agreement, Breeza State Forest is in Zone 4 Forestry, Recreation and Mineral Extraction, where mining and forestry activities are permitted.

The Project Boundary does not encompass any areas protected under the BNC Act.

1.4.5 SEPP 44 – Koala Habitat Protection

SEPP 44 – Koala Habitat Protection (SEPP 44) encourages the conservation and management of Koala habitats, to ensure permanent free-living Koala populations will be maintained over their present range. The SEPP requires the consent authority to consider whether land the subject of a development application is "potential Koala habitat" or "core Koala habitat". Populations of Koalas have been recorded within and surrounding the

Project Boundary as discussed further in **Chapter 4**. SEPP 44 encourages a coordinated and strategic approach to Koala habitat management within LGAs through the preparation of Koala Plans of Management (KPoMs). KPoMs are required where important Koala populations and / or Koala habitat are under threat. In KPoMs, Koala habitat is identified by community and field-based surveys and ranked in terms of its quality (for example, primary, secondary and tertiary habitat). A comprehensive KPoM has been prepared for the Project.

1.4.6 NSW State Groundwater Dependent Ecosystems Policy

The NSW State Groundwater-dependent Ecosystems Policy provides guidance on how to manage and protect groundwater dependent ecosystems, and contains five guiding principles. These are as follows:

Principle One: *The scientific, aesthetic and economic values of groundwater-dependent ecosystems and how threats to them may be avoided, should be identified and action taken to ensure that the most vulnerable and the most valuable ecosystems are protected.*

Principle Two: *Groundwater extractions should be managed within the sustainable yield of aquifer systems, so that the ecological processes and biodiversity of their dependent ecosystems are maintained and/or restored. Management may involve establishment of threshold levels that are critical for ecosystem health, and controls on extraction in the proximity of groundwater dependent ecosystems.*

Principle Three: *Priority should be given to ensure that sufficient groundwater of suitable quality is available at times when it is needed:*

- For protecting ecosystems which are known to be, or are most likely to be groundwater dependent; and
- For groundwater dependent ecosystems which are under an immediate or high degree of threat from groundwater related activities.

Principle Four: *Where scientific knowledge is lacking, the Precautionary Principle should be applied to protect groundwater dependent ecosystems. The development of adaptive management systems and research to improve the understanding of these ecosystems is essential to their management.*

Principle Five: *Planning, approval and management of developments and land use activities should aim to minimise adverse impacts on groundwater dependent ecosystems by:*

- *Maintaining, where possible, natural patterns of groundwater flow and not disrupting groundwater levels that are critical for ecosystems;*
- *Not polluting or causing adverse changes in groundwater quality; and*
- *Rehabilitating degraded groundwater systems where practical.*

1.4.7 Namoi Catchment Management Authority

The Namoi CMA has three main policy documents that guide developments and activities, including mining, in the Namoi Catchment. These are:

- Namoi Catchment Action Plan 2010 – 2020;
- Extractive Industries Policy for the Namoi Catchment; and
- Namoi CMA Biodiversity Offsets Policy.

i. Namoi Catchment Action Plan

A Catchment Action Plan (CAP) provides for the strategic direction of natural resource management in a Catchment. All Catchment Management Authorities (CMAs) across NSW have their own CAPs which have been specifically tailored to meet the unique needs of each catchment area. A CAP sets targets and activities for a 10 year period but is reviewed more frequently.

The Namoi CAP provides an overall framework of a way forward for groups and individuals who will be involved in managing the Catchment's natural resources over the next 10 years. The Namoi CAP (Namoi CMA 2011a) identifies four catchment targets for terrestrial biodiversity:

1. *By 2020 there is an increase in native vegetation extent and vegetation does not decrease to less than 70% in less cleared subcatchments and 30% in over cleared subcatchments and no new Regional Vegetation Community decreases to less than 30% extent as identified by 2010 baseline;*
2. *By 2020 maintain sustainable populations of a range of native fauna species by ensuring that no new Regional Vegetation Community decreases to less than 30% extent as identified by 2010 baseline;*
3. *By 2020 contribute to the information and actions supporting recovery of viable threatened species, populations and communities; and*
4. *By 2020 no new invasive species is established in the Catchment and the spread of key emerging invasive plants and animals is limited.*

ii. Namoi Catchment Management Authority Biodiversity Offsets Policy

The objective of the Namoi CMA Biodiversity Offsets Policy (Namoi CMA 2011b) is to develop a policy position on the use of biodiversity offsets in the Namoi Catchment which is consistent with Namoi CMAs vision and the Catchment Targets contained in the Namoi CAP.

The Namoi CMA Offset Policy states that the following precautionary principles must be applied when considering using biodiversity offsets in the Namoi Catchment for any development:

- *Offsets will be used as a last resort, after consideration of alternatives to avoid and/or mitigate impacts;*
- *Offset areas be kept within the Namoi Catchment boundaries (either wholly or in part – as a contiguous area of native vegetation);*
- *Offsets must be of the same vegetation type and be at least the size, equivalent biodiversity value & configuration of the vegetation lost through development and additional to existing native vegetation areas;*
- *Offsetting must achieve biodiversity benefits in perpetuity and be registered on title;*
- *Offset conditions must be monitored, enforceable, clearly mapped, recorded and publicly available; and*
- *An offset area, once designated, cannot be used for further offsetting of subsequent developments in future.*

iii. *Namoi Extractive Industries Policy*

The Namoi CMA has developed the Namoi Extractive Industries Policy (EIP) with regard to extractive industries (such as the Project) to ensure that the catchment assets are sustained. The Namoi EIP states that the Namoi CMA undertakes the following:

- *Assumes a leadership role in advising on the impact of extractive industries in the Namoi Catchment, recognising that the NSW Government is the determining authority for mine approval and licensing;*
- *Acknowledges that exploration for minerals, gas and energy resources shall continue;*
- *Adopts the Precautionary Principle on extractive industries in the Namoi Catchment;*
- *Opposes new approvals for extractive industries in the Namoi Catchment in the absence of a rigorous risk management assessment of cumulative impacts on the four key regional assets;*
- *Seeks to ensure that in-depth baseline natural resource management (NRM) databases are in place to ensure that adequate monitoring and evaluation of all extractive industry developments can take place;*
- *Seeks to identify key Catchment assets then seeks to identify the risks to those assets;*
- *Seeks to have the CAP considered during the approval process;*
- *Supports the ten (10) International Council of Mining and Metals (ICMM) Principles;*

- *Agrees to engage in constructive dialogue with the Australian/NSW Minerals Council on the risk management assessment together with the implementation and evaluation of the applicable ICMM principles; and*
- *Will seek the reimbursement of public NRM investment funds, from the developer, where these investments are impacted upon by mining or exploration, for reinvestment within the Namoi Catchment to maintain or improve the four key regional assets.*

1.4.8 Water Management Act 2000

The objective of the *Water Management Act 2000* is the sustainable and integrated management of the State's water for the benefit of both present and future generations. The *Water Management Act 2000* provides clear arrangements for controlling land based activities that affect the quality and quantity of the State's water resources.

Water sharing plans establish rules for sharing water between the environmental needs of the river or aquifer and water users, and between different types of water use such as town supply, rural domestic supply, stock watering, industry and irrigation.

Three water sharing plans cover EL 7223 and the Project area as follows:

- Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003;
- Water Sharing Plan for the NSW Murray Darling Basin Porous Rock Groundwater Sources 2011; and
- *The Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources.*

1.4.9 Other Relevant Legislation and Guidelines

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

- *National Parks and Wildlife Act 1974;*
- *Water Management Act 2000; and*
- *Fisheries Management Act 1994.*

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

- DECC (2008b) Principles for the Use of Biodiversity Offsets in NSW Department of Environment and Climate Change, Hurstville, NSW;

- DEWR (2007) Draft Policy Statement: Use of Environmental Offsets under the *Environment Protection and Biodiversity Conservation Act 1999*, Department of the Environment and Water Resources, Canberra, ACT;
- Namoi CMA (2011b) Namoi CMA Biodiversity Offsets Policy, Namoi Catchment Management Authority, Gunnedah, NSW.

1.5 NSW Director Generals Requirements for the Project

Director-General's Environmental Assessment Requirements (DGRs) were received from the NSW Department of Planning and Infrastructure (DP&I) for the Project on 19 April 2012 and the provisions that are relevant to this assessment are reproduced below.

The EIS must address the following specific issues:

- *Biodiversity – Including:*
 - *Measures taken to avoid, reduce or mitigate impacts on biodiversity;*
 - *Accurate estimates of proposed vegetation clearing;*
 - *A detailed assessment of potential impacts of the development on any:*
 - *terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and*
 - *regionally significant remnant vegetation, or vegetation corridors;*
 - *A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term.*

In addition to the requirements outlined above, several government agencies were asked to provide input into the formulation of the DGRs for the Project. These included the following:

- NSW Department of Primary Industries Agriculture;
- NSW Department of Primary Industries Fisheries;
- Heritage Council of NSW;
- Gunnedah Shire Council;
- Liverpool Plains Shire Council;
- Tamworth Regional Council;
- Namoi CMA;

- NSW Office of Water (NOW);
- NSW Office of Environment and Heritage (OEH);
- NSW Department of Trade & Investment, Regional Infrastructure & Services (DTIRIS), Division of Resources & Energy (DRE); and
- NSW Department of Roads and Maritime Services.

Appendix A provides an assessment of compliance with the requirements of these agencies that are relevant to this report.

1.6 Terms and Abbreviations

Table 1.1 Terms and Abbreviations Used in this Report	
Terminology	Description
AusRivAS	Australian River Assessment System
BNC Act	<i>Brigalow and Nandewar Community Conservation Area Act 2005</i>
BNC Agreement	Brigalow and Nandewar Community Conservation Area Agreement
BNC Conservation Area	Community Conservation Areas (Border/Gwydir, Namoi, Central West)
BOP	Biodiversity Offset 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
CAP	Catchment Action Plan
CEEC	Critically Endangered Ecological Community
CHPP	Coal Handling & Preparation Plant
CMA	Catchment Management Authority
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 delineated area on Figure 1.2 (blue line) within which the Disturbance Area will occur. The area of disturbance within the Disturbance Boundary will not exceed 4,084 ha.
DP&I	NSW Department of Planning & Infrastructure
DTIRIS	Department of Trade and Investment, Regional Infrastructure and Services
DRE	Division of Resources and Energy (Division of DTIRIS)
DGRs	Director- General's Environmental Assessment Requirements (NSW DP&I)
EEC	Endangered Ecological Community

Table 1.1 Terms and Abbreviations Used in this Report

Terminology	Description
EIA	Ecological Impact Assessment
EIS	Environmental Impact Statement
EP&A Act	<i>NSW Environmental Planning & Assessment Act 1979</i>
EPA	NSW Environment Protection Authority
EPBC Act	<i>Commonwealth Environment Protection and Biodiversity Conservation Act 1999</i>
EL 7223	Exploration Licence 7223
FM Act	<i>NSW Fisheries Management Act 1994</i>
GDE	Groundwater Dependant Ecosystem
ICMM	International Council of Mining and Metals
LGA	Local Government Area
Locality	Land within 20 km radius of the Project Boundary
MIA	Mining Infrastructure Area
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>
NV Act	<i>NSW Native Vegetation Act 2003</i>
OEH	NSW of Environment and Heritage
Project Approval	Project Approval will be sought from the Minister of Planning 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.
ROM	Run of Mine
RVC	Regional Vegetation Communities
SAT	Spot Assessment Technique
SEWPaC	Commonwealth 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
TSC Act	<i>NSW Threatened Species Conservation Act 1995</i>

Chapter 2

Methodology

Detailed ecological surveys have been conducted across the Project Boundary to provide comprehensive flora and fauna baseline data in compliance with the NSW Environment Protection Authority (EPA) guidelines for flora and fauna survey (DEC (NSW) 2004). Floristic sampling was designed to meet SEWPaC guidelines for identifying the critically endangered Box Gum Woodland and Derived Native Grassland (DEH 2006).

This chapter presents the methodology utilised in preparing this EIA. It includes a description of the methods used in the detailed flora and fauna surveys as well as the process of vegetation mapping and surveys for offset lands.

2.1 Literature Review and Database Analysis

2.1.1 Literature Review

There has been considerable ecological survey effort within the Project Boundary and the locality in recent times and relevant reports were reviewed to provide information for the EIA. Previous flora and fauna studies have been undertaken 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 Caroon Coal Project, which is currently in its exploration stage, and is located a short distance south of the Project Boundary. The findings of this report were reviewed as part of this EIA.

Literature review was also conducted for the aquatic assessment. Surface water monitoring is currently being undertaken by Carbon Based Environmental Pty Ltd (CBE) for the Project. This includes water sampling at a number of surface water monitoring stations along creeklines and streams both within and surrounding 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 EIA, 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 within the Project Boundary, the key findings of the Western Regional Assessments of the Brigalow and Nandewar bioregions (DECC (NSW) 2009) were reviewed.

2.1.2 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 2012) and EPBC Protected Matters Search Tool (SEWPaC 2012b). 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.

2.2 Terrestrial Surveys

2.2.1 Dates of Survey by Cumberland Ecology

Field surveys took place between November 2010 and March 2012 and are summarised in **Table 2.1**. 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 2.1 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 surveys
29 November - 2 December 2010	Flora quadrat surveys
13-15 December 2010.	Flora quadrat surveys
	Koala SAT surveys
21-30 March 2011	Fauna surveys (terrestrial fauna trapping, harp trapping,

Table 2.1 Dates of Field Survey	
Dates of Survey	Tasks Completed
	Anabats, diurnal and nocturnal searches and call playback)
28 March – 1 April 2011	Koala SAT 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 surveys
5-10 June 2011	Aquatic surveys
11-15 July 2011	Vegetation mapping
19-23 September 2011	Koala SAT surveys
10-14 October 2011	Koala SAT 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)

2.2.2 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.

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 (20 m x 50 m) 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.

a. Identification of Box Gum Woodland and Derived Native Grassland under the EPBC Act

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 the Critically Endangered Ecological Community (CEEC).

The flow chart that summarises the SEWPaC method for identifying Box Gum Woodland and Derived Native Grassland is reproduced in **Appendix B**. It demonstrates that to confirm the occurrence 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 (0.1 ha). SEWPaC has published a list of plant 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.

Assessment of the condition of Box Gum Woodland and Derived Native Grassland was guided by the condition classes provided within the SEWPaC listing advice. The three condition classes are:

- 'A' - An overstorey of eucalypt trees exists, but there is no substantial native understorey;
- 'B' - A native understorey exists, but the trees have been cleared; and
- 'C' - Both a native understorey and an overstorey of eucalypts exist in conjunction.

The listing advice notes 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*' (Threatened Species Scientific Committee 2006). As such, only conditions B and C were assessed within the Project Boundary.

b. Identification of Box Gum Woodland and Derived Native Grassland under the TSC Act

A detailed description that defines the Box Gum Woodland and Derived Native Grassland is included in the Final Determination made in 2004 by the NSW Scientific Committee to list Box Gum Woodland and Derived Native Grassland as an Endangered Ecological Community (EEC) under the TSC Act. The presence of the community is determined on the basis of its consistency with the community described within the Final Determination.

The TSC Act Final Determination of the Box Gum Woodland EEC provides the following description of the community:

2. White Box Yellow Box Blakely's Red Gum Woodland includes those woodlands where the characteristic tree species include one or more of the following species in varying proportions and combinations - Eucalyptus albens (White Box), Eucalyptus melliodora (Yellow Box) or Eucalyptus blakelyi (Blakely's Red Gum). Grass and herbaceous species generally characterise the ground layer. In some locations, the tree overstorey may be absent as a result of past clearing or thinning and at these locations only an understorey may be present. Shrubs are generally sparse or absent, though they may be locally common.

11. Disturbed remnants are still considered to form part of the community including remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soil and associated seed bank are still at least partially intact.

Paragraph 2 guided identification of intact woodland patches and paragraph 11 guided identification of modified patches, including grassland. Like the EPBC Act, the TSC Act Final Determination makes a comment about the viability of areas that are to be included in the TSC Act listing. Grassland forms of the TSC Act listed Box Gum Woodland are required to exhibit a “*natural regenerative ability*” (assisted or unassisted) that would indicate a mostly intact soil bed and associated seed bank. Therefore, to be considered to meet the TSC Act definition of Box Gum Woodland, the grassland should be capable of assisted natural regeneration and not require active planting of trees and understorey.

Assessment of the condition of Box Gum Woodland and Derived Native Grassland was guided by the *Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland)* (NSW NPWS 2005), which includes an initial identification assessment. The guidelines identify the following condition classes:

- ‘1’ – Multi-aged overstorey with a grassy, herb-rich understorey;
- ‘2’ – Partially cleared/thinned stands with a mixture of native and exotic understorey species;
- ‘3’ – Stands where White Box, Yellow Box or Blakely's Red Gum have been killed and other species dominate the canopy;

- '4' – Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box-Gum Woodland understorey is present; and
 - '5' – Degraded remnants that have few, if any, native species in the understorey.
- c. Identification of other EECs under the TSC Act and EPBC Act

The identification of other TSC Act listed EECs occurring within the Project Boundary was guided by the final determinations prepared by the NSW Scientific Committee and OEH threatened species profiles. The identification of other EPBC Act listed EECs was guided by the SEWPaC Community and Species Profile and Threats Database listing advice.

ii. *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 2.1**. Flora quadrat data is provided in **Appendix C**. 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.

iii. *Targeted Surveys*

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. Searches were also conducted in the vicinity of recorded specimens. The locations of threatened flora specimens were recorded using a hand held GPS.

a. *Dichanthium setosum*

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* species observed to have slightly different vegetative growth was also sampled and fertile spikelets measured.

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

b. *Bothriochloa biloba*

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.

iv. *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.

v. *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 2.2** 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 (ie quadrat number) was completed in such vegetation.

Table 2.2 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

Table 2.2 Flora Survey Effort		
Survey Technique	Recommended Survey Effort (based on total area)	Survey Effort
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

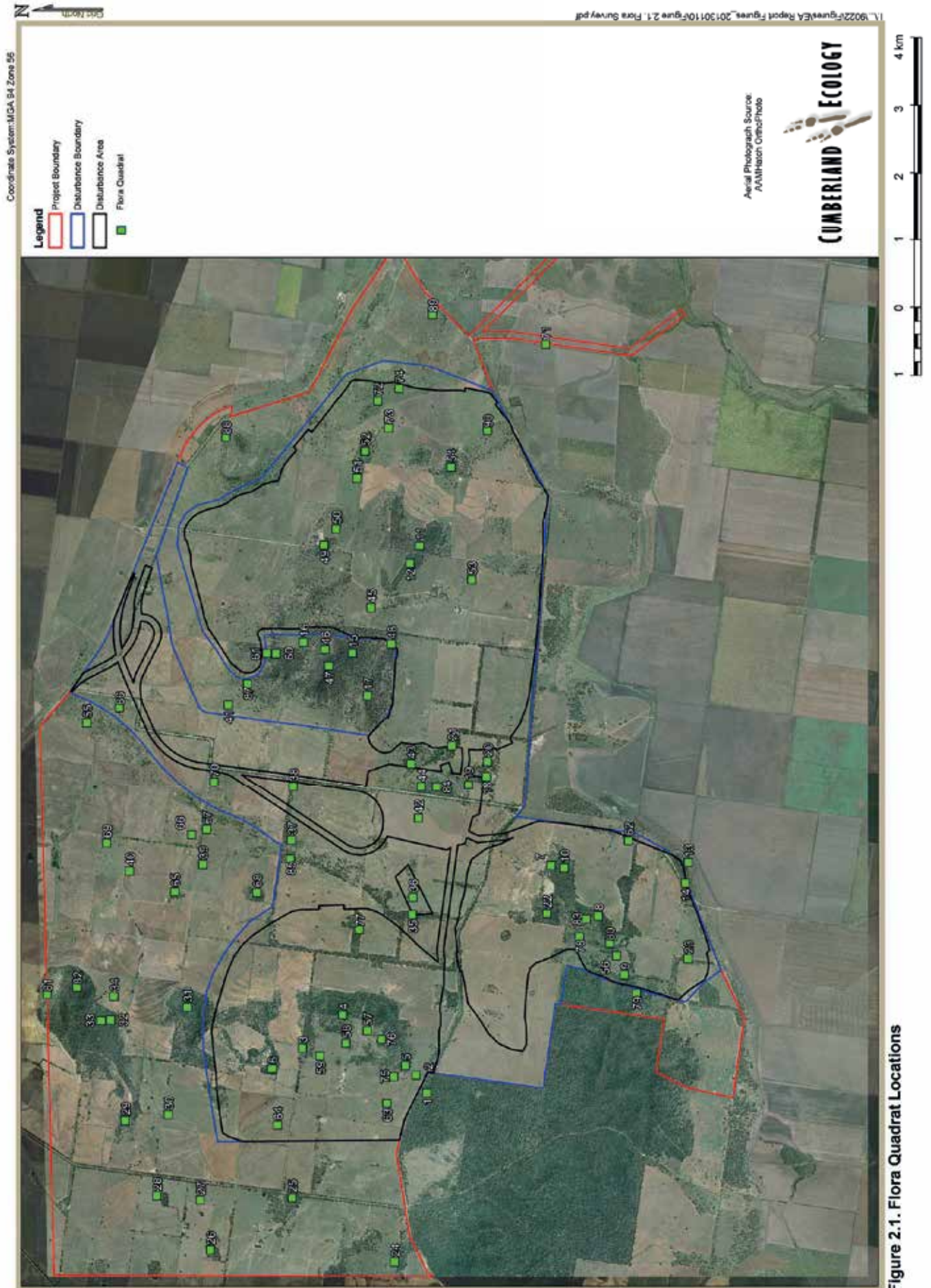
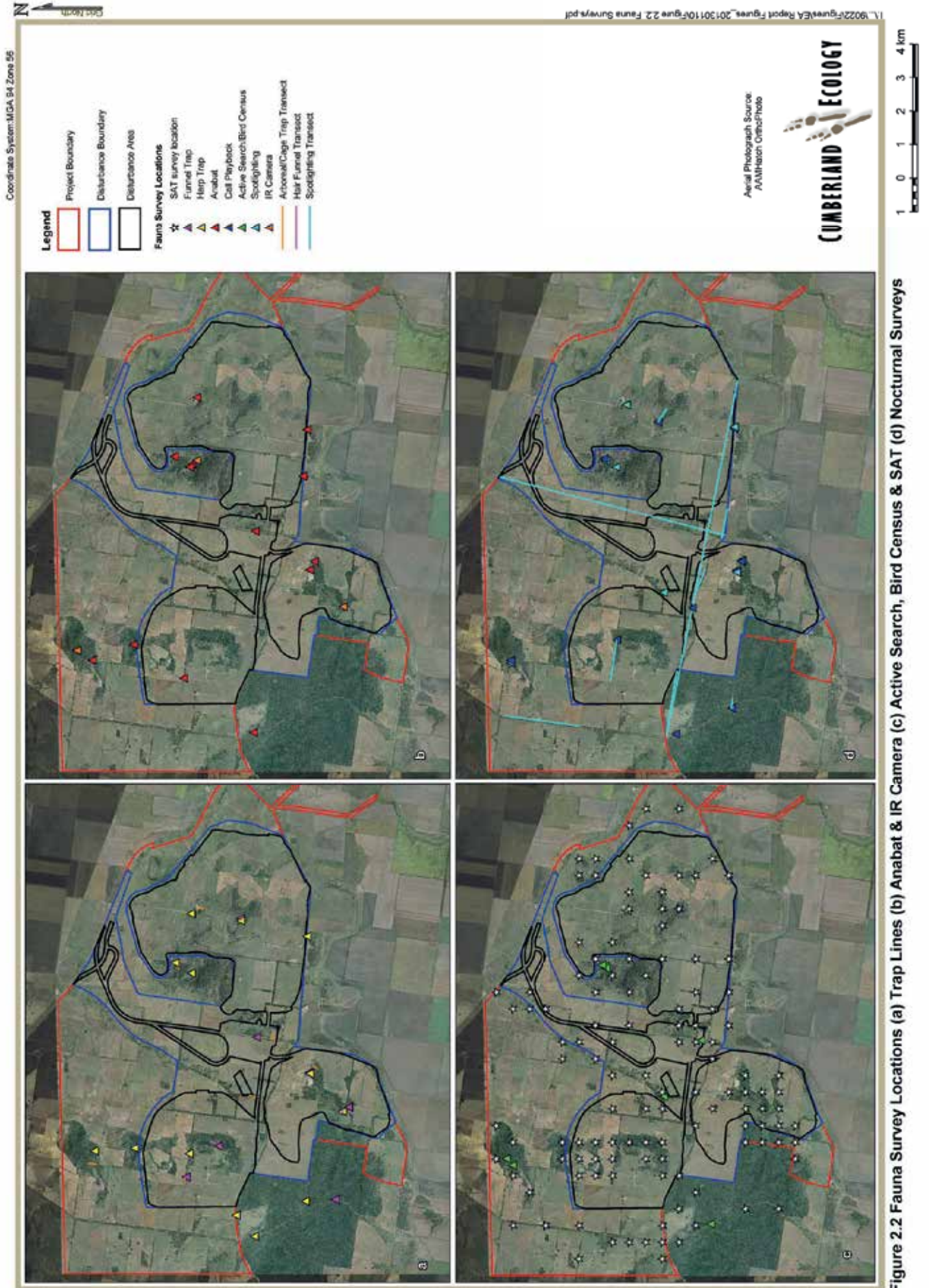


Figure 2.1. Flora Quadrat Locations

2.2.3 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). The fauna surveys included Koala activity surveys, trapping, hair tubes, Anabat detection and harp trapping, bird surveys, call playback, Infra-red (IR) camera detection, spotlighting and amphibian and reptile surveys. Surveys were undertaken over several survey sessions to increase the seasonal range of sampling to maximise detection.

Survey methods utilised within the ecological assessment are described in detail in the following sections. The locations of fauna survey sites are shown in **Figure 2.2**. Given the area of land required to be surveyed, the Project Boundary was divided into eight zones as a surrogate for fauna habitat and survey locations were 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 detailed surveys were primarily 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).

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 2.3** 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 2.3 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 polyanthemos</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 20 m 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.

iii. Hair Tubes

'Faunatech' hair tubes were used during field surveys to detect small and medium sized terrestrial mammals. 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.

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.

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.

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.

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*) and Squirrel Glider

(*Petaurus norfolcensis*). 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.

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. SAT surveys involved raking of leaf litter beneath trees, which is also an effective method for detecting fossorial reptiles.

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 2.4** below. 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 **Section 2.6.3**.

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.

Table 2.4 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
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

Table 2.4 Fauna Survey Effort		
Survey Technique	Recommended Survey Effort based on area of habitat: 1,997 ha of Woodland	Survey Effort
		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 hair tubes).
Hair tubes	1,680 trap nights (840 small and 840 large sizes)	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 Koala 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
*Koala SAT/Area Search surveys	n/a	168 SAT 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

2.2.4 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.

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 121 SAT sampling points used for the Koala assessment described in **Section 2.2.3 i**. At each sampling point, searches for hollow-bearing trees were made within a 20 x 50 m 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 2.5** below. The data obtained was used to determine densities of tree hollows per hectare.

Table 2.5 Tree Hollow Class Size	
Class	Diameter (cm)
1	<5
2	5-10
3	11-15
4	16-20
5	21-25
6	26-30
7	>30

2.3 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.

2.3.1 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. 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 2.3**):

- 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. 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
 - Sampling 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, taken including:
 - Alkalinity (as mg/L of CaCO_3): Measure of the buffering capacity of the water;
 - Conductivity ($\mu\text{S}/\text{cm}$): 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 ($^{\circ}\text{C}$): 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.

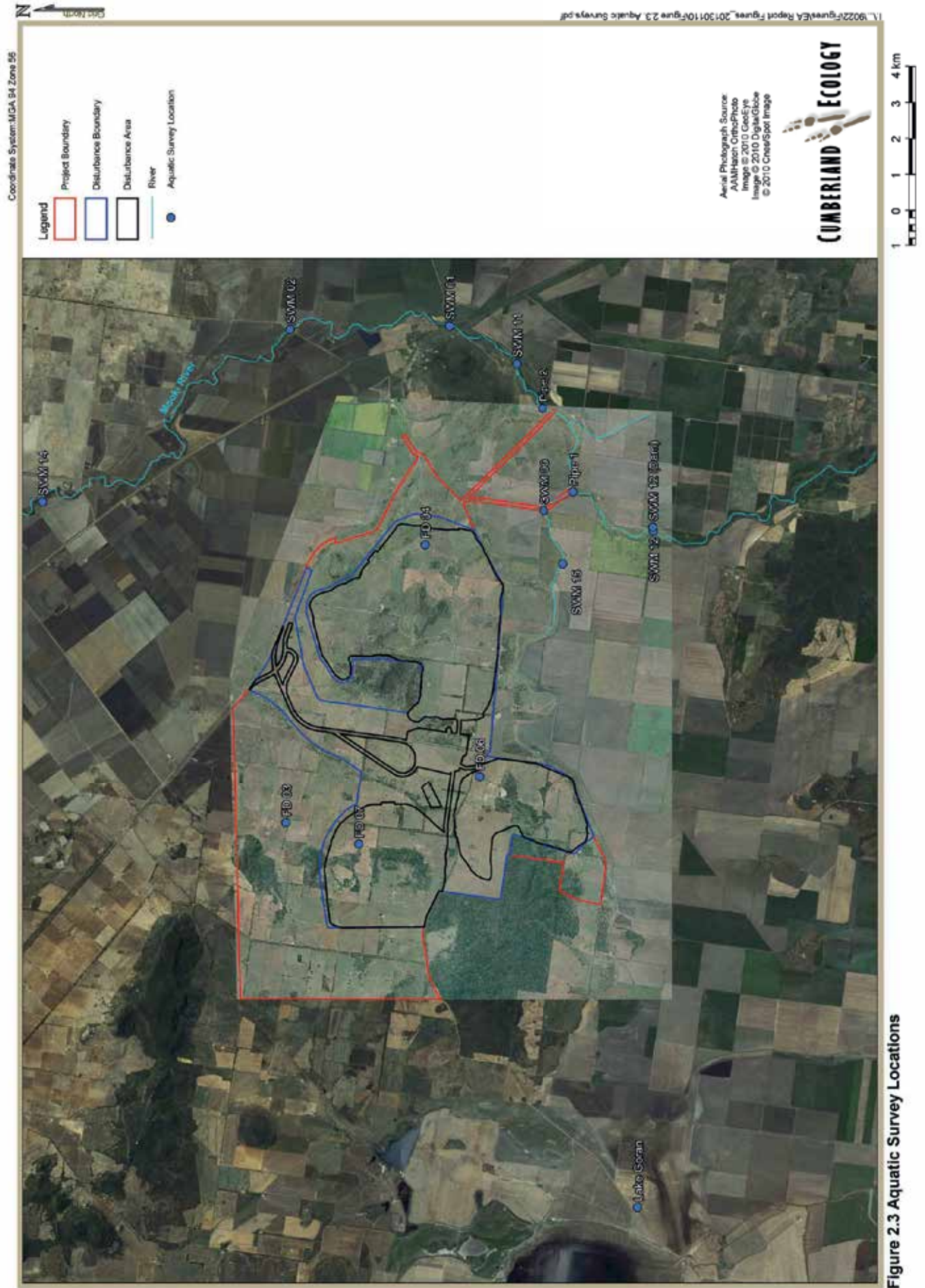
AusRivAS is a set of computer models that compare the abundance and identity of macro-invertebrates collected from a sample site with a database from a large number of reference sites throughout Australia. The AusRivAS models compare the sample site to reference sites for similar types of streams in 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 presence 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.



2.4 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 2.6**.

Table 2.6 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

Table 2.6 Survey Weather Conditions

Date	Max Temp (°C)	Min Temp (°C)	Rain (mm)
12/05/2011	16.9	0.9	0.4
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

Table 2.6 Survey Weather Conditions

Date	Max Temp (°C)	Min Temp (°C)	Rain (mm)
23/12/2011	27.2	18.0	0
13/02/2012	31.8	15.8	0
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).

2.5 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 of 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 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).

2.5.1 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 several 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.

2.5.2 Fauna

The fauna surveys were undertaken with reference to 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 under-represented 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 Koala 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 also targeted threatened species predicted to occur. The targeted threatened species surveys generally utilised survey techniques outlined within the OEH guidelines, however in some instances the recommended techniques were not utilised, including terrestrial Elliott A trapping. 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. 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).

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 at 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 EIA to be prepared 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.

2.6 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.

2.6.1 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.

2.6.2 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 2.7**. In addition to the survey techniques utilised within the Project Boundary (see **Section 2.2.2** and **2.2.3**), 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 2.4** and **Figure 2.5**, 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 2.7 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)		
Harp Trapping	28-29 March 2012 (6 trap nights)		

Table 2.7 Summary of Additional Surveys Undertaken within the Onsite and Offsite Offset Areas			
Survey Technique	Offset Area 6	Clonmeen Offset Area	Aandra Offset Area
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)		

2.6.3 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 this is not a limitation as the entire parcel of land is assumed to have limited ecological value in its current largely cleared state and is proposed to be revegetated.

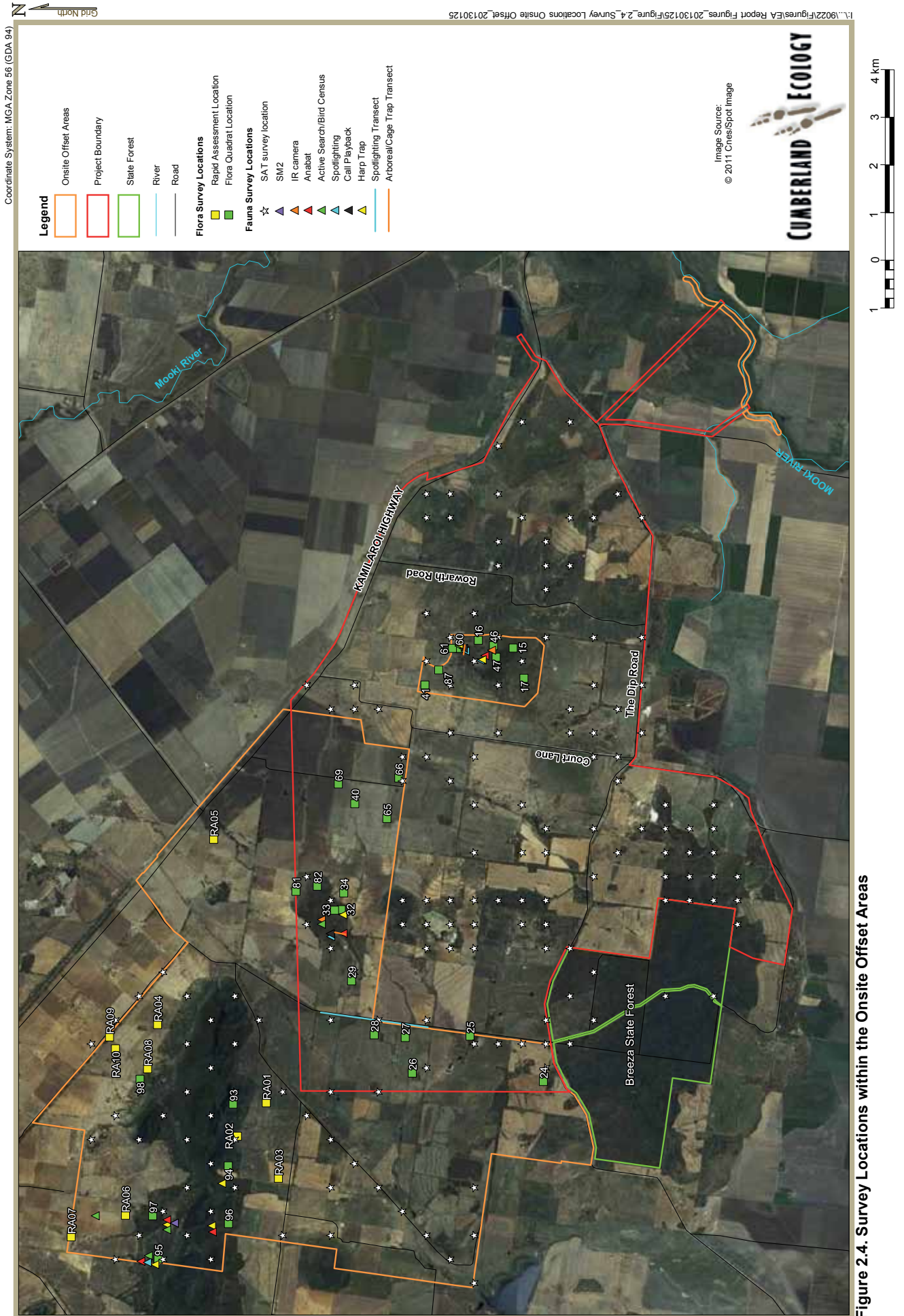


Figure 2.4. Survey Locations within the Onsite Offset Areas

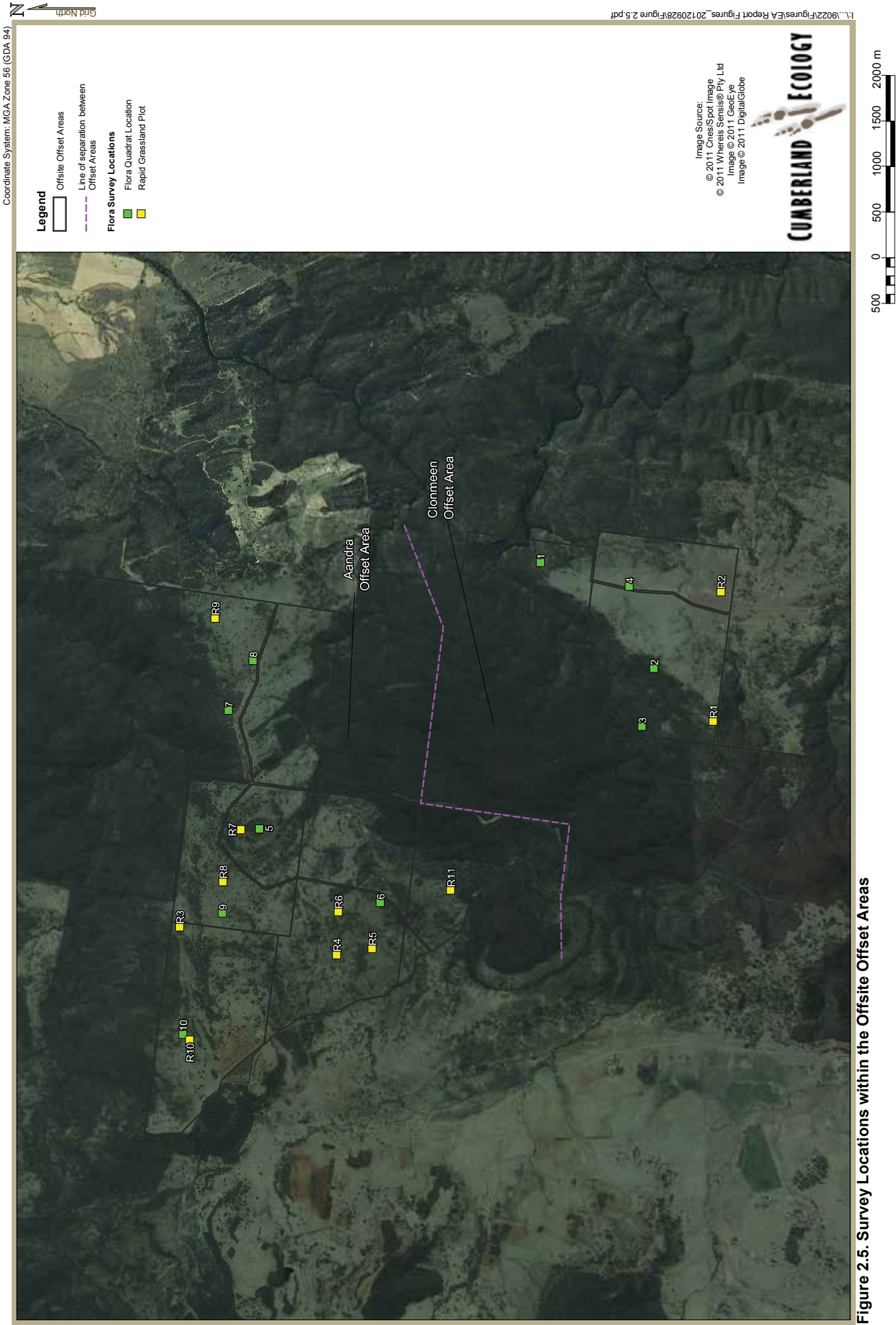


Figure 2.5. Survey Locations within the Offsite Offset Areas

Chapter **3**

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. 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.

A comprehensive lists of flora recorded within the Project Boundary during the survey are provided in **Appendix D**.

3.1 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 low diversity 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 of derived grassland.

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 has been removed; to pasture improved grassland, 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* (White 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 wooded vegetation community within the Project Boundary is White Box Grassy Woodland (**Table 3.1**). This community conforms to the description of White Box, Yellow Box, Blakely's Red Gum Woodland and Derived Native Grassland (commonly referred to as Box Gum Woodland), which is listed as a CEEC under the EPBC Act and as an EEC under the TSC Act. Other variants of Box Gum Woodland occur within the Project Boundary, but are represented by minor occurrences only. 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%;
- The patch has a predominantly native understorey;
- A patch is 0.1 ha or greater in size;
- A patch of 0.1 ha in size contains 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.

In addition to this community, several other communities listed by the EPBC Act and/or the TSC 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 3.1** below, and are shown in **Figure 3.1**.

An analysis of the likelihood of occurrence within the Project Boundary of C/EECs known, or predicted to occur within the Gunnedah LGA is presented in **Table E.1** in **Appendix E**.

Table 3.1 Vegetation Communities Recorded within the Project Boundary			
Vegetation Community	TSC Act Status	EPBC Act Status	Project Boundary (ha)
White Box Grassy Woodland (C/EEC)	EEC	CEEC	988
Regenerating White Box Grassy Woodland (C/EEC)	EEC	CEEC	28
Blakely's Red Gum Grassy Woodland (C/EEC)	EEC	CEEC	90
Regenerating Blakely's Red Gum Grassy Woodland (C/EEC)	EEC	CEEC	17
Yellow Box Grassy Woodland (C/EEC)	EEC	CEEC	69
Derived Native Grassland (C/EEC)	EEC	CEEC	73
Subtotal Box Gum Woodland (C/EEC)			1,265
Inland Grey Box Grassy Woodland (EEC)	EEC	EEC	55
Weeping Myall Woodland (EEC)	EEC	EEC	22
Brigalow (EEC)	EEC	EEC	9
Semi-evergreen Vine Thicket (EEC)	EEC	EEC	n/a*
Fuzzy Box Woodland (TSC - EEC)	EEC		36
Subtotal Other EEC			122
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

Table 3.1 Vegetation Communities Recorded within the Project Boundary			
Vegetation Community	TSC Act Status	EPBC Act Status	Project Boundary (ha)
<i>Subtotal Other Woodland</i>			683
Low Diversity Grassland, Planted and Exotic Pasture			7,290
Cleared Areas (roads, dams, buildings, etc.)			141
<i>Subtotal Other</i>			7,431
TOTAL			9,501

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

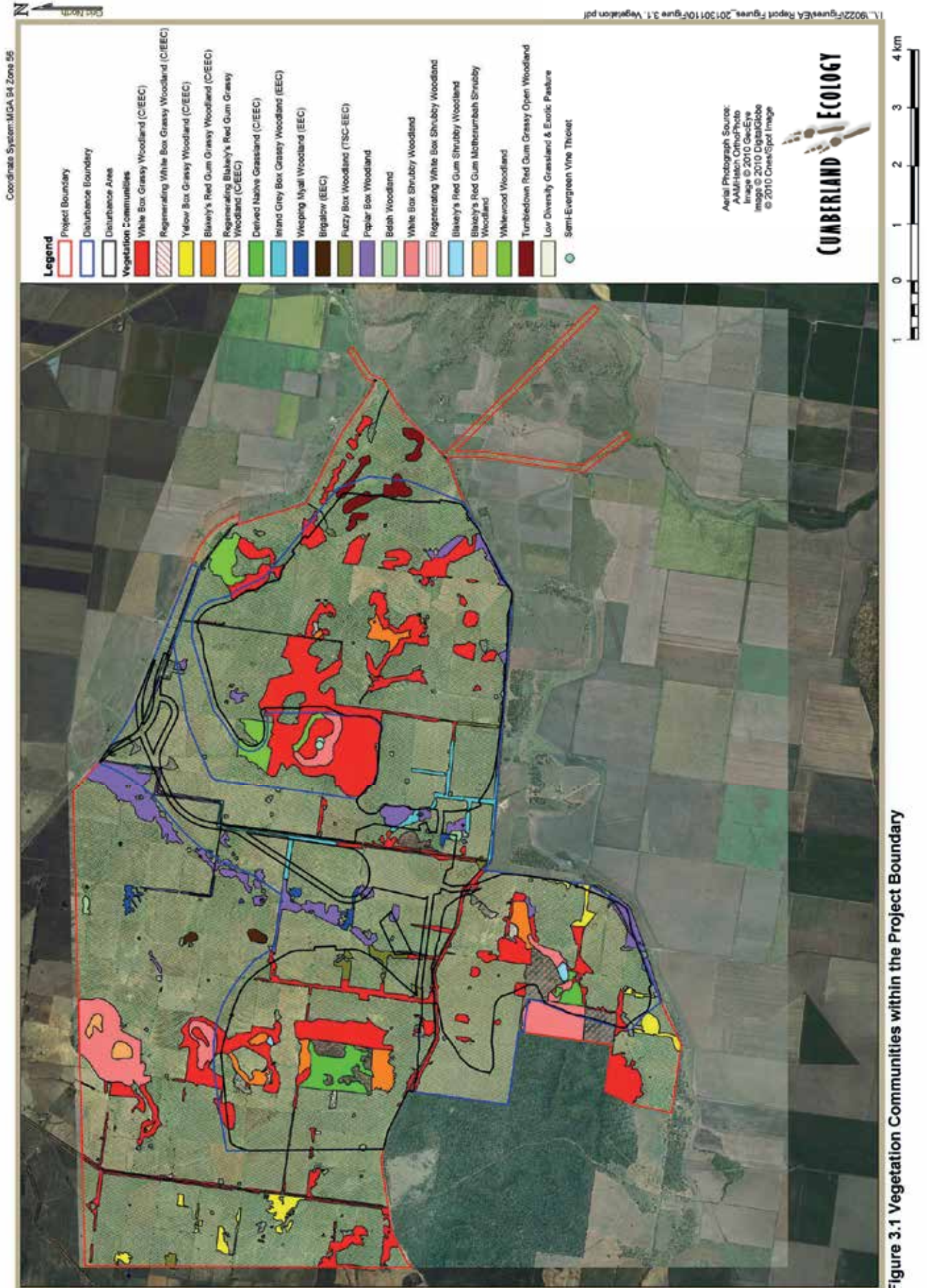


Figure 3.1 Vegetation Communities within the Project Boundary

3.1.1 Vegetation Community Nomenclature

Vegetation community nomenclature can vary depending on the scale and origin of the mapping, and it is common for the same vegetation community to be known by several different names. Relevant vegetation nomenclature for this Project includes the following:

- Definitions of EEC listed under the EPBC Act;
- Definitions of EEC listed under the TSC Act;
- BioBanking Metric Vegetation Types;
- Regional Vegetation Communities identified by the Namoi CMA; and
- Vegetation Classes mapped by Keith (2004).

Table 3.2 below lists all vegetation communities recorded within the Project Boundary and aligns each with other relevant nomenclature. This nomenclature has also been provided within each vegetation community description within **Section 3.1.2** below.

Table 3.2 Nomenclature of Vegetation Communities Recorded Within the Project Boundary

Cumberland Ecology Vegetation Community	EPBC Act	TSC Act	BioBanking Metric Vegetation Types	Regional Vegetation Community	Keith Vegetation Class
White Box Grassy Woodland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions(NA226)	White Box Grassy Woodland, Brigalow Belt South and Nandewar	Western Slopes Grassy Woodlands
Regenerating White Box Grassy Woodland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (NA226)	White Box Grassy Woodland, Brigalow Belt South and Nandewar	Western Slopes Grassy Woodlands
Blakely's Red Gum Grassy Woodland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)	Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar	Western Slopes Grassy Woodlands
Regenerating Blakely's Red Gum Grassy Woodland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)	Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar	Western Slopes Grassy Woodlands
Yellow Box Grassy Woodland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)	Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar	Western Slopes Grassy Woodlands
Derived Native Grassland	White Box, Yellow Box, Blakely's Red Gum Grassy Woodland and Derived Native Grassland	White box Yellow box Blakely's Red Gum Woodland	Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)	Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar	Derived from Western Slopes Grassy Woodland

Table 3.2 Nomenclature of Vegetation Communities Recorded Within the Project Boundary						
Cumberland Ecology Vegetation Community	EPBC Act	TSC Act	BioBanking Metric Vegetation Types	Regional Vegetation Community	Keith Vegetation Class	
Inland Grey Box Grassy Woodland	Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Inland Grey Box Woodland in the Riverina, New South Wales South Western Slopes, Cobar Penplain, Nandewar and Brigalow Belt South Bioregions	Inland Grey Box tall grassy woodland on clay soils in the Brigalow Belt South and Nandewar Bioregions (NA146)	Inland Grey Box Tall Grassy Woodland on clay soils, Brigalow Belt South and Nandewar	Floodplain Transition Woodlands	
Weeping Myall Woodland	Weeping Myall Woodland	Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregion (NA219)	Weeping Myall Open Woodland	Riverine Plain Woodlands	
Brigalow	Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions	Brigalow – Belah woodland on alluvial often gilgaied clay soil mainly in the Brigalow Belt South Bioregion (NA117)	Brigalow –Belah woodland on alluvial clay soil, mainly Brigalow Belt South	Brigalow Clay Plain Woodlands	
Semi-evergreen Vine Thicket	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Semi-evergreen vine thicket in the Brigalow Belt South and Nandewar bioregions	Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) (NA199)	Semi-evergreen vine thicket of basalt hills, Brigalow Belt South and Nandewar	Dry Rainforests	

Table 3.2 Nomenclature of Vegetation Communities Recorded Within the Project Boundary						
Cumberland Ecology Vegetation Community	EPBC Act	TSC Act	BioBanking Metric Vegetation Types	Regional Vegetation Community	Keith Vegetation Class	
Fuzzy Box Woodland	not listed	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (NA141)	Not listed	Floodplain Transition Woodlands	
Poplar Box Woodland	not listed	not listed	Poplar Box – Belah woodland on clay-loam soils of the alluvial plains of north-central New South Wales (NA182)	Poplar Box Woodland on alluvial clay soils	Floodplain Transition Woodlands	
Belah Woodland	not listed	not listed	Belah woodland on alluvial plains in central-north New South Wales (NA102)	Brigalow –Belah woodland on alluvial clay soil, mainly Brigalow Belt South	Brigalow Clay Plain Woodlands	
Whitewood Woodland	not listed	not listed	Whitewood open woodland of the subtropical sub-humid plains (BBS and eastern DRIP Bioregions) (NA234)	Whitewood Open Woodland	Subtropical Semi-arid Woodlands	
Tumbledown Red Gum Grassy Open Woodland	not listed	not listed	not listed	not listed	Western Slopes Grassy Woodlands	

Table 3.2 Nomenclature of Vegetation Communities Recorded Within the Project Boundary					
Cumberland Ecology Vegetation Community	EPBC Act	TSC Act	BioBanking Metric Vegetation Types	Regional Vegetation Community	Keith Vegetation Class
White Box Shrubby Woodland	not listed	not listed	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)	White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar	North-west Slopes Dry Sclerophyll Woodlands
Regenerating White Box Shrubby Woodland	not listed	not listed	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)	White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar	North-west Slopes Dry Sclerophyll Woodlands
Blakely's Red Gum Shrubby Woodland	not listed	not listed	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)	White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar	North-west Slopes Dry Sclerophyll Woodlands
Blakely's Red Gum Motherumbah Shrubby Woodland	not listed	not listed	not listed	not listed	North-west Slopes Dry Sclerophyll Woodlands
Low Diversity Grassland and Exotic Pastures	not listed	not listed	not listed	Derived Grasslands, Brigalow Belt South and Nandewar	Western Slopes Grasslands

3.1.2 Vegetation Communities Recorded from the Project Boundary

i. White Box, Yellow Box, Blakely's Red Gum Grassy Woodland

White Box, Yellow Box and Blakely's Red Gum Woodland and Derived Native Grassland is listed as a CEEC under the EPBC Act and as an EEC under the TSC Act.

This grassy woodland complex is a floristically diverse complex of communities that occupy a range of landscape positions on a gradation of semi-fertile to fertile soils. These communities are dominated 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). Within the Project Boundary the following vegetation communities have been recorded that comprise Box Gum Woodland:

- White Box Grassy Woodland;
- Regenerating White Box Grassy Woodland;
- Blakely's Red Gum Grassy Woodland;
- Regenerating Blakely's Red Gum Grassy Woodland; and
- Yellow Box Grassy 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. pilligaensis* (Narrow-leaved Grey Box), *E. microcarpa* (Inland Grey Box) and *Allocasuarina leuhmannii* (Bulloak).

The understorey across these communities 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.

Brief descriptions of the defining characteristics of each community recorded within the Project Boundary that conforms to the description of Box Gum Woodland are presented in the following sections. The main differences between these grassy woodland communities are the canopy tree species composition. Generally, the understorey of these grassy woodland communities within the Project Boundary have slight localised variations related to soil type and position in the landscape but contain similar species.

These communities conform to the woodland component of Box Gum Woodland and Derived Native Grassland under the EPBC Act. These communities align with Condition C which is defined in the SEWPaC listing advice as having '*both a native understorey and an overstorey of eucalypts exist in conjunction*'. These communities also conform to the woodland component of Box Gum Woodland and Derived Native Grassland under the TSC Act. These communities align with the following condition classes defined within *Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland)* (NSW NPWS 2005):

- '1' – Multi-aged overstorey with a grassy, herb-rich understorey; and
- '2' – Partially cleared/thinned stands with a mixture of native and exotic understorey species.

These two condition classes overlap within the Project Boundary. Condition 1 is largely comprises of the larger intact portions of the community and Condition 2 is predominate along roadside corridors.

a. White Box Grassy Woodland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (NA266)

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: White Box Grassy Woodland, Brigalow Belt South and Nandewar

White Box Grassy Woodland is the most extensive woodland community occurring within the Project Boundary and is largely restricted to the drier slopes of valley floors and floodplain flats, where soils are fertile. This community is dominated by *Eucalyptus albens* (White Box)

forming sometimes monotypic woodlands with occasional presence of the less frequent *E. blakelyi* (Blakely's Red Gum).

Common small tree species within the Project Boundary include *Geijera parviflora* (Wilga), *Notelaea microcarpa* (Native Olive), and *Capparis mitchelli* (Native Orange). *Callitris glaucophylla* (White Cypress Pine) was also observed when the community crossed into more sandy soils. These small tree species were also observed in the shrub layer. Other smaller shrub species, occurring more sparsely include *Bursaria spinosa subsp. spinosa* (Blackthorn), *Indigofera adesmiifolia* (Tick Indigo), *Maireana microphylla* (Small-leaved Bluebush) and *Solanum parvifolium*.

The ground layer is grassy and contains diverse native tussock grasses interspersed by native herbs. Native grasses and herbs include but were not limited to *Chloris ventricosa*, *Austrostipa verticillata*, *A. scabra*, *Bothriochloa decipiens*, *Lomandra filiformis*, *Cymbopogon refractus*, *Vittadinia cuneata*, *V. dissecta*, *Glycine tabacina*, *Calotis lappulacea*, *Einadia hastata*, *Oxalis perennans*, *Dichondra sp. A.*, *Cymbonotus lawsonianus* and *Daucus glochidiatus*. The main structural features of this community are shown in **Photograph 3.1**.

Within the Project Boundary, this community contains mature trees with many hollow-bearing trees. Generally, weed densities are low to moderate; however weed cover in the ground layer ultimately related to the size and shape of the patch, degree of past disturbance and/or severity of adjacent land use. Although all patches of White Box Grassy Woodland within the Project Boundary are modified, they still conform to the definition of Box Gum Woodland and Derived Native Grassland CEEC as defined under the EPBC Act.



Photograph 3.1 **White Box Grassy Woodland**

b. Regenerating White Box Grassy Woodland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (NA226)

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: White Box Grassy Woodland, Brigalow Belt South and Nandewar

Regenerating White Box Grassy Woodland resembles White Box Grassy Woodland that has undergone past disturbance and is currently regenerating. Typically these areas within the Project Boundary lack canopy trees, however they contain some *Eucalyptus albens*, either as trees or small shrubs within or directly adjacent the patch which indicates that they once comprised White Box Grassy Woodland. The small tree layer is the dominant canopy layer and contains *Geijera parviflora*, *Notelaea microcarpa*, *Capparis mitchelli* and *Callitris glaucophylla*. The understorey and shrub layers generally have denser grass growth than White Box Grassy Woodland due to increased sunlight availability and / or grazing.

c. Blakely's Red Gum Grassy Woodland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar

Blakely's Red Gum Grassy Woodland was recorded on mid to lower valley slopes and lower rises within the Project Boundary, on sedimentary or basaltic soils varying in fertility and sand content. The canopy is dominated by *Eucalyptus blakelyi*, supported by a small tree layer comprising *Geijera parviflora*, and *Notelaea microcarpa* var. *macrocarpa*. In areas where soils contained more sand and gravel material, *Callitris glaucophylla* and *Acacia cheelii* (Motherumbah) were observed.

The community is sparsely shrubby, containing localised patches of *Bursaria spinosa* subsp. *spinosa*, *Maireana microphylla* and regenerating small trees on the better soils. The slightly sandier or gravelly sites show a discernable association between the presence of *Acacia*

cheelii and shrubs of the *Cassinia* genus. The ground layer is grassy throughout this community and contains a diversity of native grasses and herbs similar to White Box Grassy Woodland. The main structural features of this community are shown in **Photograph 3.2**.

Even though the patches of Blakely's Red Gum Woodland within the Project Boundary are modified, they still conform to the Box Gum Woodland and Derived Native Grassland CEEC as defined under the EPBC Act.



Photograph 3.2 **Blakely's Red Gum Grassy Woodland**

d. Regenerating Blakely's Red Gum Woodland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar

Regenerating Blakely's Red Gum Woodland is similar to Blakely's Red Gum Grassy Woodland, but has undergone past disturbance (clearing) and shows signs of regeneration.

Typically these areas within the Project Boundary lack a canopy layer, but they contain some specimens of *Eucalyptus blakelyi*, which indicate they once comprised Blakely's Red Gum Grassy Woodland. The understorey also resembles that of Blakely's Red Gum Grassy Woodland, though it usually contains more grass species as a result of increased light and/or grazing.

e. Yellow Box Grassy Woodland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237)

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: Box Gum Grassy Woodlands, Brigalow Belt South and Nandewar

Yellow Box Grassy Woodland occurs in lower areas of the landscape (approximately 350 m) within the Project Boundary and is dominated by *E. melliodora* or is co-dominant with *E. conica* (Fuzzy Box), *E. populnea* (Poplar Box) and *E. albens*. Other trees species co-occurring at some sites include *Allocasuarina leuhmannii* (Buloke). It is sparsely vegetated with small trees and shrubs of *Geijera parviflora*, *Maytenus cunninghamii* and *Maireana microphylla*. The ground layer contains a diversity of native tussock grasses and herb species. The main structural features of this community are shown in **Photograph 3.3**.

Even though the patches of Yellow Box Woodland within the Project Boundary are impacted, they still conform to the description of Box Gum Woodland and Derived Native Grassland CEEC as defined under the EPBC Act.



Photograph 3.3 **Yellow Box Grassy Woodland**

ii. Other Listed Woodland Communities

In addition to the group of woodland communities that comprise Box Gum Woodland, several other communities that conform to communities listed under the EPBC Act and or TSC Act were recorded within the Project Boundary, and these are considered below.

a. Inland Grey Box Grassy Woodland

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

TSC Act Status: Inland Grey Box Woodland in the Riverina, New South Wales South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (EEC)

BioBanking Metric: Inland Grey Box tall grassy woodland on clay soils in the Brigalow Belt South and Nandewar Bioregions (NA146)

Keith Vegetation Class: Floodplain Transition Woodlands

Regional Vegetation Community: Inland Grey Box Tall Grassy Woodland on clay soils, Brigalow Belt South and Nandewar

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 3.4**.

This community is consistent with the description of Inland Grey Box Grassy Woodland and Derived Native Grassland, which is listed as an EEC under the EPBC Act. EPBC Act conditional threshold (category 1) applies to the Inland Grey Box Grassy Woodland recorded within the Project Boundary. The criteria to meet the conditional threshold (category 1) 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%.

Even though the patches of Inland Grey Box Woodland are heavily grazed, it still retains sufficient conservation value to be considered a MNES as defined under the EPBC Act.



Photograph 3.4 **Inland Grey Box Grassy Woodland**

b. Weeping Myall Woodland

EPBC Act: Weeping Myall Woodland (EEC)

TSC Act Status: Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion (EEC)

BioBanking Metric: Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregion (NA219)

Keith Vegetation Class: Riverine Plain Woodlands

Regional Vegetation Community: Weeping Myall Open Woodland

Weeping Myall Woodland 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 3.5**.

The 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.



Photograph 3.5 **Weeping Myall Woodland**

c. Brigalow

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

TSC Act Status: Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (EEC)

BioBanking Metric: Brigalow – Belah woodland on alluvial often gilgaied clay soil mainly in the Brigalow Belt South Bioregion (NA117)

Keith Vegetation Class: Brigalow Clay Plain Woodlands

Regional Vegetation Community: Brigalow –Belah woodland on alluvial clay soil, mainly Brigalow Belt South

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 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 3.6**.



Photograph 3.6 **Brigalow**

d. Semi-evergreen Vine Thicket

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

TSC Act Status: Semi-evergreen vine thicket in the Brigalow Belt South and Nandewar bioregions (EEC)

BioBanking Metric: Semi-evergreen vine thicket of basalt hills of the NSW north western slopes (Benson 147) (NA199)

Keith Vegetation Class: Dry Rainforests

Regional Vegetation Community: Semi-evergreen vine thicket of basalt hills, Brigalow Belt South and Nandewar

Semi-evergreen vine thicket is a community that is dominated by low trees, shrubs and vines that occurs mainly on hills on light clay soils derived from basalt.

This community 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 0.1ha and is located outside the Disturbance Area on Mt Watermark. The vegetation is a shrubland dominated by *Atalaya hemiglauc*, *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 suavisissimum*, the former species considered a diagnostic species for this community.

e. Fuzzy Box Woodland

EPBC Act: Not listed

TSC Act Status: Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions (EEC)

BioBanking Metric: Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion (NA141)

Keith Vegetation Class: Floodplain Transition Woodlands

Regional Vegetation Community: Not listed

This grassy woodland community was recorded in on floodplains and valley flats adjacent to Inland Grey Box Woodland and Poplar Box Woodland, down slope of White Box Grassy Woodland. The tree canopy is dominated by *Eucalyptus conica* with *E. albens*, *E. populnea* and *Allocasuarina leuhmannii* occurring frequently. The key characteristic of this community is the presence of Buloke (*Allocasuarina leuhmannii*) and the dominance of *E. conica*. This community has a similar understorey composition to the Box Gum Woodland community, with a sparse shrub layer containing *Maireana microphylla*, *Eremophila debilis* (Winter Apple), and *Sida cunninghamii* (Ridged Sida) and a diverse grassy layer containing native tussock grasses interspersed with native herbs. The main structural features of this community are shown in **Photograph 3.7**.



Photograph 3.7 **Fuzzy Box Woodland**

iii. Other Non-Listed Woodland Communities

Other grassy woodland communities present within the Project Boundary that do not conform to the description of EPBC Act listed communities are discussed below.

a. Poplar Box Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Poplar Box – Belah woodland on clay-loam soils of the alluvial plains of north-central New South Wales (NA182)

Keith Vegetation Class: Floodplain Transition Woodlands

Regional Vegetation Community: Poplar Box Woodland on alluvial clay soils

In the Project Boundary, Poplar Box Woodland occurs as regenerated vegetation within and adjacent to agricultural land. Poplar Box Woodland occurs on the lowest parts of the Project Boundary on valley floors and floodplains particularly in areas where water pools. The upper tree canopy layer is dominated by *Eucalyptus populnea*. Other tree species recorded from the Project Boundary from within this community include *Eucalyptus microcarpa*, *E. conica*, *E. albens* and *Acacia pendula*; however the three box eucalypts are never dominant or co-

dominant. Small trees are largely absent with the occasional occurrence of *Geijera parviflora*. The ground layer contains diverse native tussock grasses and native herb species. The main structural features of this community are shown in **Photograph 3.8**.

This community is not listed under the EPBC Act or TSC Act, however it is known to be rare in the region as it shares similar habitats with other threatened floodplain communities located on fertile agricultural soils that have undergone extensive clearing.



Photograph 3.8 **Poplar Box Woodland**

b. Belah Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Belah woodland on alluvial plains in central-north New South Wales (NA102)

Keith Vegetation Class: Brigalow Clay Plain Woodlands

Regional Vegetation Community: Brigalow –Belah woodland on alluvial clay soil, mainly Brigalow Belt South

The Belah Woodland community within the Project Boundary forms a woodland or open woodland structure and is found on rich alluvial clay soils similar to Weeping Myall

Woodland. Within the Project Boundary the canopy is dominated by *Casuarina cristata* (Belah). Other tree species and small trees co-occurring are *Eucalyptus populnea*, *Acacia pendula*, *Eremophila mitchellii*, *Capparis mitchellii* and *Geijera parviflora*, albeit in low abundance.

The shrub layer is also sparse and species poor commonly consisting of mostly chenopods including *Mairena microphylla*, a sign of productive clay soils. The ground layer is a mixture of native tussock grasses and native herb species such as *Austrostipa verticillata*, *A. scabra*, *Sporobolus caroli*, *Dichondra sp. A.*, *Vittadinia cuneata*, *Einadia polygonoides*, *Chamesyce drummondii* and *Plantago debilis*. The main structural features of this community are shown in **Photograph 3.9**.

This community is not listed under the EPBC Act or TSC Act, however it is known to be rare in the region due to sharing similar habitat to other threatened floodplain communities located on fertile agricultural soils that have undergone extensive clearing.



Photograph 3.9 **Belah Woodland**

c. Whitewood Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Whitewood open woodland of the subtropical sub-humid plains (Brigalow Belt South and eastern Darling Riverine Plains Bioregions) (NA234)

Keith Vegetation Class: Subtropical Semi-arid Woodlands

Regional Vegetation Community: Whitewood Open Woodland

The Whitewood Woodland community is restricted to dry northern facing aspects of moderate to steep slopes on colluvial soils within the Project Boundary. The canopy is dominated by *Atalaya hemiglauca* (Whitewood) and or *Alectryon oleifolius ssp. elongatus* (Rosewood). Other trees co-occurring of lower frequencies include *Eremophila mitchellii*, *Geijera parviflora*, *Capparis mitchellii* and *Notelaea microcarpa*. The shrub and ground layer contains various chenopod shrubs, grasses and herbs such as *Lycium ferocissimum*, *Chenopodium auricomum*, *Einadia nutans ssp. linifolia*, *E. hastata*, *Chenopodium carinatum*, *Vittadinia cuneata var. cuneata*, *Cymbopogon refractus*, *Austrostipa scabra ssp. scabra*, *Leptochloa decipiens ssp. asthenes* and *Bidens pilosa*. The main structural features of this community are shown in **Photograph 3.10**.



Photograph 3.10 **Whitewood Woodland**

d. Tumbledown Red Gum Grassy Open Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Not listed

Keith Vegetation Class: Western Slopes Grassy Woodlands

Regional Vegetation Community: Not listed

Tumbledown Red Gum Grassy Open Woodland is largely located in the eastern portions of the Project Boundary above White Box Grassy Woodland on drier slopes of valley floors. This community is dominated by *Eucalyptus dealbata* (Tumbledown Red Gum) forming an open woodland structure. Small tree species are rare within this community as the area looks to be grazing frequently though *Callitris glaucophylla* was also observed. Smaller shrub species include *Bursaria spinosa* subsp. *spinosa* (Blackthorn), *Indigofera adesmiifolia* (Tick Indigo), *Maireana microphylla* (Small-leaved Bluebush) and *Solanum parvifolium*. The ground layer is grassy and contains a diversity of native tussock grasses interspersed by native herbs. Native grasses and herbs include but were not limited to *Chloris ventriosca*, *Austrostipa verticillata*, *A. scabra*, *Bothriochloa decipiens*, *Cymbopogon refractus*, *Vittadinia cuneata*, *Glycine tabacina*, *Calotis lappulacea*, *Oxalis perennans*, *Dichondra* sp. A., *Cymbonotus lawsonianus* and *Daucus glochidiatus*. The main structural features of this community are shown in **Photograph 3.11**.



Photograph 3.11 **Tumbledown Red Gum Open Grassy Woodland**

e. White Box Shrubby Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)

Keith Vegetation Class: North-west Slopes Dry Sclerophyll Woodlands

Regional Vegetation Community: White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar

White Box Shrubby Woodland occurs on higher elevations on volcanic soils too steep to retain water, or on poorer sandstone soils in conditions which do not favour the growth of a grassy ground layer. Within the landscape of Project Boundary this community occurs above Box Gum Woodland communities. The upper tree canopy layer is dominated by *Eucalyptus albens*, which can form monotypic stands. Other trees species co-occurring but less frequent include *Eucalyptus blakelyi*. It is marked by a dense shrub stratum of *Dodonea viscosa* ssp. *angustifolia*, *Beyeria viscosa* (Sticky Wallaby Bush) similar to Blakely's Red Gum Shrubby Woodland in densities above well above 30% projective foliage cover. The main structural features of this community are shown in **Photograph 3.12**.

The Commonwealth's description of Box Gum Woodland and Derived Native Grassland stipulates the ground layer must be dominated by native grasses and herbs. As the density of the shrub cover in White Box Shrubby Woodland is more than 30%, this community does not conform to the EPBC Act or TSC Act listings for Box Gum Woodland and Derived Native Grassland (NSW Scientific Committee 2004i, Threatened Species Scientific Committee 2006). White Box Shrubby Woodland occurs on less fertile soils that have not been as extensively cleared as Box Gum Woodland, which occurs on highly fertile soils, flat to undulating topography dominated by grasses.



Photograph 3.12 **White Box Shrubby Woodland**

f. Regenerating White Box Shrubby Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)

Keith Vegetation Class: North-west Slopes Dry Sclerophyll Woodlands

Regional Vegetation Community: White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar

Regenerating White Box Shrubby Woodland resembles White Box Shrubby Woodland in a more disturbed state and is found in similar habitat and locations in the landscape. The canopy contains scattered *Eucalyptus albens*. The understorey is more open and could be considered grassy; however this is a result likely due from clearing and grazing. There is a noticeable recruitment of a dense native shrub layer. This occurs as impenetrable expanding islands or banding which had extended from areas protected by fencing. The shrub species are consistent to those found within White Box Shrubby Woodland and Blakely's Red Gum Shrubby Woodland communities and include a dominance of *Dodonea viscosa* ssp. *angustifolia*, *Ollearia elliptica* and *Beyeria viscosa*. The frequency of

regenerating native shrubs discounts this community to be eligible for listing at CEEC Box Gum Woodland Box Gum Woodland and Derived Native Grassland.

g. Blakely's Red Gum Shrubby Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions (NA225)

Keith Vegetation Class: North-west Slopes Dry Sclerophyll Woodlands

Regional Vegetation Community: White Box - pine - Silver-leaved Ironbark shrubby open forests, Brigalow Belt South and Nandewar

Blakely's Red Gum Shrubby Woodland within the Project Boundary occurs on the mid-upper slopes on less fertile soils. It is generally recorded upslope of White Box Grassy Woodland or adjacent White Box Shrubby Woodland. The tree canopy layer contains predominantly *Eucalyptus blakelyi*, but *E. albens* also occurs, though in lower frequencies with *Callitris glaucophylla*. It is marked by a dense shrub stratum of *Dodonea viscosa* ssp. *angustifolia*, *Beyeria viscosa* (Sticky Wallaby Bush) occurring in frequencies above 30% projective foliage cover. The main structural features of this community are shown in **Photograph 3.13**.

Due to the density of the shrub cover being more than 30% this community within the Project Boundary does not conform to the EPBC Act or TSC Act listings for CEEC Box Gum Woodland and Derived Native Grassland (NSW Scientific Committee 2004i, Threatened Species Scientific Committee 2006). The Commonwealth's description of Box Gum Woodland and Derived Native Grassland stipulates the ground layer must be dominated by native grasses and herbs.



Photograph 3.13 **Blakely's Red Gum Shrubby Woodland**

h. Blakely's Red Gum – Motherumbah Shrubby Woodland

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Not listed

Keith Vegetation Class: North-west Slopes Dry Sclerophyll Woodlands

Regional Vegetation Community: Not listed

Blakely's Red Gum – Motherumbah Shrubby Woodland occurs in one location within the Project Boundary, which is on a hill top above slopes supporting White Box Shrubby Woodland. This community is relatively low and open with *Eucalyptus blakelyi* growing to 10 metres and *Acacia cheelii* sometimes sharing the dominance in the canopy layer. The soil contains numerous loose quartz stones and the species assemblage seems to show some resemblance to the sandy gravel sites where Blakely's Red Gum Grassy Woodland was recorded; however the species composition shows a shift towards sandstone species not detected anywhere else within the Project Boundary, in particular the ground layer. Furthermore the required number of non-grassy understorey species specifically in the ground layer was very low. The ground layer is sparse and patchy containing a low diversity of species and consists of largely *Pomax umbellata*, typically a species found in sandstone and *Aristida ramosa*. *Lepidosperma laterale*, another typical sandstone species was also

observed in some areas. The main structural features of this community are shown in **Photograph 3.14**.



Photograph 3.14 **Blakely's Red Gum Motherumbah Shrubby Woodland**

iv. Grasslands

a. Derived Native Grassland

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

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (NA237) / White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions (NA226)

Keith Vegetation Class: Derived from Western Slopes Grassy Woodland

Regional Vegetation Community: Derived Grasslands, Brigalow Belt South and Nandewar

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.

The main structural features of this community are shown in **Photograph 3.15**. These grasslands conform to the description of the EPBC Act listed and TSC Act listed, Box Gum Woodland and Derived Native Grassland.

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*’.

In order to be identified as the grassland form of the TSC Act listed Box Gum Woodland, the vegetation is required to exhibit a “*natural regenerative ability*” (assisted or unassisted) that would indicate a mostly intact soil bed and associated seed bank. The suite of species recorded within these areas and their abundance indicate that they are included within the TSC Act definition of the community. These areas of grassland conform to Condition 4 of the condition classes defined within the the *Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland (Box Gum Woodland)* (NSW NPWS 2005). Condition 4 is defined as ‘*Grasslands (secondary or derived grasslands), where the tree overstorey has been removed and only the Box-Gum Woodland understorey is present*’.

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 3.15 **Derived Native Grassland**

b. Low Diversity Grassland, Plantings and Exotic Pasture

EPBC Act: Not listed

TSC Act Status: Not listed

BioBanking Metric: Not listed

Keith Vegetation Class: Derived from Western Slopes Grassy Woodland

Regional Vegetation Community: Derived Grasslands, Brigalow Belt South and Nandewar

Much of the grassland within the Project Boundary is degraded to varying degrees by past clearing, grazing practices and exploration and mining activities. Therefore, most areas of grassland contain a very low diversity of native species while others have been heavily impacted by agriculture and exist as monoculture of crops and/or pasture. Some areas of grassland contain native and non-native plantings. The main structural features of this community are shown in **Photograph 3.16**.

These grassland areas comprise a combination of land currently being cultivated or that have lain fallow in recent years. A combination of highly intense land use and variable resting periods has resulted in paddocks that range between being dominated by crop or pasture-improvement exotic species to being dominated by a few species of native grasses and a low diversity of herbs. For the purpose of this assessment, these areas have been

mapped as one vegetation type. This is due to the constantly changing land use of these areas. That is, areas may fall within the low diversity grassland component one season, however the following season it may fall within the exotic component as it has been ploughed and a crop planted.

To be considered to meet the TSC Act definition of Box Gum Woodland, the site should be capable of assisted natural regeneration and not require active planting of trees and understorey. Regeneration relies on native seed stored in the soil or in the canopy, or seed transported to the site by water, wind or animals; revegetation is the introduction of seed or seedlings (Rawlings et al. 2010) to a site that would otherwise remain predominantly exotic or poorly diverse. Due to these paddocks having been cropped, ploughed and fertilised over many decades, the soil profile and native seed bank have been disturbed to the extent that natural regeneration of the grassland to woodland is unlikely. The original native soil seed bank is likely to be highly compromised (partial or total physical damage) by the passing of considerable periods of time and extensive mechanical disturbance.

The EPBC Act criteria provide a very clear prescription and cover relatively high condition grasslands with a considerable diversity of native herbaceous plants other than grasses. This community does not contain sufficient diversity of native herbaceous plants to conform to the grassland component of Box Gum Woodland and Derived Native Grassland.



Photograph 3.16 Low Diversity Grasslands, Plantings and Exotic Pastures

3.1.3 Condition Assessment

The results of the vegetation/habitat condition assessments are shown in **Figure 3.2**. 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.

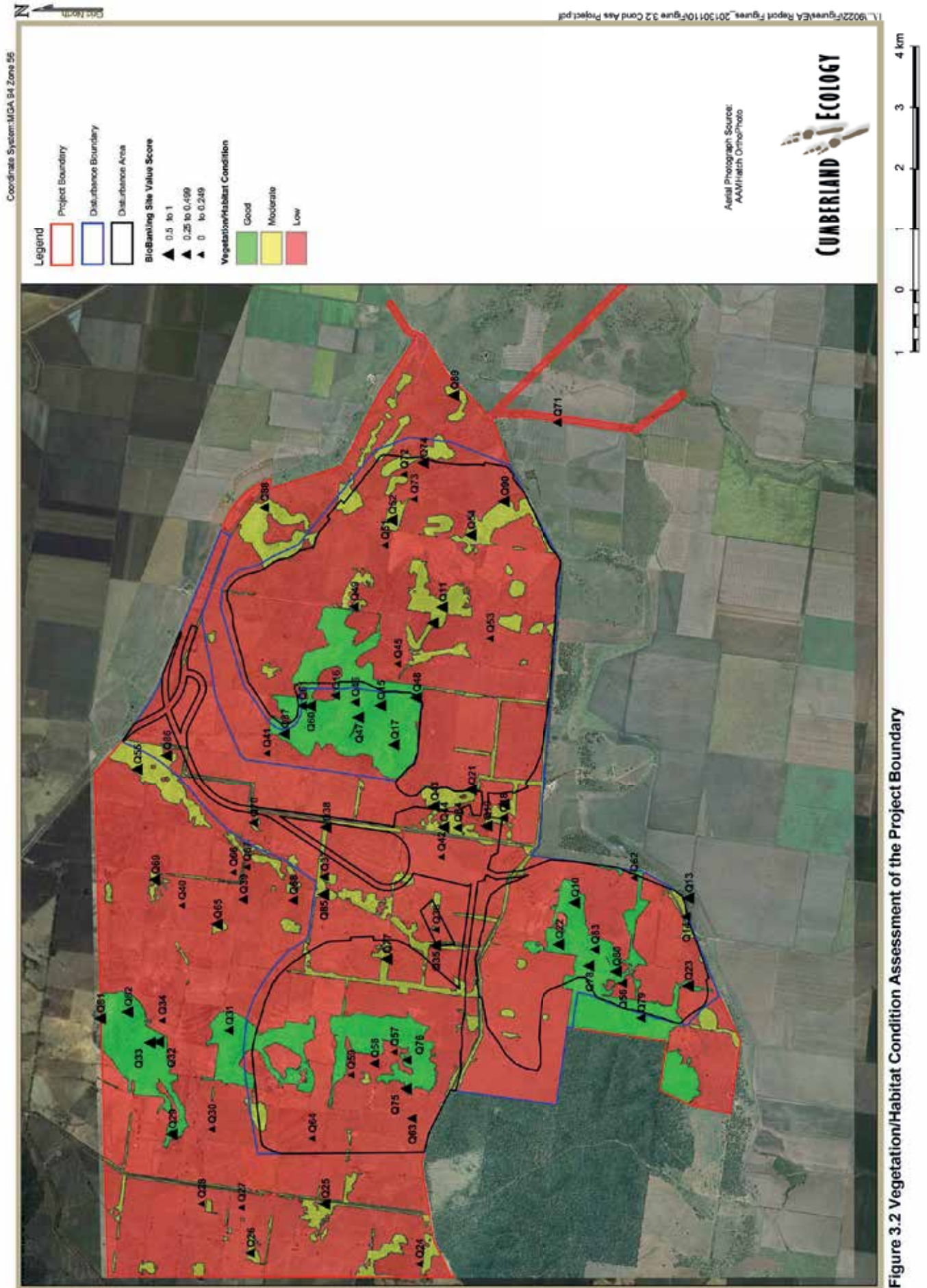


Figure 3.2 Vegetation/Habitat Condition Assessment of the Project Boundary

3.2 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.

3.2.1 *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).

3.2.2 *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 3.3**. None of these communities occurs within the Project Boundary. The communities identified in **Table 3.1** 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 3.3 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. Eucalyptus camaldulensis) 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. *Eco Logical 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. A detailed description of this community is provided in **Section 3.1.2.ii.e**. 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 in 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 3.3**, 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.

3.2.3 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. Analysis 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).

3.3 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 D**). The dominant plant families within the Project Boundary include the Myrtaceae, Fabaceae, Asteraceae and Poaceae families. The most common genera 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 3.1**). Small trees and shrubs are more patchily distributed but are generally consistent across different areas within the Project Boundary where a shrub stratum exists. The groundcover is species diverse and variable, however it mainly comprises tussock grasses in low frequency as well as diverse herbaceous 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 either the TSC Act or the EPBC Act have been recorded within the Project Boundary during surveys conducted by GHD (2009) or surveys conducted by Cumberland Ecology, and no regionally significant flora species listed as Rare or Threatened Australian Plants (ROTAP) have been recorded within the Project Boundary.

Database records indicate that several threatened plant species listed under either the EPBC Act and/or the TSC Act have been recorded from the Gunnedah LGA. 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 **Table E.2** in **Appendix E**. Based on this analysis, those known or considered to have potential to occur within the

Project Boundary due to the presence of suitable habitat are discussed in more detail in subsequent sections.

3.3.1 *Bothriochloa biloba*

Bothriochloa biloba (Lobed Blue Grass) is listed as Vulnerable under the EPBC Act, however it is not listed under the TSC Act. *Bothriochloa biloba* is known to occur from the Darling Downs district in Queensland, south to North Star, Wialda, 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 2008d).

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 2008d). 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 2008d).

This preference to heavy soils means the species is found to overlap Brigalow and Box Gum Woodland ecological communities, which have been found within the Project Boundary. There are 21 records of the species within the Gunnedah LGA. This species was recorded from the Project Boundary, along Court Lane and The Dip Road (see **Figure 3.5**). Its distribution is patchy along these two roads and restricted to road verges, land between the road edge and neighbouring properties. Indicating 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. 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.

3.3.2 *Dichanthium setosum*

The threatened flora species, *Dichanthium setosum* (Bluegrass) is listed as Vulnerable under the EPBC Act and TSC 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 NSW (DEC (NSW) 2005b). 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) 2005b).

There are nine Atlas of NSW Wildlife records of the species within the Gunnedah LGA. Of these nine, eight recent (dated 2009) occur within a localised area of the Project Boundary.

Although the majority of habitats within the Project Boundary are disturbed, suitable habitats for the species were identified within the Project Boundary. Despite targeted searches for the species in suitable habitat and areas surrounding historical Atlas of NSW Wildlife records, this species was not recorded. 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.

3.3.3 *Digitaria porrecta*

Digitaria porrecta (Finger Panic Grass) is listed as Endangered under the EPBC Act and TSC Act. *Digitaria porrecta* occurs in four disjunct areas extending over 1,000 km (Threatened Species Scientific Committee 2008b). In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran (DEC (NSW) 2005d). 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) 2005d).

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.

3.3.4 *Cadellia pentastylis*

Cadellia pentastylis (Ooline) is listed as Vulnerable under the EPBC Act and TSC Act. *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). 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.

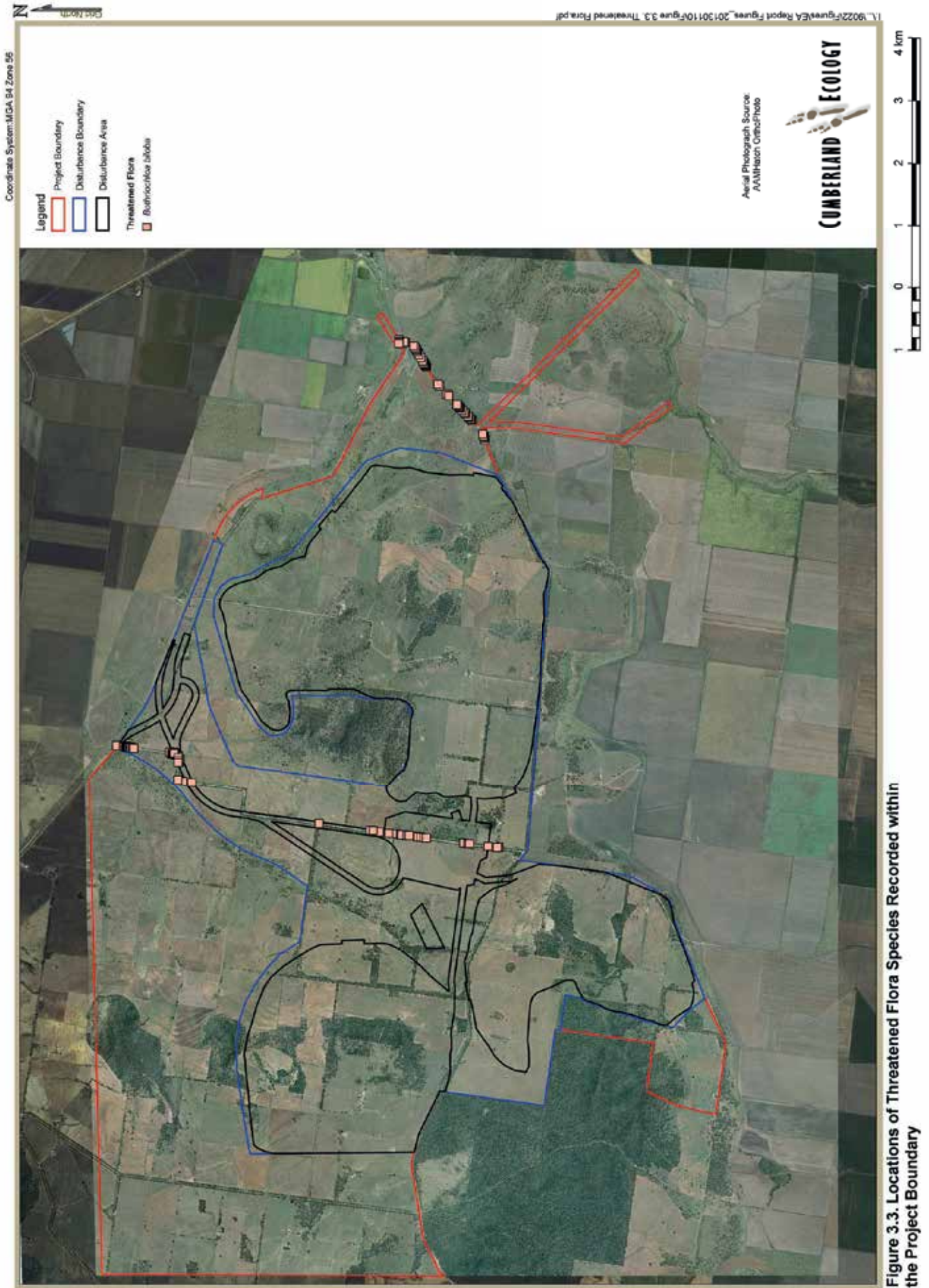
There are two Atlas of NSW Wildlife records of *Cadellia pentastylis* known within the Gunnedah LGA, however no plants were detected during previous (GHD 2009) or current targeted searches by Cumberland Ecology within the Project Boundary. Despite this, there is suitable habitat within areas of Whitewood 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.

3.3.5 *Swainsona murrayana*

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 2008c).

There are no records of *Swainsona murrayana* within 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. 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.



Chapter 4

Fauna Results

4.1 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 within the Project Boundary include:

- Wetland and riparian environments suitable for fauna species dependent on these habitats such as wetland birds, some amphibians 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.

4.1.1 *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 a 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 (see **Section 5.1.2** for more details).

Lake Goran lies in the catchment of the Mooki River, located 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.

4.1.2 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.

4.1.3 Tree Hollows

Tree hollows were counted within 20 m x 50 m quadrats at 31 of the Koala SAT survey sites. Tree hollow size and abundance observations were recorded and are summarised in **Table 4.1** 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 tree hollows occur, White Box and Inland Grey Box communities 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 this reflects the removal and regrowth of trees that has occurred within the Project Boundary in the past.

Table 4.1 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

4.1.4 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. Isolated individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the southern easement in the south eastern portion of the Project Boundary. A number of secondary food trees for Koalas were identified within the Project Boundary, 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 secondary feed trees growing on the more fertile slopes and plains. Preferred habitat within the Project Boundary includes vegetation communities dominated by trees in the Eucalypt genus.

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* sp. also showed signs of occupation by Koalas, albeit at low activity levels. Whilst it is considered that all of the woodland communities within the Project Boundary could provide suitable habitat for Koalas, occupation of areas dominated by non-feed trees is likely to be by transient individuals.

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.

4.1.5 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.

4.1.6 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.

4.1.7 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 4.1 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. The majority of threatened species recorded from the Project Boundary or considered to have potential to inhabit woodland environments. 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 4.1**, 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. 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.



4.2 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. A comprehensive lists of fauna recorded within the Project Boundary during the survey are provided in **Appendix F**. Locations of threatened fauna recorded within the Project Boundary and adjacent areas are shown in **Figure 4.2**.

Several threatened fauna species listed under the TSC Act have been recorded within the Project Boundary. In addition to those recorded from the Project Boundary, database records indicate that several threatened fauna species listed under either the EPBC Act and/or the TSC Act have been recorded from the Gunnedah LGA.

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 **Table H.1** in **Appendix G**. Species considered to have potential to occur within the Project Boundary due to the presence of suitable habitat are discussed in more detail below in appropriate subsections. A summary of the threatened species listed under the TSC Act and the EPBC Act which were recorded within the Project Boundary or with potential to occur within the Project Boundary is provided in **Section 4.3** and **Section 4.4**.

4.2.1 Birds

The woodland communities of the Project Boundary support a high diversity of avifauna. A total of 100 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 EIA is provided in **Appendix F**.

Several bird species listed as Vulnerable under the TSC Act have been recorded within the Project Boundary. These were:

- Little Lorikeet (*Glossopsitta pusilla*);
- Brown Treecreeper (*Climacteris picumnus victoriae*);
- Speckled Warbler (*Chthonicola sagittatus*);
- Grey-crowned Babbler (*Pomatostomus temporalis*);
- Diamond Firetail (*Stagonopleura guttata*);
- Spotted Harrier (*Circus assimilis*);
- Little Eagle (*Hieraaetus morphnoides*); and
- Barking Owl (*Ninox connivens*).

One bird species listed as Migratory under the EPBC Act, the White-bellied Sea-eagle (*Haliaeetus leucogaster*) was recorded within the Project Boundary during current surveys.

In addition to the threatened birds recorded from the Project Boundary, several bird species listed under the EPBC Act and TSC 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 either the EPBC Act or the TSC 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. Blossom-dependent Birds

A number of blossom-dependent birds have been recorded from the Project Boundary or have potential to occur. One species listed as Vulnerable under the TSC Act, the Little Lorikeet (*Glossopsitta pusilla*), was recorded within the Project Boundary during current surveys. Two other blossom dependent bird species listed as Vulnerable under the TSC Act; the Black-chinned Honeyeater (*Melithreptus gularis gularis*) and the Painted Honeyeater (*Grantiella picta*), are also likely to occur within the Project Boundary, however these species were not identified during recent surveys.

Two blossom-dependent birds listed as Endangered under the EPBC Act; the Swift Parrot (*Lathamus discolor*) and, Regent Honeyeater (*Anthochaera phrygia*) were not recorded from the Project Boundary, however they are considered to have potential to occur. The Regent Honeyeater is also listed as Migratory under the EPBC Act and Critically Endangered under the TSC Act and the Swift Parrot is also listed as Endangered under the TSC Act.

These birds are all blossom feeding species and have a strong reliance upon suitable flowering feed trees. **Table 4.2** 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 4.2 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) 2005m). 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).

The Swift Parrot migrates from its Tasmanian breeding grounds to overwinter in the box-ironbark forests and woodlands of Victoria, NSW 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.

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. Suitable 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.

ii. Woodland Birds

During the current surveys, four woodland birds listed as Vulnerable under the TSC Act were recorded within the Project Boundary. These were:

- Brown Treecreeper (*Climacteris picumnus victoriae*);
- Speckled Warbler (*Chthonicola sagittatus*);
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*); and
- Diamond Firetail (*Stagonopleura guttata*).

Of these species, the Grey-crowned Babbler was the most abundant, being recorded in most areas within the Project Boundary. The Brown Treecreeper and Speckled Warbler were recorded less frequently, appearing to be strongly associated with the larger, more intact vegetation communities of the Project Boundary and the adjacent Breeza State Forest. The Diamond Firetail was rarely recorded during the survey period. Locations of threatened birds recorded within the Project Boundary and adjacent areas are shown in **Figure 4.2**.

Although not recorded during field surveys, Atlas of NSW Wildlife records indicate that four additional woodland birds listed as Vulnerable under the TSC Act have been recorded from the Gunnedah LGA. These are:

- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*);
- Varied Sittella (*Daphoenositta chrysoptera*);

- Turquoise Parrot (*Neophema pulchella*); and
- Superb Parrot (*Polytelis swainsonii*).

Of these species, the Superb Parrot (*Polytelis swainsonii*) is also listed as Vulnerable under the EPBC Act.

One woodland bird species listed as Endangered under the TSC Act, the Bush Stone-curlew (*Burhinus grallarius*) also has potential to occur due to the presence of suitable habitat.

Most of these species have been recorded in the locality of the Project Boundary, and larger woodland patches, and ecotonal woodland/grassland habitats provide suitable habitat for these species. All of these species are therefore considered to have potential to occur within the Project Boundary.

The Superb Parrot was not recorded from the Gunnedah LGA and the nearest recent Atlas of NSW Wildlife records for this species are approximately 70km 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. The Superb Parrot is a non-breeding winter migrant to the upper Namoi River (DEC (NSW) 2005q). 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.

iii. Raptors

Three raptors (birds of prey) listed as Vulnerable under the TSC Act were recorded within the Project Boundary during recent surveys. These were:

- Spotted Harrier (*Circus assimilis*);
- Little Eagle (*Hieraaetus morphnoides*); and
- Barking Owl (*Ninox connivens*).

Although not recorded during field surveys, Atlas of NSW Wildlife records indicate that three additional raptors listed as Vulnerable under the TSC Act have potential to occur within the Project Boundary. These species are:

- Square-tailed Kite (*Lophoictinia isura*);
- Black-breasted Buzzard (*Hamirostra melanosternon*); and
- Masked Owl (*Tyto novaehollandiae*).

These raptor species rely on large home ranges providing a matrix of suitable forage and breeding habitat. The forest, woodland and grassland of the Project Boundary provides

suitable forage habitat for all of these species. Most of these species require hollows in which to nest however, and as larger, hollow-bearing trees are rare, the amount of breeding habitat available is limited. Some of the nocturnal raptors such as the Barking Owl and Masked Owl require dense riparian vegetation for breeding and roosting; these habitat components are lacking within the Project Boundary, thereby limiting the suitability of habitat for these species.

The diurnal raptors (i.e. the Spotted Harrier, Black-breasted Buzzard, Little Eagle, and Square-tailed Kite) with potential to occur within the Project Boundary also require large hollows for nesting, and the lack of this kind of habitat restricts the ability of the Project Boundary to provide habitat for these species.

iv. Migratory Species

The White-bellied Sea-eagle was recorded foraging over small farm dams within the Project Boundary during the current surveys. This species was also observed in larger dams and lakes in the wider locality. The White-bellied Sea-eagle occurs from India and Sri Lanka, through south-east Asia to Australia on coasts and major waterways (SEWPaC 2012c). This species breeds and hunts near water, and fish form around half of its diet. It is opportunistic and also consumes carrion and a wide variety of animals. The small dams throughout the Project Boundary provide occasional foraging habitat for this species.

One migratory species with the potential to occur within the Project Boundary, the Regent Honeyeater, is also listed under the the EPBC Act as Endangered and under the TSC Act as Critically Endangered (see **Section 4.2.1.i**). Five additional 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 species are:

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

Although listed as Migratory, they are not listed under any category of threat.

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 throughout 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 commonly occur 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.

4.2.2 Mammals

A total of 25 mammal species were detected within the Project Boundary during recent surveys by Cumberland Ecology and GHD (2009). This included 13 terrestrial species, three arboreal species and nine bat species. 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 during surveys is provided in **Appendix F**.

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 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.

Commonwealth and NSW database searches indicate that several threatened mammal species listed under the EPBC Act and/or the TSC Act have been recorded in the locality or are considered to have potential habitat within the Project Boundary despite the absence of records during field surveys. These species are discussed in more detail below.

i. Koala

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

The dominant trees across a high proportion of the woodland and open forest areas 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).

The results of the SAT surveys (see **Figure 4.3**) 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 areas of “Low” activity indicate historical or occasional presence of Koalas.

Within NSW, legislation has been prepared to assist in the conservation of the Koala. SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas (Department of Planning, 1995). Schedule 1 of SEPP 44 lists the LGAs which SEPP 44 applies to and Schedule 2 of SEPP 44 lists the feed tree species for the Koala. The Project Boundary falls within Gunnedah LGA, which is listed in Schedule 1 of SEPP 44. Two of the ten feed species listed in Schedule 2 of SEPP 44 are located within the Project Boundary.

An approved Recovery Plan for the Koala has been prepared by OEH (DECC (NSW) 2008). Within this plan, management areas have been delineated across NSW. The Project Boundary falls within “Koala Management Area 6: Western Slopes and Plains” of the Recovery Plan. The Recovery Plan lists primary, secondary and supplementary Koala food tree species within each management area. The primary food tree species in this area is *Eucalyptus camaldulensis* (River Red Gum). It is an important feed species for Koalas where it occurs along the Namoi River and its tributaries in the wider locality. Isolated individuals of *Eucalyptus camaldulensis* (River Red Gum) were recorded within the southern easement in the south eastern portion of the Project Boundary. The Project Boundary contains seven of the secondary food tree species listed within Koala Management Area 6 in the Recovery Plan; (*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).

The Recovery Plan also provides two systems to categorise Koala habitat which are both based upon the abundance of primary and secondary food tree species. Within the first category system (Option 1), the Project Boundary is considered as secondary habitat (Class B) as the primary food tree species is absent. According to this category, the Project Boundary is capable of supporting a viable, low density population of Koalas.

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

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.

The Commonwealth listing advice gives a best estimate of the NSW population at 21,000 individuals (SEWPaC 2012d); 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 2012d). Population estimates for the Gunnedah region and the Disturbance Area are provided within the KPoM (Appendix L of the EIS).

ii. *Spotted-tailed Quoll*

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Endangered under the EPBC Act and as Vulnerable under the TSC 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.

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.

iii. *Microchiropteran Bats*

One species of microbat listed as Vulnerable under the TSC Act has been recorded within the Project Boundary; the Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*). This species is insectivorous and forages for its prey in the air above a wide range of habitats, including communities with and without trees (DEC (NSW) 2005s), therefore the majority of the Project Boundary would provide potential foraging habitat for this species, with hollows suitable for roosting and nesting being present in the wooded areas.

Despite the absence of records from within the Project Boundary, five additional microbats listed as Vulnerable under the TSC Act or the EPBC Act are known to occur in the locality and considered to have potential to occur within the Project Boundary. These are:

- Eastern Freetail-bat (*Mormopterus norfolkensis*) (TSC Act);
- Little Pied Bat (*Chalinolobus picatus*) (TSC Act);
- Eastern Cave Bat (*Vespadelus troughtoni*) (TSC Act);
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (TSC Act and EPBC Act); and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*) (TSC Act and EPBC Act).

Neither the Large-eared Pied Bat nor the South-eastern Long-eared Bat were recorded within the Project Boundary during the recent surveys, although the latter species was recorded from adjacent lands to the north-west of the Project. 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 of the Project Boundary. The Atlas of NSW Wildlife indicates records for the South-eastern Long-eared Bat 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 include woodland communities (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 potentially occur within the Project Boundary, despite the absence of survey recordings of either species.

The Eastern Freetail-bat and the Little Pied Bat roost in trees, caves, mines and a variety of other locations, and forage in forest and woodland habitats. The Eastern Cave Bat is a predominantly cave-roosting species. The higher rocky outcrops within the Project Boundary provide potential roosting and breeding habitat for this species. The forest and woodland habitat within the Project Boundary may also provide suitable forage habitat for the Eastern Cave Bat.

Although these species were not recorded during recent surveys, suitable foraging habitat was identified within the Project Boundary for these species. It is therefore considered that these species have the potential to occur within the Project Boundary.

iv. *Squirrel Glider*

The Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act. This species was not recorded during any of the current surveys, despite targeted searches.

The matrix of larger intact woodland patches connected in places by linear corridors within the Project Boundary provide potential Squirrel Glider habitat, therefore it is possible that Squirrel Gliders occur within the Project Boundary, although they are likely to occur in very low density.

4.2.3 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 F**.

No threatened reptile species listed under the TSC Act or the EPBC Act were recorded during the recent surveys despite targeted searches for these species. Commonwealth and NSW database searches indicate the occurrence of several reptiles listed as Vulnerable

under the EPBC Act or the TSC 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 species are:

- Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) (TSC Act and EPBC Act);
- Five-clawed Worm-skink (*Anomalopus mackayi*) (TSC Act and EPBC Act);
- Pink-tailed Legless Lizard (*Aprasia parapulchella*) (TSC Act and EPBC Act); and
- Pale-headed Snake (*Hoplocephalus bitorquatus*) (TSC Act).

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 Boundary, at Culgoora 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 woodland communities within the Project Boundary provide suitable forage, shelter and breeding habitat for most of these reptile species and rocky outcrops within the Project Boundary (e.g. Mt. Watermark) provide suitable habitat for the Border Thick-tailed Gecko. Woodland trees with substantial hollows would also provide suitable shelter habitat for the Pale-headed Snake. The Pink-tailed Legless Lizard is a fossorial species that forages and shelters beneath leaf litter.

Although these species were not recorded during recent surveys, suitable habitats were identified within the Project Boundary for all of these species. It is therefore considered that these species have the potential to occur within the Project Boundary.

4.2.4 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 amphibian species are considered likely to occur within the Project Boundary due to a lack of suitable aquatic habitat. A complete list of the amphibian species recorded during surveys is provided in **Appendix F**.

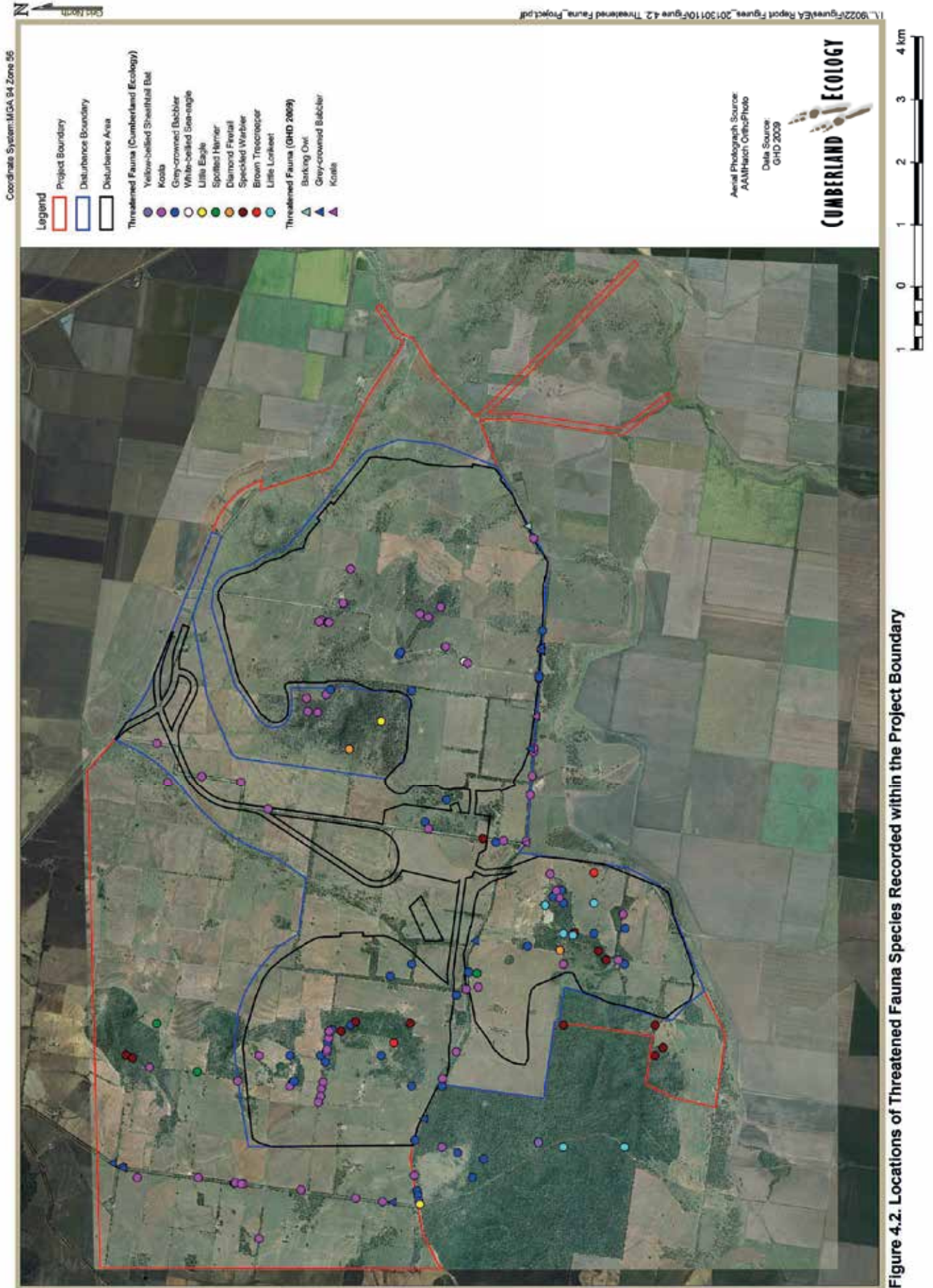


Figure 4.2. Locations of Threatened Fauna Species Recorded within the Project Boundary

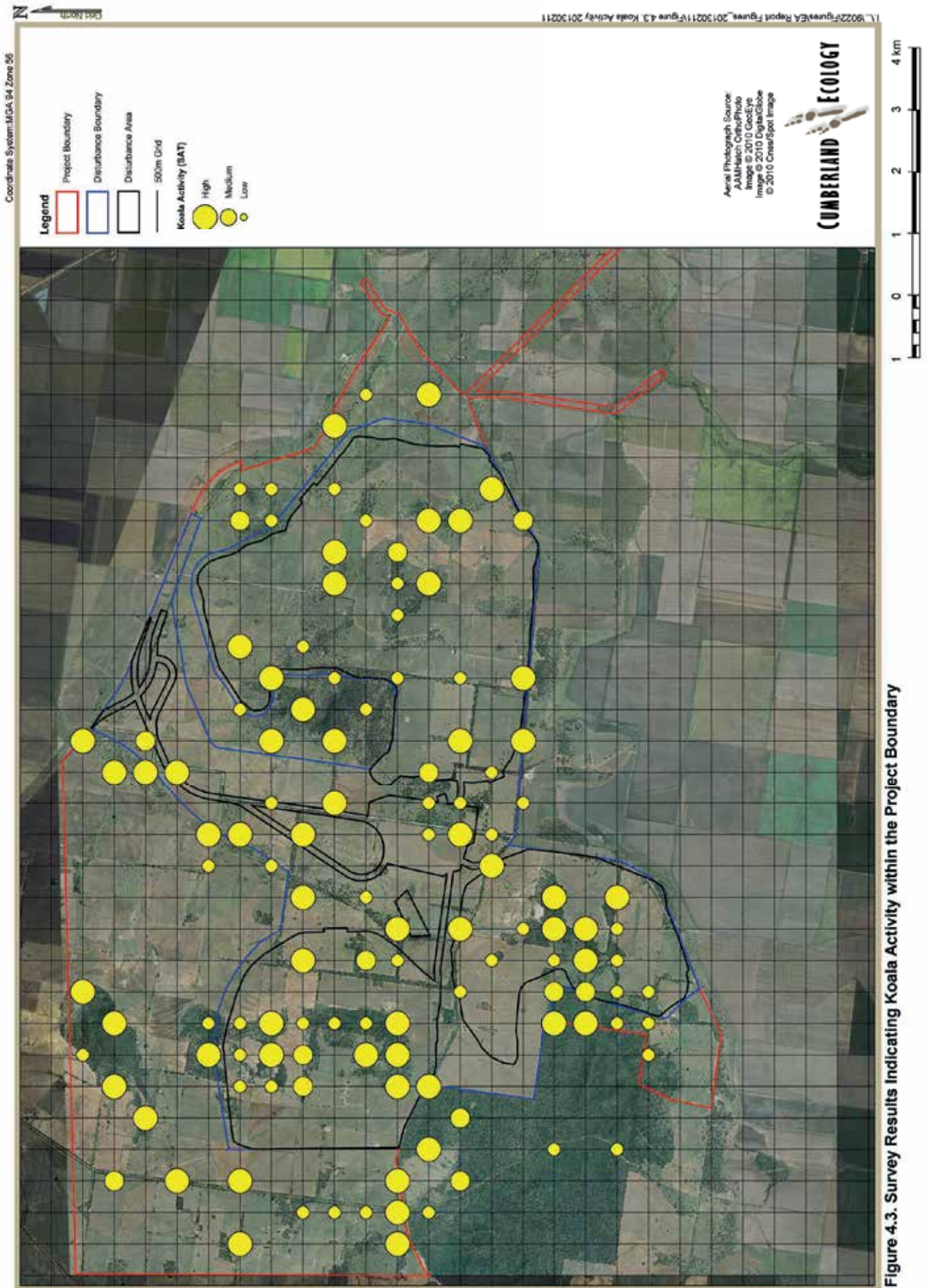


Figure 4.3. Survey Results Indicating Koala Activity within the Project Boundary

4.3 Summary of TSC Act Listed Species

Several fauna species listed under the TSC Act have been recorded from the Project Boundary, and others have been recorded in the Gunnedah LGA according to Atlas of NSW Wildlife records. An assessment of the likelihood of occurrence of these species is provided in **Appendix G**. Based on this analysis, the fauna species listed under the TSC Act that are known to occur or have potential to occur within the Project Boundary are listed within **Table 4.3**.

Table 4.3 Summary of TSC Act Listed Species Known or Potentially Occurring within the Project Boundary			
Common Name	Scientific Name	TSC Act Status	Occurrence within Project Boundary
Birds			
Little Lorikeet	<i>Glossopsitta pusilla</i>	Vulnerable	Known
Brown Treecreeper	<i>Climacteris picumnus victoriae</i>	Vulnerable	Known
Speckled Warbler	<i>Chthonicola sagittatus</i>	Vulnerable	Known
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	Vulnerable	Known
Diamond Firetail	<i>Stagonopleura guttata</i>	Vulnerable	Known
Spotted Harrier	<i>Circus assimilis</i>	Vulnerable	Known
Little Eagle	<i>Hieraaetus morphnoides</i>	Vulnerable	Known
Barking Owl	<i>Ninox connivens</i>	Vulnerable	Known
Painted Honeyeater	<i>Grantiella picta</i>	Vulnerable	Potential
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>	Vulnerable	Potential
Regent Honeyeater	<i>Anthochaera phrygia</i>	Critically Endangered	Potential
Swift Parrot	<i>Lathamus discolor</i>	Endangered	Potential
Hooded Robin	<i>Melanodryas cucullata cucullata</i>	Vulnerable	Potential
Varied Sittella	<i>Daphoenositta chrysoptera</i>	Vulnerable	Potential
Turquoise Parrot	<i>Neophema pulchella</i>	Vulnerable	Potential
Superb Parrot	<i>Polytelis swainsonii</i>	Vulnerable	Potential
Bush Stone-curlew	<i>Burhinus grallarius</i>	Endangered	Potential
Square-tailed Kite	<i>Lophoictinia isura</i>	Vulnerable	Potential
Black-breasted Buzzard	<i>Hamirostra melanosternon</i>	Vulnerable	Potential
Masked Owl	<i>Tyto novaehollandiae</i>	Vulnerable	Potential
Mammals			
Koala	<i>Phascolarctos cinereus</i>	Vulnerable	Known

Table 4.3 Summary of TSC Act Listed Species Known or Potentially Occurring within the Project Boundary			
Common Name	Scientific Name	TSC Act Status	Occurrence within Project Boundary
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	Vulnerable	Potential
Squirrel Glider	<i>Petaurus norfolcensis</i>	Vulnerable	Potential
Yellow-bellied Sheath-tail Bat	<i>Saccolaimus flaviventris</i>	Vulnerable	Known
Eastern Freetail-bat	<i>Mormopterus norfolkensis</i>	Vulnerable	Potential
Little Pied Bat	<i>Chalinolobus picatus</i>	Vulnerable	Potential
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	Vulnerable	Potential
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Vulnerable	Potential
South-eastern Long-eared Bat	<i>Nyctophilus corbeni</i>	Vulnerable	Potential
Reptiles			
Border Thick-tailed Gecko	<i>Underwoodisaurus sphyrurus</i>	Vulnerable	Potential
Five-clawed Worm-skink	<i>Anomalopus mackayi</i>	Endangered	Potential
Pink-tailed Legless Lizard	<i>Aprasia parapulchella</i>	Vulnerable	Potential
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	Vulnerable	Potential

4.4 Summary of EPBC Act Listed Threatened Fauna Species

The Atlas of NSW Wildlife indicates that several fauna species listed under the EPBC Act have been recorded from within the Gunnedah LGA and/or within the Project Boundary. An assessment of the likelihood of occurrence of these species within the Project Boundary is provided in **Appendix G**, based on the known habitat preferences of these species and the availability of that habitat within the Project Boundary. Based on this analysis, the fauna species listed under the EPBC Act that are known to occur or have potential to occur within the Project Boundary, are listed within **Table 4.4**.

Table 4.4 Summary of EPBC Act Listed Species Known or Potentially Occurring within the Project Boundary			
Scientific Name	Scientific Name	EPBC Act Status	Occurrence within Project Boundary
Birds			
Regent Honeyeater	<i>Anthochaera phrygia</i>	Endangered, Migratory	Potential
Swift Parrot	<i>Lathamus discolor</i>	Endangered	Potential
Superb Parrot	<i>Polytelis swainsonii</i>	Vulnerable	Potential

Table 4.4 Summary of EPBC Act Listed Species Known or Potentially Occurring within the Project Boundary			
Scientific Name	Scientific Name	EPBC Act Status	Occurrence within Project Boundary
White-throated Needletail	<i>Hirundapus caudacutus</i>	Migratory	Potential
Fork-tailed Swift	<i>Apus pacificus</i>	Migratory	Potential
Rainbow Bee-eater	<i>Merops ornatus</i>	Migratory	Potential
Cattle Egret	<i>Bubulcus ibis</i>	Migratory	Potential
Great Egret	<i>Ardea alba</i>	Migratory	Potential
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	Migratory	Known
Mammals			
Koala	<i>Phascolarctos cinereus</i>	Vulnerable	Known
Spotted-tailed Quoll	<i>Dasyurus maculatus</i>	Endangered	Potential
Large-eared Pied Bat	<i>Chalinolobus dwyeri</i>	Vulnerable	Potential
South-eastern Long-eared Bat	<i>Nyctophilus corbeni</i>	Vulnerable	Potential
Reptiles			
Border Thick-tailed Gecko	<i>Underwoodisaurus sphyrurus</i>	Vulnerable	Potential
Five-clawed Worm-skink	<i>Anomalopus mackayi</i>	Vulnerable	Potential
Pink-tailed Legless Lizard	<i>Aprasia parapulchella</i>	Vulnerable	Potential

Chapter 5

Aquatic 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 has been 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.

5.1 Aquatic Habitat Assessment

5.1.1 Farm Dams

The farm dams within the Project Boundary are small and shallow, and are likely to dry up during periods of low rainfall. 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. Similar to the Mooki River, the dams offer marginal habitat with little or no instream vegetation, rocks or snags, making it difficult for aquatic macroinvertebrates to colonise (see **Photographs 5.1 to 5.3**).

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



Photograph 5.1 **Aquatic Survey Location - SWM15**



Photograph 5.2 **Aquatic Survey Location - SWM12**



Photograph 5.3 Aquatic Survey Location - FD07

5.1.2 *Waterways*

Two waterways were sampled to the south-east of the Project Boundary; Mooki River and Native Dog Gully, which is a tributary of Mooki River. 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.

The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River is listed as an EEC under the *Fisheries Management Act 1994* (FM Act). The definition of what constitutes this EEC is somewhat unclear, however advice from the NSW Department of Primary Industries (Fisheries) indicates that they consider the Mooki River to be included in this EEC. The Mooki River 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 10 m of the bank edge at many locations. 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, erosion 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 5.1** and **Photograph 5.2**).

The Mooki River and Native Dog Gully are considered to be in poor physical condition (Thoms et al. 1999) and provide highly simplified aquatic habitat with little or no riparian and instream vegetation, or rocks and snags required for aquatic macroinvertebrate habitation. The Mooki River has a degraded channel and banks, with the deposition of fine clay and silt materials (Thoms et al. 1999). 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 locations surveyed are unlikely to support significant freshwater fish communities due to:

- The ephemeral nature of the watercourses and general low water levels and flow;
- Proximate agricultural practices, including cropping up to the bare banks; degraded physical condition of banks and channels;
- The presence of barriers and road crossings across the channel (e.g. Pipe 1, SWM15); and
- A lack of both woody debris and macrophyte coverage for shelter and spawning.

5.1.3 Lake Goran

Lake Goran is an extensive but shallow lake located to the west of the Project Boundary (see **Figure 2.3**). 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, and when this occurs, it 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 5.4**).

Table 5.1 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 an AusRivAS ranking of disturbance levels from human activities. This table indicates that habitat quality is generally low at all surface water monitoring locations.

Table 5.1 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	Instream 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 5.4 **Aquatic Survey Location - Lake Goran**

5.2 Aquatic Vertebrate 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.

Limited publically available database records have been found for native fish species from the Mooki River. Database searches of the OEH Atlas of NSW Wildlife did not identify any records for native fish within the Gunnedah LGA or Mooki River. Searches of the NSW DPI Species Protection database found records of one threatened fish species from the Mooki River and three species that have previously been found in the Namoi River. Other literature has identified native fish species from further downstream in the Namoi Catchment and several threatened species of fish are likely to be present within the catchment, including Murray Cod (*Maccullochella peellii peellii*) and Silver Perch (*Bidyanus bidyanus*) (Thoms et al. 1999).

Fisheries NSW has provided a list of native fish species previously recorded in the Mooki River by Fisheries NSW surveys. As such, baseline information and impact assessments have been completed for each of these species:

- Eel-tail Catfish (*Tandanus tandanus*);
- Golden Perch (*Macquaria ambigua*);
- Bony Bream (*Nematalosa erebi*);
- Silver Perch (*Bidyanus bidyanus*);
- Spangled Perch (*Leiopotherapon unicolor*);
- Murray Darling Rainbowfish (*Melanotaenia fluviatilis*);
- Murray Cod (*Maccullochella peellii peellii*);
- Carp Gudgeon (*Hypseleotris spp*);
- Olive Perchlet (*Ambassis agassizii*); and
- Purple-spotted Gudgeon (*Mogurnda adspersa*).

5.3 Threatened Species

The following threatened species may have some potential to occur downstream of the Project in the Namoi River based on available database records. However, they are not considered likely to occur as far upstream as the Mooki River and at the water extraction site due to the highly degraded and often non-existent nature of aquatic habitat along the Mooki River, reduced water quality, terrestrial impacts such as run-off from agriculture, unstable banks and artificial obstructions to water flow and thus interruptions to fish passage (NSW Department of Primary Industries 2006). These fish species were not recorded during the field surveys, and due to the poor quality of the aquatic habitat at the sampling sites, are not considered likely to occur within the Project Boundary. Despite the unlikelihood of native species occurring in the portion of the Mooki River proximate to the Project, general mitigation measures have also been considered for threatened fish species in **Chapter 7**.

5.3.1 Olive Perchlet (*Ambassis agassizii*)

The Olive Perchlet is listed as an Endangered population under the FM Act.

This species occurs in coastal streams from northern NSW to north Qld, but has undergone a significant decline in most of the Murray-Darling Basin. The species was formerly widespread in the lower Murrumbidgee, Lachlan and lower Murray rivers and throughout the Darling drainage in NSW. In NSW it is now only known from a few localities in the Darling drainage upstream of Bourke, and is locally abundant in the Border Rivers and Condamine-Balonne (NSW Department of Primary Industries 2013).

The Olive Perchlet inhabits the vegetated edges of lakes, creeks, swamps, wetlands and rivers, where it is often associated with woody habitat and aquatic vegetation in areas with little or no flow, particularly backwaters. Spawning occurs from October to December, when

water temperature reaches 22-23°C. Eggs are adhesive and attach to aquatic plants and rocks on the streambed (NSW Department of Primary Industries 2013). The species is carnivorous and typically feeds on microcrustaceans (copepods and cladocera), aquatic and terrestrial insects including mosquito wrigglers and small arachnids and, occasionally, small fish.

5.3.2 Silver Perch (*Bidyanus bidyanus*)

The Silver Perch is listed as Vulnerable under the FM Act. According to the DPI Species Protection database, the species has been recorded in 2001 and 2005 in the Namoi River.

This species was formerly widespread over much of the Murray-Darling Basin excluding the most upper reaches, but has now severely declined or disappeared over most of its range. Only nine Silver Perch were recorded in a two-year survey of 40 randomly selected sites in the NSW portion of the Basin in the mid 1990s. Similarly, the first 2 sampling rounds of the Sustainable Rivers Audit has so far only recorded a total of 20 Silver Perch whilst surveying 351 randomly selected sites covering 16 river valleys. The species is still patchily abundant in the mid-Murray. Only one remaining secure and self sustaining population occurs in NSW in the central Murray River downstream of Yarrawonga weir, as well as several anabranches and tributaries (NSW Department of Primary Industries 2013).

Silver Perch are found in lowland, turbid and slow-flowing rivers. They spawn in spring and summer after an upstream migration, when large schools often form. Silver Perch are omnivorous and feed on aquatic plants, snails, shrimps and aquatic insect larvae (NSW Department of Primary Industries 2013).

5.3.3 Eel-tail Catfish (*Tandanus tandanus*)

The Eel-tail Catfish is listed as an Endangered population within the Murray-Darling Basin under the FM Act. According to the DPI Species Protection database, the species has been recorded in 2004, 2008 and 2009 in the Namoi River, north of the Oxley Highway. It has also been recorded in 2002 in the Mooki River approximately 10km south-east of Gunnedah and downstream of the Project.

This species was originally widely distributed throughout the Murray-Darling River System in NSW, Queensland, Victoria and South Australia, with the exception of the cooler parts of the southern tributaries. A moderate remnant population occurs in the Namoi catchment upstream of Wee Waa.

The Eel-tail Catfish is a carnivorous, non migratory benthic species and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. It is rare in natural riverine habitats but can be found in farm dams through-out inland NSW and southern Queensland (NSW Department of Primary Industries 2013).

5.3.4 The Purple-spotted Gudgeon (*Mogurnda adspersa*)

The Purple-spotted Gudgeon is listed as Endangered under the FM Act.

This species is present in coastal streams of northern NSW and Qld as well as the Murray-Darling Basin. In the Basin it has undergone a significant decline and is now patchily distributed and rare in northern NSW. It is a slow-moving carnivorous ambush predator that eats small fish, aquatic macroinvertebrates, worms and tadpoles. It is a benthic species, usually associated with good cover such as cobble and rocks in the Queensland parts of its range, or aquatic vegetation in its southern range. It is found in slow moving or still waters of creeks, rivers, wetlands and billabongs, and prefers slower flowing, deeper habitats (NSW Department of Primary Industries 2013).

5.3.5 Murray Cod (*Maccullochella peellii peellii*)

The Murray Cod is listed as Vulnerable under the EPBC Act.

This species was once abundant throughout the Murray-Darling river system, but overfishing and environmental changes have drastically reduced its numbers. Murray cod generally prefer slow flowing, turbid water in streams and rivers, favouring deeper water around boulders, undercut banks, overhanging vegetation and logs. It is a large, long lived predator species that is highly territorial and aggressive and feed on fish, crustaceans, water birds, frogs, turtles and terrestrial animals such as mice and snakes. It occurs naturally in the waterways of the Murray–Darling Basin in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs. The upper reaches of the Murray and Murrumbidgee Rivers are considered too cold to contain suitable habitat (NSW Department of Primary Industries 2013).

5.4 Endangered Ecological Communities

The Mooki River is a tributary of the Namoi River, which is a major tributary of the Darling River. The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River is listed as an EEC under the FM Act, and it has been advised by the Department of Primary Industries (Fisheries) within the agency and stakeholder input into key assessment issues for the DGRs that the Mooki River conforms to the definition of this EEC.

The Darling River endangered ecological community includes (DEH 2005):

all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, flow diversions to anabranches, the anabranches, and the floodplains of the Darling River within the State of New South Wales, and including Menindee Lakes and the Barwon River. Excluded from this recommendation are the man made/artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs. Other watercourses above 500m not specifically named in this recommendation are excluded.

The Project Boundary is generally located outside of the Mooki River, however two pipeline corridors extend from the Project Boundary to the Mooki River and it is proposed that a pump may be installed in the river.

5.5 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 for Gunnedah 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 2000) 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 5.2 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 2000, Turak and Waddell 2001b).

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

EC ($\mu\text{S}/\text{cm}$): EC levels measured at the survey sites were highly variable, and are expected to fluctuate greatly depending on the amount of water flowing at each site. ANZECC guideline trigger value ranges are from 125 - 2,200 $\mu\text{S}/\text{cm}$. 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): DO concentrations 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 <6 ppm were measured at some sites during the March 2011 sampling event, which is unsuitable for many aquatic organisms. DO concentrations 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 5.2 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 5.2 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.															

5.6 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).

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 5.1**). 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 5.1** shows a clear divide between the abundance of taxa collected at stream / river sites and dam sites/ the Lake Goran site. 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 Goran) group closest to each other. These results show clearly that there is a 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 5.1**.

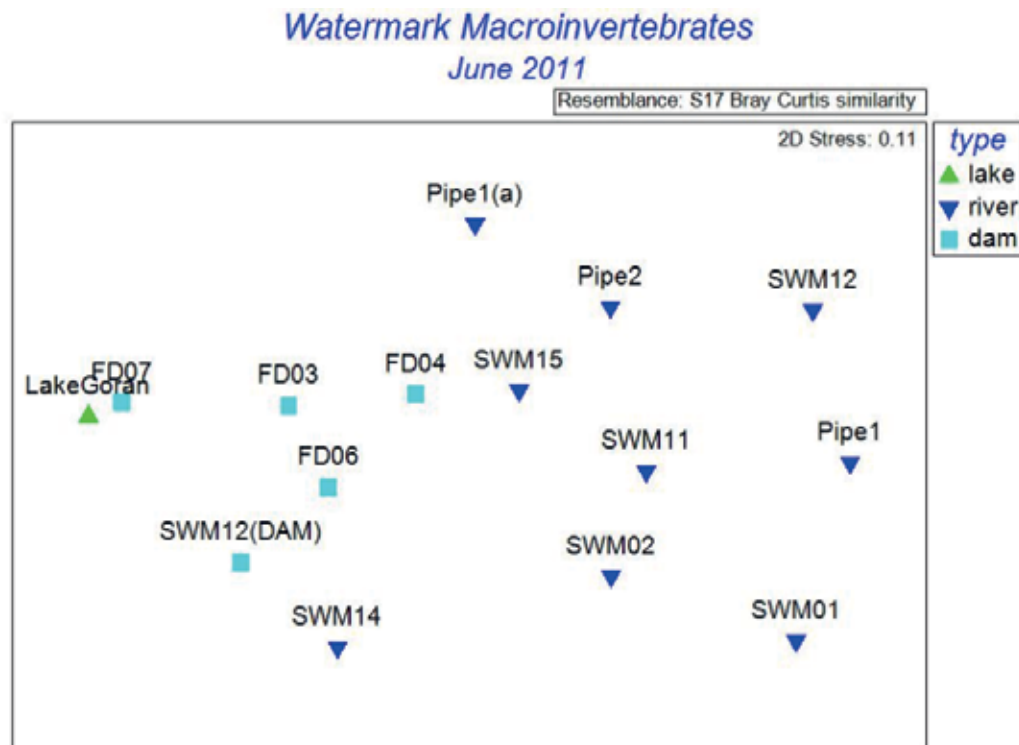


Figure 5.1 MDS Plot of Invertebrate Diversity and Abundance

5.6.1 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 the abundance and diversity of published reference sites to allocate each sampling site into bands representing different levels of biological condition. Reference sites are considered to be sites in near perfect condition and the model assesses the relative health of the sampling site against the reference site to calculate a value indicative of its ecological condition. When assessing the aquatic health of a stream, the model predicts the reference site ecological 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 or OE50.

An OE50 score of around 1 means that the observed diversity and abundance of the 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 fewer 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 sites with OE50 scores around 1, whilst Bands B, C and D are given to sites with 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 5.3**.

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 5.4**). Sites that were 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 of 16% to 45% of the expected macroinvertebrate biodiversity (compared to the reference site). Band C sites are further degraded, where 46% to 75% of expected biodiversity has been lost and habitat condition is severely impaired (see **Table 5.4**).

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

Table 5.3 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. <u>Highly degraded</u>
?	Beyond the capacity of current AusRivAS models	Could not be assessed using current AusRivAS models	Could not be assessed using current AusRivAS models

Table 5.4 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.

5.6.2 *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 caddisfly larvae, and beetles; generally those with low SIGNAL grades indicating their tolerance to 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 5.2**. 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 have the highest ecological condition and sites in Quadrant 4 are considered to have the lowest ecological condition. **Figure 5.2** 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.

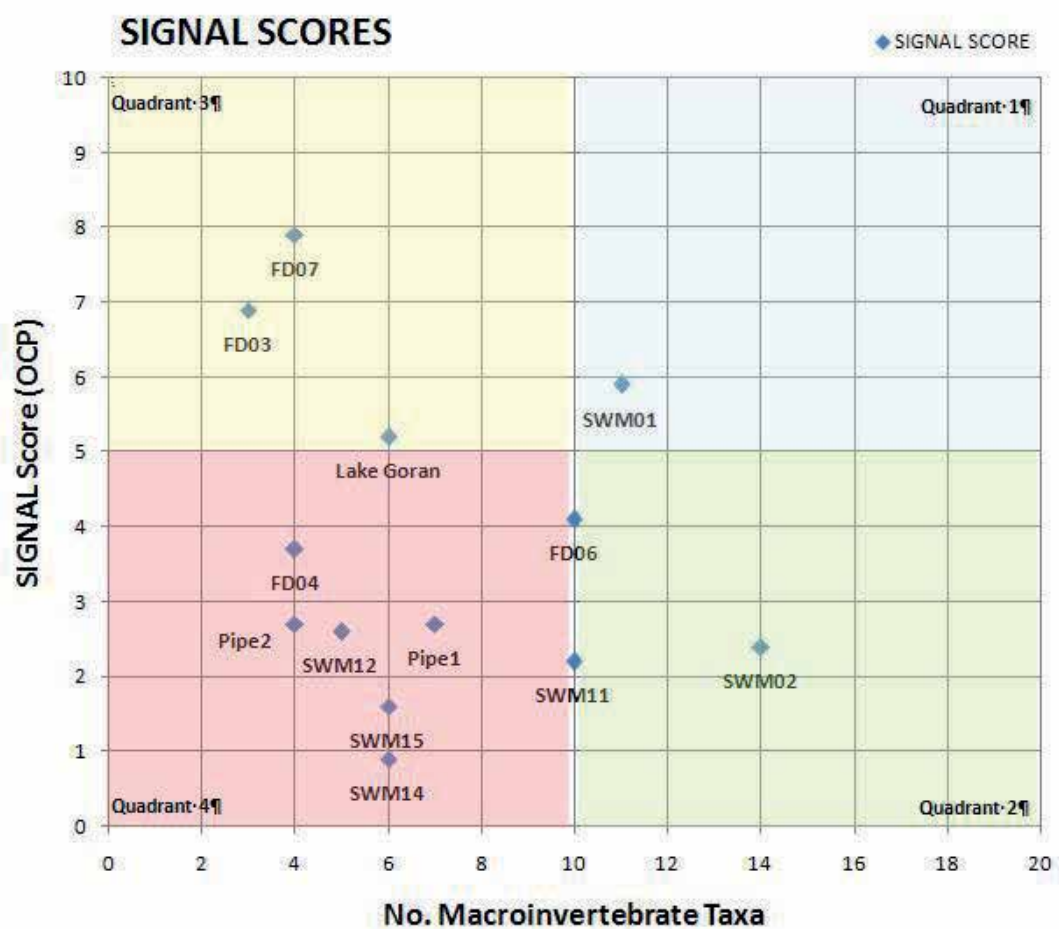


Figure 5.2 **Quadrant Diagram of Signal Scores**

Chapter 6

Impact Assessment

This chapter considers the ecological impacts of the Project on the biodiversity values within 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 that provides significant habitat for both native flora and fauna species would be cleared for the Project. 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 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 anticipated impacts, and the permanence and reversibility of anticipated impacts.

6.1 Impacts to Vegetation Communities

The largest direct impact of the Project is the removal of threatened woodland vegetation communities that also provides 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 up to 4,021 ha of woodland and grassland habitat will be removed by the Project, comprising a suite of communities as shown in **Table 6.1** and **Figure 6.1**. The vegetation communities that would be most impacted by the Project include: White Box, Yellow Box, Blakely's Red Gum Woodland, Derived Native Grassland; Inland Grey Box Woodland; Weeping Myall Woodland; Fuzzy Box Woodland; and other non-threatened woodland communities and grasslands (**Table 6.1**).

A summary of the potential impacts to these species as a result of the Project is provided in **Table 6.2** for TSC Act listed communities and **Table 6.3** for EPBC Act listed communities.

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 (see **Section 6.3** below). Remnant vegetation is already fragmented within the Project Boundary; however the proposed development has potential to increase the level of fragmentation and isolation of forested areas. Mitigation measures and a biodiversity offset strategy have been developed to address and counter such predicted impacts. These are discussed in **Chapter 7** and **Chapter 8**, respectively.

Table 6.1 Summary of Vegetation Clearance within the Project Boundary					
Vegetation Community	TSC Act Status	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
White Box Grassy Woodland	EEC	CEEC	988	517	52
Regenerating White Box Grassy Woodland	EEC	CEEC	28	28	100
Blakely's Red Gum Grassy Woodland	EEC	CEEC	90	89	99
Regenerating Blakely's Red Gum Grassy Woodland	EEC	CEEC	17	17	100
Yellow Box Grassy Woodland	EEC	CEEC	69	14	20
Derived Native Grassland	EEC	CEEC	73	73	100
Subtotal Box Gum Woodland (C/EEC)			1,265	738	58
Inland Grey Box Grassy Woodland	EEC	EEC	55	30	55
Weeping Myall Woodland	EEC	EEC	22	3	14
Brigalow	EEC	EEC	9	0	0
Semi-evergreen Vine Thicket	EEC	EEC	n/a*	0	0
Fuzzy Box Woodland	EEC		36	18	50
Subtotal Other EEC			122	51	42
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
Subtotal Other Woodland			683	148	22

Table 6.1 Summary of Vegetation Clearance within the Project Boundary					
Vegetation Community	TSC Act Status	EPBC Act Status	Project Boundary (ha)	Disturbance Area (ha)	Cleared within Project Boundary (%)
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 TSC Act EEC			1,387	789	57
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*



6.1.1 *Box Gum Woodland and Derived Native Grassland*

The Project will result in the removal of approximately 665 ha of woodland and 73 ha of derived native grassland conforming to the EPBC Act listed CEEC White Box Yellow Box Blakely's Red Gum Woodland and Derived Native Grassland, and also conforming to the TSC Act listed EEC White Box Yellow Box Blakely's Red Gum Woodland. Shenhua Watermark has committed to aim to avoid impacts on Box Gum Woodland during the final design where ever possible. The actual direct impact on Box Gum Woodland is 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.

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 (DECCW (NSW) 2010). Due to these pressures, the Key Threatening Processes "*Clearing of native vegetation*" (TSC Act) and "*Land Clearance*" (EPBC Act) are considered the most prevalent threats to this community (DECCW (NSW) 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 H**. Recovery of this community can be expected to directly benefit the recovery of these species.

6.1.2 *Inland Grey Box Woodland*

The Project will result in the removal of approximately 30 ha of Inland Grey Box Woodland, which conforms to the EPBC Act listed EEC Grey Box (*Eucalyptus microcarpa*) Grassy Woodland and Derived Native Grassland, and conforms to the TSC Act listed EEC Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.

The most recent and comprehensive estimates of extent of this community in NSW are from Benson (2008) and Benson et al. (2006). They indicate that the community has declined from between 1,800,000 to 2,000,000 ha to a present extent of between 300,000 to 330,000 ha in NSW, which equates to a decline in the order of 82% to 85% (Threatened Species Scientific Committee 2010). Accordingly, the Key Threatening Processes "*Clearing of native vegetation*" (TSC Act) and "*Land Clearance*" (EPBC Act) have been named as the most prevalent threats to this community.

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.

As a consequence of the decline of this community, many flora and fauna species occurring within this community are now listed as threatened under State and/or Commonwealth legislation. Recovery of the ecological community can be expected to directly benefit the recovery of these species.

6.1.3 Weeping Myall Woodland

The Project will result in the removal of approximately 3 ha of Weeping Myall Woodland, which conforms to the EPBC Act listed EEC Weeping Myall Woodlands, and which conforms to the TSC Act listed EEC Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions.

Similarly to other grassy woodlands occupying flat fertile lands Weeping Myall Woodland was cleared extensively. Weeping Myall Woodland has declined in NSW from an estimated original extent between 1,900,000 and 3,300,000 ha to a current extent of between 190,000 and 330,000 ha, which equates to a decline of 83% to 94% (Threatened Species Scientific Committee 2008e). 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 and thus the Key Threatening Processes “*Clearing of native vegetation*” (TSC Act) and “*Land Clearance*” (EPBC Act) have been named as the most prevalent threats to this community (Threatened Species Scientific Committee 2008e).

As a consequence of the decline of this community, many flora and fauna species occurring within this community are now listed as threatened under State and/or Commonwealth legislation. Recovery of the ecological community can be expected to directly benefit the recovery of these species.

6.1.4 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) or woodland conforming to the TSC Act listed EEC Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. 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.

6.1.5 *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 thickets of the Brigalow Belt (North and South) and Nandewar Bioregions and TSC Act listed EEC Semi-evergreen vine thicket in the Brigalow Belt South and Nandewar bioregions. 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. This community will be conserved within the Mt Watermark Offset Area.

6.1.6 *Fuzzy Box Woodland*

The Project will result in the removal of approximately 18 ha of woodland conforming to TSC Act listed EEC Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions.

Similarly to other grassy woodlands and flood plain formations, Fuzzy Box Woodland was cleared extensively. It is estimated that less than 5% of Fuzzy Box Woodland remains in NSW compared to pre-European settlement (NSW Scientific Committee 2004g). As remnant patches become more fragmented and isolated, they become even less resilient to outside pressures and indirect effects and will require active management to counter the effects of continued degradation.

Since this EEC remains poorly represented in NSW, the conservation of remaining remnants are critical to the recovery of the EEC and thus the Key Threatening Process "*Clearing of native vegetation*" (TSC Act) has been named as the most prevalent threats to this community (NSW Scientific Committee 2004g, DECCW (NSW) 2010).

6.2 Loss of Habitat Features

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

- Dense understorey vegetation – shelter and foraging habitat for amphibians, reptiles, small birds and terrestrial mammals;
- Fallen logs, debris and leaf litter – shelter habitat for amphibians, reptiles and terrestrial mammals;
- Rocky outcrops – shelter and breeding habitat for amphibians, reptiles and terrestrial mammals;

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

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

The largest patches of vegetation occur at Mt. Watermark and Smokey Point. These larger patches of woodland display good structural integrity compared to the more disturbed smaller patches and linear strips within the Project Boundary.

6.2.1 Loss of Tree Hollows

Tree hollows are an essential resource for a number of fauna species that rely on them for refuge and nesting (Newton 1994, Gibbons and Lindenmayer 2002, Heinsohn et al. 2003, Cockle et al. 2010). Tree hollows have been shown to be a key limiting resource for hollow-dependent fauna (Brawn and Balda 1988, Lindenmayer et al. 1990, Newton 1994, Gibbons and Lindenmayer 2002, Gibbons et al. 2002, Heinsohn et al. 2003, Cameron 2006), especially when we consider that the processes of natural decay and primary excavation that produce hollows are time-consuming and energy costly (Marsden and Pilgrim 2003, Aitken and Martin 2007, Murphy and Legge 2007, Aitken and Martin 2008). Furthermore, many hollow-dependent species will only occupy hollows with specific hollow characteristics (Gibbons et al. 2002), which means that many hollows are unlikely to be suitable, thereby increasing the demand on the remaining suitable hollows.

In spite of the history of tree clearing and gathering of timber for firewood from much of the woodland habitat within the Project Boundary, many trees remaining within the woodland have hollows; particularly White Box, Yellow Box and Inland Grey Box. Of these, it is possible that only a small proportion of available hollows are likely to be functional habitats

(Cockle et al. 2008) and so the importance of this limited resource within the Project Boundary is likely to be quite high.

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

The recommended mitigation and offset measures to minimise adverse impacts resulting from the mining process are described in detail in **Chapter 7** and **Chapter 8**, respectively.

6.3 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.

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.

Indirect impacts may also be felt outside the Project Boundary. For mobile species with large territories, such as the Barking Owl and Spotted Harrier, the clearance of habitat within the Disturbance Area may potentially impact the territories further afield. The Project could also potentially sever wildlife corridors in the wider region and potentially negatively impact fauna moving across the landscape to and from Breeza State Forest if left unmitigated and without offsets.

Indirect impacts relevant to the Project are considered in more detail below. Whilst not quantifiable, these impacts have been considered within the Assessments of Significance within **Appendix I**.

6.3.1 *Habitat Fragmentation*

One of the major impacts of the Project on flora and fauna will be habitat fragmentation. Fragmentation is the process where habitats that were once continuous become divided into separate fragments isolated from each other by non forest land (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 6.3.2**). 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. The threatened species found within the Project Boundary are mainly mobile species such as Koalas, birds and microbats, which have potential to move across disturbed areas. Notwithstanding this, it is thought that many threatened birds in agricultural landscapes of NSW are declining due to clearing for agriculture (Reid 1999). Koalas are known to be adversely affected by habitat fragmentation (DEWHA 2009). It is likely that fragmentation has impacted some threatened microbat species, although there is less information available regarding the impacts of fragmentation on microbats. Progressive rehabilitation of some mined areas back to woodland will help to address the impacts of fragmentation on native fauna.

6.3.2 Edge Effects

A consequence of habitat fragmentation is that it produces “edge effects”. Edge effects are impacts that occur at the interface between natural habitats, especially forests and disturbed or developed land (Yahner 1988). When an edge is created between 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 will result in edge effects where woodland is cleared to make way for infrastructure or mining. Due to edge effects, impacts extend beyond the mining areas, MIA and transport corridors into areas of adjacent woodland. 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.

Progressive rehabilitation of some mined areas back to woodland will help to mitigate edge effects on native fauna.

6.3.3 Noise

Noise can affect animal physiology and behaviour, and if it becomes an ongoing stress, it can be injurious to an animal's energy budget, reproductive success and long-term survival. There are other potential impacts that include habitat loss through avoidance, reduced reproductive success and a retreat away from favourable habitats (AMEC Americas Limited 2005).

Noise also affects the way that animal-created sounds are heard and interpreted by other animals. This can include mating calls, territorial calls and alarm calls. Interference with these calls by noise 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. 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 area (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.

6.3.4 Light

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

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. It is likely that most fauna species would habituate to the periodic disturbance and light pollution from the Project is unlikely to have a significant or long-term impact on any fauna species.

Artificial 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.

6.3.5 Vehicle Strike

Vehicle strike can pose a significant risk to some wildlife, particularly but not exclusively ground dwelling species (Taylor and Goldingay 2010). Koalas are 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.

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 animals as a result of vehicle strike is likely, 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.

6.3.6 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 Boundary, dust generated by the Project could impact vegetation within woodland communities, reducing health of some species along the edge of mined areas. It could also impact upon potential foraging resources for wildlife, including Koalas, threatened birds and microbats. 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. Standard dust minimisation strategies such as watering haul roads will be implemented to minimise the creation of dust.

6.3.7 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 (Harpstead et al. 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. During wet periods large volumes of rain would wash away any disturbed earth relatively easily. This would result in

sedimentation and increased turbidity of streams and would impact the aquatic environment. 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.

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

6.3.8 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. 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 cause problems for native fauna species by preying upon them or by competing with them for food and resources.

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) 2005I) 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.

6.4 Impacts to Regionally Significant Vegetation and Corridors

Regionally significant vegetation is considered by the Namoi CMA to comprise the following (Namoi CMA 2010):

- Native vegetation in riparian areas;

- Native vegetation that forms habitat for communities, populations or species listed by state or federal legislation as endangered or vulnerable (under the TSC Act) or critically endangered or conservation dependant (EPBC Act);
- Native vegetation that forms part of a corridor or linkage (min. 50m width);
- Native vegetation on recharge areas for salinity;
- Cultural heritage sites; and
- Native vegetation in creeks and rivers.

The Project Boundary contains vegetation that supports several threatened species and communities listed under the EPBC Act and the TSC Act, and accordingly these areas are considered to comprise regionally significant vegetation. Other areas of regionally significant vegetation occur nearby in Breeza State Forest. This area of forest is located directly adjacent to the south-western portion of the Project Boundary (see **Figure 1.1**). The Project will impact on regionally significant vegetation by removing areas of endangered communities and habitat for threatened species within the Disturbance Area.

A significant regional corridor between Breeza State Forest and Wondoba State Conservation Area has been identified by Taylor and Drielsma (Taylor and Drielsma 2012). This regional corridor forms a component of a large scale habitat corridor, called the Western Woodlands Way, which is centred along a chain of conservation reserves and associated remnants running in a north-south spine from Weddin Mountains National Park in the south to the Queensland border (Whitten et al. 2011). The corridor is currently fragmented, with larger stepping stones of habitat surrounded by agricultural land with some scattered trees, primarily along road corridors. The clearing of habitat within the Western Mining Area will remove an area of stepping stone habitat immediately to the north of Breeza State Forest. There is potential for the removal of this habitat to have a significant impact on a suite of native species moving across the landscape to and from Breeza State Forest. Such species that use corridors would include threatened woodland birds and bats recorded within the Project Boundary.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. These include minimising 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 including large areas of EECs and habitat for threatened species to be impacted by the Project. The offset strategy also includes the protection and revegetation of a large parcel of land that adjoins Breeza State Forest, immediately to the west of the Western Mining Area, extending further north to other stepping stone habitat. The revegetation of this area will commence prior to the impact occurring when clearance of the Western Mining Area takes place. 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 regionally significant vegetation.

6.5 Impacts on Threatened 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 either the TSC Act or the EPBC Act have been recorded within the Project Boundary during surveys conducted by GHD (2009) or surveys conducted by Cumberland Ecology.

There are however 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 and/or TSC 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 6.2** for TSC Act listed species and **Table 6.3** for EPBC Act listed species. Formal Assessments of Significance for ecological communities and flora are provided in **Appendix I**.

6.5.1 *Bothriochloa biloba*

Bothriochloa biloba 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 Lobed Blue-grass is limited due to the degree of degradation of the vegetation through grazing. Lobed Blue-grass 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, Lobed Blue-grass has a wide distribution and the Project Boundary is not located at the limits of its distribution. This is reflected by its delisting as a threatened species from the TSC Act due to extensive populations of this species in NSW. 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. 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. An assessment of significance for this species has been

conducted and is presented in **Appendix I**. This indicates that the Project is considered unlikely to result in a significant impact to *Bothriochloa biloba*.

6.5.2 *Dichanthium setosum*

Dichanthium setosum is listed as Vulnerable under both the EPBC Act and TSC 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. An assessment of significance for this species has been conducted and is presented in **Appendix I**. This indicates that the Project is considered unlikely to result in a significant impact to *Dichanthium setosum*.

6.5.3 *Digitaria porrecta*

Digitaria porrecta is listed as Endangered under both the EPBC Act and the TSC Act. There are seven records of *Digitaria porrecta* known 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) 2005d). 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 2008b). *Digitaria porrecta* also persists in fallow paddocks, but its capability to maintain a viable population is unknown (Halford 1995, SEWPaC 2011d).

Large areas of similar habitat occur in the locality outside of the Project Boundary that will not be affected by the Project. An assessment of significance for this species has been conducted and is presented in **Appendix I**. This indicates that the Project is considered unlikely to result in a significant impact to *Digitaria porrecta*.

6.5.4 *Cadellia pentastylis*

Cadellia pentastylis is listed as Vulnerable under both the EPBC Act and the TSC 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. An assessment of significance for this species has been conducted and is presented in **Appendix I**. This indicates that the Project is considered unlikely to result in a significant impact to *Cadellia pentastylis*.

6.5.5 *Swainsona murrayana*

Swainsona murrayana is listed as Vulnerable under both the EPBC Act and the TSC 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 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. An assessment of significance for this species has been conducted and is presented in **Appendix I**. This indicates that the Project is considered unlikely to result in a significant impact to *Swainsona murrayana*.

6.6 Impacts on Threatened Fauna Species

A number of listed threatened fauna species were recorded within the Project Boundary during recent surveys by Cumberland Ecology and GHD. Several additional threatened species 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 6.2** for TSC Act listed species and **Table 6.3** for EPBC Act listed species and is discussed in the following sections. Formal Assessments of Significance are provided in **Appendix I**.

6.6.1 *Birds*

i. Blossom-dependent Birds

The following blossom dependent bird species occur or have potential to occur in the woodland habitats of the Project Boundary. These are:

- Little Lorikeet (*Glossopsitta pusilla*) – recorded during recent surveys;
- Black-chinned Honeyeater (*Melithreptus gularis gularis*) – likely to occur;
- Painted Honeyeater (*Grantiella picta*) – likely to occur;
- Regent Honeyeater (*Anthochaera phrygia*) – potential to occur;

- Swift Parrot (*Lathamus discolor*) – potential to occur.

The Black-chinned Honeyeater has been recorded from near Lake Goran to the west of the Project Boundary, and Wallabadah to the south-east. The Painted Honeyeater has been recorded from near Gunnedah to the north of the Project, and south of Mullaley to the west. These blossom-dependent birds are likely to occur within islands of woodland foraging habitat within the predominantly cleared landscape.

Both the Regent Honeyeater and the Swift Parrot have the potential to occur within the Project Boundary, although they have not been recorded during recent surveys. Regent Honeyeaters have been recorded from near Quipolly and Goonoo Goonoo to the south-east and east of the Project Boundary, near Coolah Tops to the south and from Kelvin State Forest to the north (OEH 2012). 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 Boundary and from Wallabaddah Nature Reserve to the south-east (OEH 2012).

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 864 ha of woodland that provides potential foraging habitat for these blossom-dependent bird species. In the absence of appropriate mitigation measures this would represent the loss of locally important foraging and roosting habitat. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. 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 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 not expected that the Project will result in a significant impact to blossom-dependent birds.

ii. Woodland Birds

The following threatened woodland birds occur or have potential to occur in the woodland habitats of the Project Boundary:

- Brown Treecreeper (*Climacteris picumnus victoriae*) – recorded during recent surveys;
- Speckled Warbler (*Chthonicola sagittatus*) – recorded during recent surveys;
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) – recorded during recent surveys;
- Diamond Firetail (*Stagonopleura guttata*) – recorded during recent surveys;
- Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) – potential to occur;
- Varied Sittella (*Daphoenositta chrysoptera*) – potential to occur;
- Turquoise Parrot (*Neophema pulchella*) – potential to occur;
- Superb Parrot (*Polytelis swainsonii*) – potential to occur; and
- Bush Stone-curlew (*Burhinus grallarius*) – potential to occur.

These birds are dependent on woodland for their survival and although they may forage in areas of grassland, they seek shelter and breed in woodland. Woodland birds in NSW are declining, and some of the processes that are perceived to be most responsible for the decline are increasing fragmentation, and diminishing sizes of woodland patches in the fertile wheat belt of western NSW (Reid 1999). The species that are most at risk appear to be mainly ground-feeding, insectivorous, and sedentary passerine species (Reid 1999). These characteristics are likely render these woodland birds more susceptible to direct habitat loss and landscape fragmentation because they are less able to disperse to other patches of remnant woodland. Many woodland birds have limited capacity for dispersal, and it has been shown that the Brown Treecreeper has a maximum gap-crossing threshold of less than 100m (Cooper et al. 2002, Doerr et al. 2011), and Grey-crowned Babblers were recorded in a recent study moving less than 900m (Blackmore et al. 2011).

Reduction of woodland patches below a critical size can eliminate or significantly reduce the population of some species. Research into the capacity of Speckled Warblers to persist in fragmented habitat suggests that small isolated populations are most at risk of extinction in the long term; a study undertaken in Canberra suggested that the species was more likely to decrease in numbers in patches below 200 to 400 ha (Gardner and Heinsohn 2007).

Where populations are able to disperse to nearby patches, increasing intraspecific and interspecific competition for space and resources (e.g. Maron et al. (2011)) and increased exposure to predation (Ford 2011) can be significant factors contributing to continuing decline. Equally important to direct loss is the degradation of remaining patches of habitat from key threatening processes that facilitates further decline, including:

- Land degradation, particularly salinity, dieback and decreasing fertility (Watson 2011);
- Collection of timber for fuel wood;
- Grazing by feral herbivores and agricultural stock;
- Weed invasions;
- Loss of and competition for hollows;
- Lack of or limited regeneration in remnants; and
- Predation by feral carnivores.

Many woodland bird species are dependent on tree hollows for nesting. Such hollows take many decades to develop, with the largest hollows taking over 150 years on average to form (Mackowski 1984). In a closely related species to the Brown Treecreeper (i.e. the Rufous Treecreeper), the availability of nesting sites exerted a strong influence on habitat use (Luck 2002). 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 Brown Treecreeper.

The woodland communities within the Project Boundary are likely to constitute important local habitat for many of the threatened woodland birds detected or likely to occur here. Although small woodland birds are largely restricted to woodland habitats and are generally reluctant to cross open grassland, the presence of scattered paddock trees throughout the Project Boundary is likely to facilitate some dispersal between patches of woodland vegetation and the adjacent Breeza State Forest. This is an important factor for the persistence of these woodland bird species in the long term, including reducing inbreeding depression (Sunnucks 2011).

The Project would remove 864 ha of habitat for woodland-dependent birds. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. These include 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 within the Project Boundary and in the locality of the Project Boundary, within offset areas, and the rehabilitation of mined lands within the Project Boundary will ensure that foraging habitat is maintained or increased for woodland birds 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 woodland birds.

iii. Raptors

The following raptors listed as Vulnerable under the TSC Act have been recorded or have the potential to occur within the Project Boundary:

- Spotted Harrier (*Circus assimilis*) – recorded during recent surveys;
- Little Eagle (*Hieraaetus morphnoides*) – recorded during recent surveys;
- Barking Owl (*Ninox connivens*) – recorded within the Project Boundary by GHD;
- Square-tailed Kite (*Lophoictinia isura*) – potential to occur;
- Black-breasted Buzzard (*Hamirostra melanosternon*) – potential to occur; and
- Masked Owl (*Tyto novaehollandiae*) – potential to occur.

Raptors are typically reliant on very large territories for foraging and nesting. Many species occupy a large home range that includes both remnant forest/woodland and grassland habitats (Debus 1984) and are generally tolerant of agricultural landscapes providing there is some woodland habitat available for nesting (Marchant and Higgins 1993).

Species such as the Little Eagle hunt primarily rabbits in disturbed areas but in undisturbed habitat the prey species also includes marsupials and birds (Olsen et al. 2010). The Masked Owl is also tolerant of disturbed areas and has a close association with drier, unlogged, or selectively logged forests (Newton et al. 2002). Thus, the vegetation within the Project Boundary is likely to support both potential breeding sites (tall remnant trees) and foraging resources (abundant mammal and bird prey) for the Little Eagle and the Masked Owl.

Owl species are typically reliant on large tree hollows for nesting. Large hollow-bearing trees in woodland communities are a limiting resource in fragmented and disturbed landscapes. There are few large hollows within the Project Boundary due to the immaturity of the majority of the woodland vegetation, and it does not provide an important source of hollows.

The Project will remove 864 ha of woodland habitat and 3,157 ha of grassland habitat that provides suitable forage and nesting habitat for raptors and owls. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. 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 raptors and owls 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 raptors and owls.

iv. *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:

- Regent Honeyeater (*Anthochaera phrygia*);
- 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 Regent Honeyeater is also listed as Endangered and under the EPBC Act and as Critically Endangered under the TSC Act. Impacts to this species are addressed in **Section 6.6.1.i**.

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. 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.

6.6.2 *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.

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*). However the primary feed species for Koalas in the locality is the River Red Gum (*Eucalyptus camaldulensis*) which does not occur within the Project Boundary.

The Project would clear approximately 847 ha of preferred habitat, resulting in a sizeable loss of foraging resources for Koalas in the locality. Preferred habitat includes vegetation communities dominated by trees in the Eucalypt genus. In particular the Project would 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 7** and **Chapter 8**, respectively. These include minimising clearing of woodland, pre-clearance surveys to relocate individuals and rehabilitation of vegetation within the Project Boundary. A Project specific KPOM is provided in Appendix L of the EIS.

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 secondary 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. 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 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. A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. These include 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 offset areas. 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 Spotted-tailed Quoll.

iii. *Microchiropteran Bats*

A number of threatened microbats have been recorded or have the potential to occur within the Project Boundary. These are:

- Yellow-bellied Sheath-tail Bat (*Saccolaimus flaviventris*) – recorded during recent surveys;
- Eastern Freetail-bat (*Mormopterus norfolkensis*) – potential to occur;
- Little Pied Bat (*Chalinolobus picatus*) – potential to occur;
- Eastern Cave Bat (*Vespadelus troughtoni*) – potential to occur;
- Large-eared Pied Bat (*Chalinolobus dwyeri*) – potential to occur; and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*) – potential to occur.

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 Yellow-bellied Sheath-tail Bat, Eastern Freetail-bat, South-eastern Long-eared Bat and the Little Pied Bat. The Project is likely to impact on the Eastern Cave Bat and the Large-eared Pied Bat to a lesser extent, as these species roost in rocky outcrops, and the only significant rocky outcrops within the Project Boundary that are likely to provide suitable shelter habitat for these species (e.g. Mt. Watermark) will not be impacted by the Project.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. These include 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 offset areas. 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 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 microbat species.

iv. *Squirrel Glider*

The Squirrel Glider was not recorded during recent surveys. However, Atlas of NSW Wildlife records from near Gunnedah combined with the presence of suitable habitat indicate that this species has the potential to occur within the Project Boundary

Without mitigation, the Project will remove 864 ha of woodland vegetation providing potential habitat for the Squirrel Glider, including tree hollows used for shelter and extensive areas of forage habitat. Pre-clearing surveys and other measures will be required to mitigate impacts on the Squirrel Glider during the clearing phase of the Project. The rehabilitation of woodland vegetation within the Project Boundary following mining operations will provide foraging and shelter habitat for the Squirrel Glider in the long term.

6.6.3 *Reptiles*

No threatened reptile species were recorded within the Project Boundary during recent surveys, however several threatened reptiles have been recorded from in and near the Gunnedah LGA and habitat assessment indicates that the following have potential habitat within the Project Boundary:

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

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, Five-clawed Worm-skink, and the Pale-headed Snake, including tree hollows used for shelter by the Pale-headed Snake and extensive areas of forage habitat for the other species. 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.

A range of impact avoidance, mitigation and compensation measures have been developed for the Project and these are presented in **Chapter 7** and **Chapter 8**, respectively. These include 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

extensive areas 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.

6.7 Summary of Impacts to TSC Act and EPBC Act Species and Communities

The following tables present a summary of the potential impacts on threatened species and ecological communities listed under the TSC Act (**Table 6.2**) and the EPBC Act (**Table 6.3**) based on the potential impacts to species and communities' habitat.

Table 6.2 Summary of Project Impacts on TSC Act Listed Ecological Communities and Threatened Species							
Ecological Communities and Threatened Species	TSC Act Status	LGA Count [#]	Occurrence within Project Boundary	Preferred Habitat within Project Boundary [^]	Total Area in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
ECOLOGICAL COMMUNITIES							
Box Gum Woodland and Derived Native Grassland	EEC		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	n/a*
Fuzzy Box Woodland	EEC		Known		36	18	18
FLORA							
<i>Dichanthium setosum</i>	Vulnerable	9	Potential	W,G	9,360	4,021	5,339
<i>Digitaria porrecta</i>	Endangered	8	Potential	W,G	9,360	4,021	5,339
<i>Cadellia pentastylis</i>	Vulnerable	2	Potential	W	1,997	864	1,133
<i>Swainsona murrayana</i>	Vulnerable	0	Potential	W,G	9,360	4,021	5,339
BIRDS							
Little Lorikeet	Vulnerable	29	Known	W	1,997	864	1,133

Table 6.2 Summary of Project Impacts on TSC Act Listed Ecological Communities and Threatened Species							
Ecological Communities and Threatened Species	TSC Act Status	LGA Count [#]	Occurrence within Project Boundary	Preferred Habitat within Project Boundary [^]	Total Area in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
Brown Treecreeper	Vulnerable	35	Known	W	1,997	864	1,133
Speckled Warbler	Vulnerable	30	Known	W	1,997	864	1,133
Grey-crowned Babbler	Vulnerable	35	Known	W	1,997	864	1,133
Diamond Firetail	Vulnerable	6	Known	W	1,997	864	1,133
Spotted Harrier	Vulnerable	4	Known	W, G	9,360	4,021	5,339
Little Eagle	Vulnerable	7	Known	W, G	9,360	4,021	5,339
Barking Owl	Vulnerable	6	Known	W, G	9,360	4,021	5,339
Painted Honeyeater	Vulnerable	1	Potential	W	1,997	864	1,133
Black-chinned Honeyeater	Vulnerable	1	Potential	W	1,997	864	1,133
Regent Honeyeater	Critically Endangered	1	Potential	W	1,997	864	1,133
Swift Parrot	Endangered	1	Potential	W	1,997	864	1,133
Hooded Robin	Vulnerable	11	Potential	W	1,997	864	1,133
Varied Sittella	Vulnerable	5	Potential	W	1,997	864	1,133
Turquoise Parrot	Vulnerable	26	Potential	W	1,997	864	1,133
Superb Parrot	Vulnerable	0	Potential	W	1,997	864	1,133
Bush Stone-curlew	Endangered	1	Potential	W	1,997	864	1,133

Table 6.2 Summary of Project Impacts on TSC Act Listed Ecological Communities and Threatened Species							
Ecological Communities and Threatened Species	TSC Act Status	LGA Count [#]	Occurrence within Project Boundary	Preferred Habitat within Project Boundary [^]	Total Area in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
Square-tailed Kite	Vulnerable	5	Potential	W, G	9,360	4,021	5,339
Black-breasted Buzzard	Vulnerable	1	Potential	W, G	9,360	4,021	5,339
Masked Owl	Vulnerable	3	Potential	W, G	9,360	4,021	5,339
MAMMALS							
Koala	Vulnerable	720	Known	W	1,883	847	1,036
Spotted-tailed Quoll	Vulnerable	11	Potential	W	1,997	864	1,133
Squirrel Glider	Vulnerable	4	Potential	W	1,997	864	1,133
Yellow-bellied Sheathtail Bat	Vulnerable	20	Known	W	1,997	864	1,133
Eastern Freetail-bat	Vulnerable	1	Potential	W	1,997	864	1,133
Little Pied Bat	Vulnerable	3	Potential	W	1,997	864	1,133
Eastern Cave Bat	Vulnerable	5	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
REPTILES							
Border Thick-tailed Gecko	Vulnerable	2	Potential	W	1,997	864	1,133

Table 6.2 Summary of Project Impacts on TSC Act Listed Ecological Communities and Threatened Species							
Ecological Communities and Threatened Species	TSC Act Status	LGA Count [#]	Occurrence within Project Boundary	Preferred Habitat within Project Boundary [^]	Total Area in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
Five-clawed Worm-skink	Endangered	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
Pale-headed Snake	Vulnerable	1	Potential	W	1,997	864	1,133

[#]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

Table 6.3 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 in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area 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	n/a*
PLANTS							
<i>Bothriochloa biloba</i>	Vulnerable	21	Known	W,G	9,360	4,021	5,339
<i>Dichanthium setosum</i>	Vulnerable	9	Potential	W,G	9,360	4,021	5,339
<i>Digitaria porrecta</i>	Endangered	8	Potential	W,G	9,360	4,021	5,339
<i>Cadellia pentastylis</i>	Vulnerable	2	Potential	W	1,997	864	1,133
<i>Swainsona murrayana</i>	Vulnerable	0	Potential	W,G	9,360	4,021	5,339
BIRDS							
White-bellied Sea-eagle	Migratory	2	Known	G	7,362	3,157	4,206

Table 6.3 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 in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
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	7,362	3,157	4,206
Great Egret	Migratory	0	Potential	G	7,362	3,157	4,206
MAMMALS							
Koala	Vulnerable	720	Known	W	1,883	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
REPTILES							

Table 6.3 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 in Project Boundary (ha)	Area Cleared within the Project Boundary (ha)	Area Remaining within the Project Boundary (ha)
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

6.8 Impacts to the Aquatic Environment

The Project has very low potential to impact on the aquatic environment as the majority of the Project Boundary does not occur in the vicinity of any aquatic ecosystem, with the exception of several degraded farm dams and ephemeral waterways. The Project includes two pipeline options from the Mooki River to the Project Boundary (see **Figure 1.1**). The Mooki River is listed as an EEC under the FM Act (The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River), and the potential ecological impacts of water extraction from this river are discussed below.

6.8.1 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. Sediment control and bank stabilisation measures should be implemented where necessary to prevent any effects of erosion and runoff into the Mooki River at the pipeline sites. No significant impact is predicted on threatened flora and fauna or the aquatic EEC from the Project.

6.8.2 Impacts of Water Extraction

Water extraction from the Mooki River may occur periodically for the Project. This would 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 removing water from 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 Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources (DIPNR 2005) (Barma Water Resources and Thurtell 2012). This includes rules for protecting the environment, extractions, managing licence holders' water accounts, and water trading in the plan area. The provisions in the Water Sharing 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 Water Sharing 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 to the aquatic EEC 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 the portion of the Mooki River adjacent to the Project Boundary is 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 pump intake; however no threatened invertebrates were recorded in the aquatic surveys undertaken in 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.

6.9 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 7** and **Chapter 8**, respectively. 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 potential 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.

6.10 Cumulative Impacts

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 and Fischer 2006). Direct and indirect impacts that may be considered insignificant on their own may be significant when considered together with other actions being undertaken as part of the Project, or with other similar projects in the locality.

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. These processes are still occurring and impacting the habitat both within the Project Boundary and locality. The primary impact of the previous clearing is the loss of extensive areas of habitat and fragmentation of wildlife corridors. The vegetation

clearance that will occur as a result of the Project will exacerbate these existing ecological impacts if left unmitigated.

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), located 15km 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. 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 DoPI 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 is 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 biodiversity in the region by clearing substantial areas of vegetation and habitat. 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 for the Project, further development within the locality will also result in cumulative impacts on flora and fauna as 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 aforementioned developments in this section offer mitigation or compensatory measures, including proposals to rehabilitate mined areas and return them to forest and woodland. The mined landscapes 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 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 proposed biodiversity offsetting by the Project are provided in **Chapter 8**.

Despite these cumulative impacts, the Project is unlikely to directly threaten the occurrence of the vegetation and habitat recorded within the Project Boundary. Large areas of native vegetation will remain both within and surrounding the Project Boundary, including areas within Breeza State Forest and surrounding rural areas. Some vegetation communities that will be impacted by the Project, particularly the CEEC Box Gum Woodland and Derived Native Grassland, are not well represented within secure tenures, particularly conservation reserves. However, this situation is likely to change within the locality and subregion (the Liverpool Plains Subregion) in the near future because a number of mining projects have proposed to establish permanent biodiversity offsets containing Box Gum Woodland and Derived Native Grassland and other closely related vegetation. A comprehensive biodiversity offset strategy has been prepared for the Project and is presented in **Chapter 8**. The offsetting arrangements will both protect existing forest and woodland communities and restore vegetation, 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.

6.11 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, a large portion of 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 life of the Project, 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 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, a large portion of the mined areas will be revegetated to forest and woodland using local provenance species in the long term.

6.12 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.

A large portion of the 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 to be possible to recreate the communities that previously existed in these areas.

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 Area by rehabilitating mined areas, and increase the area of woodland by the strategic acquisition of lands in surrounding areas for biodiversity offsets (see **Chapter 8**).

6.13 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 State and Commonwealth legislation. These areas of woodland also provide biodiverse habitats and important habitat resources for a wide range of species including several listed under the TSC Act and 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 7** and **Chapter 8**, respectively. 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 this 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 threatened species or ecological communities.

Chapter 7

Impact Mitigation

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 considerations for reducing the ecological impacts of the Project follow the NSW Government principles for the use of biodiversity offsets in NSW (DECC 2008b), and 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 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 7.4**.

The structure of this chapter is as follows:

- Measures to Avoid Impacts (**Section 7.1**);

- Measures to Mitigate Impacts (**Section 7.2**);
- Monitoring (**Section 7.3**); and
- Biodiversity Management Plan (**Section 7.4**).

A comprehensive Biodiversity Offset Package (BOP) has been provided in **Chapter 8** 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.

7.1 Measures to Avoid Impacts

Open cut mining projects cannot readily avoid impacts where mineral resources are beneath flora and fauna habitats. However, avoidance can be achieved to varying degrees by modification of the design and location of Project associated infrastructure away from natural habitats where feasible. Wherever possible, risks of environmental impacts have been avoided through the overall Project design itself. At the local scale some of the avoidance measures are discussed below.

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. 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.

7.2 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 summarises the proposed mitigation measures.

7.2.1 General Mitigation Measures

A suite of general environmental control measures will be implemented for the Project which will help to protect the ecology of the site. These general measures are outlined within **Table 7.1**.

Table 7.1 Summary of Proposed General Mitigation Measures at Watermark	
Mitigation Measures	General Ecological Benefits
Dust minimisation	Reduces the indirect impacts on vegetation condition and the habitat quality for all native species.
Noise minimisation	Benefits fauna by reducing the potential for disturbance of animals in habitat patches around the Project.
Management of surface water, erosion and sedimentation	Protects the integrity of the landscape.
Due diligence inspections for proposed disturbance areas	Provides data for ongoing adaptive management and protection of adjacent landscape areas if required.
Visual and lighting management	Benefits fauna by reducing the potential for disturbance of nocturnal animals via night light emissions around the Project.

Additional mitigation measures specific to ecology that will be implemented include; minimising vegetation and habitat loss, and vegetation restoration and rehabilitation, and these are discussed in subsequent subheadings below.

7.2.2 Minimising Vegetation and Habitat Loss

During the detailed design stage, opportunities to further minimise vegetation disturbance should be considered. However, disturbance to areas of native vegetation and habitat is likely to be largely unavoidable during the construction and mining operation process. In order to minimise clearing impacts and unnecessary disturbance to native vegetation, the following procedures should 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 should not be disturbed; and
- Ancillary facilities such as stockpile sites, site compounds and construction zones should not be located beyond the limits of clearing.

Where clearing of vegetation and fauna habitats will take place, clearing protocols should 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.

7.2.3 Minimising Aquatic Impacts during Water Extraction

It is considered unlikely that many native fish species, including threatened species, occur in the Mooki River although it is possible that some of the species occur further downstream in the Namoi River. As such, native fish species are not considered likely to be adversely impacted by water extraction at the proposed extraction site. However, to minimise any risks, the Water Sharing Plan (DIPNR 2005) and general mitigation measures should be adhered to.

Such mitigation measures, including various pipeline design approaches and operational precautions that can be employed to minimise any potential impacts to fish and larvae are summarised below (Turnpenny 1998, Baumgartner 2007, Baumgartner 2009, Cardno Ecology Lab 2012). These are considered consistent with current research findings and of factors assessed of similar SSDs in the region.

Fish screening measures, whether mechanical or behavioural, will minimise the potential entry of fish and aquatic invertebrates into the intake pipeline. As summarised in Turnpenny et al. (1998), fish screening involves three conditions:

- A structure or stimulus that will allow fish to detect its approach to the intake valve and redirect their path (e.g. lighting);
- The escape velocity (water velocity against which fish must swim to escape) must be within its swimming capability; a widely accepted standard velocity that would

suit the native fish species with potential to occur in the Mooki River should be adopted; and

- A suitable bypass or escape option must be provided for fish that do become entrained.

Other mitigation measures include:

- Install mesh screens at the intake pipeline opening to minimise the potential for fish, larvae and eggs to be drawn into the intake valve (a variety of design plans are provided in Turnpenny et al. (1998), the most appropriate of which should be determined by the Proponent after pipeline details are finalised);
- Where necessary, use bank stabilisation techniques at the pipeline sites, including revegetation, geotextiles and sediment fences, to minimise erosion and runoff into the Mooki River;
- Avoid buildup of aquatic debris, and thus potential fish, aquatic invertebrate and bird habitat, around the pipelines; and
- Start the pump at a reduced velocity to minimise the likelihood of fish and other aquatic fauna becoming entrained.

Regular long-term monitoring at, upstream and downstream of the pipeline locations is advised to determine whether the Project has any adverse impacts on water quality and aquatic life, and modifications made where necessary. Regular upkeep and cleaning of the pipeline and mesh screens is also required to prevent colonisation and blockages by algae and invertebrates on the new substrate and ensure fish are not being injured or otherwise impacted.

7.3 Monitoring

A monitoring program should 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 8**), including both vegetation monitoring and threatened species monitoring. This will provide feedback data to determine the level of success of the mitigation and amelioration measures. The proposed monitoring program includes 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 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.

7.3.1 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 (see **Section 7.3.3**). 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. More specific details of the vegetation monitoring strategy will be contained in the BMP.

7.3.2 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.

Threatened species monitoring will:

- 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).

7.3.3 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.

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.

7.4 Biodiversity Management Plan

In order to provide a comprehensive framework for the implementation of the proposed biodiversity impact mitigation and offset measures, a BMP should 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 should 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 BMP should 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 should 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 should 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 should 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 should be guided by best practice guidelines and should 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 should 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 should 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 should 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 should include post-mining land use, conceptual final landform design, and rehabilitation methodology.

Chapter 8

Biodiversity Offsetting

8.1 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, preferably 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 7** have been implemented.

Shenhua Watermark will fund the final BOP as determined by the Regional Biodiversity Strategy Committee and relevant government agencies.

8.2 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, 33.7:1 for other EECs and 31.9:1 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 (e.g. 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.

8.3 Biodiversity Offsets Package

8.3.1 Introduction

The avoidance and mitigation measures described in the **Chapter 7** 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 through the direct and indirect impacts described in **Chapter 6**. 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;

- BioBanking Assessments: Use of BioBanking methods to calculate the areas of offsets required based upon GIS measurements and the algorithms within the BioBanking software. This method measures offsets in terms of “credits” which are not specific areas and which are influenced not only by areas but by connectivity and condition of habitats within impact areas and proposed offsets ; and
- Offset Principles: OEH and SEWPaC have guidelines for offsetting that each set out principles that offsets should follow. Proposed offset packages can 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 in NSW 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. Recent mining projects in 2011 and 2012 have calculated their offset requirements in this way, such as the Ulan mining and Duralie mining projects approved by the Land and Environment Court in 2011, and the Warkworth mining project approved by the Minister of Planning in 2012.

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 native grassland, including several communities listed as threatened under the EPBC Act and/or TSC Act, that will be disturbed and which requires to be offset. This includes approximately 738 ha of Box Gum Woodland and Derived Native Grassland, 30 ha of Inland Grey Box Woodland, 3 ha of Weeping Myall Woodland and 18 ha of Fuzzy Box Woodland. Highly modified vegetation (Low Diversity Grassland, Planted & Exotic Pasture) and cleared areas (roads, dams, buildings etc) totalling 3,417 ha will not require offsetting.

For the purpose of establishing minimum area thresholds for the BOP, a ratio of 5:1 for State and 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 ratio is targeted towards compensating the direct loss of vegetation and habitat as well as potential indirect impacts. 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 C/EEC. A summary of the minimum offsetting requirements for the Project is provided in **Table 8.1**.

Table 8.1 Total Offset Areas Required for the Project			
Vegetation Community	Disturbance Area (ha)	Ratio	Offset Required (ha)
White Box Grassy Woodland (C/EEC)	517		
Regenerating White Box Grassy Woodland (CEEC)	28		
Blakely's Red Gum Grassy Woodland (C/EEC)	89		
Regenerating Blakely's Red Gum Grassy Woodland (CEEC)	17		
Yellow Box Grassy Woodland (C/EEC)	14		
Derived Native Grassland (C/EEC)	73		
<i>Subtotal Box Gum Woodland (C/EEC)</i>	738	5:1	3,690
Inland Grey Box Grassy Woodland (EEC)	30		
Weeping Myall Woodland (EEC)	3		
Fuzzy Box Woodland (TSC - EEC)	18		
<i>Subtotal Other EEC</i>	51	5:1	255
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		
<i>Subtotal Other Woodland</i>	148	5:1	740
Low Diversity Grassland, Planted & Exotic Pasture	3,084		
Cleared Areas (roads, dams, buildings, etc.)	63		
<i>Subtotal Other</i>	3,147	n/a	n/a
TOTAL	4,084		4,685

ii. BioBanking Assessments

BioBanking assessments are undertaken where a person or agency is considering using BioBanking to trade in ecological “credits” for a proposed development. The BioBanking Assessment Methodology (BBAM) provides rules and software for calculating the number and type of credits that a development site will require in order to offset its impacts and thus improve or maintain biodiversity values. “Credits” are the currency used within BioBanking and they are not specifically area measurements. Rather, they are a measure of the current quality of habitat for threatened flora and fauna. The methodology also provides rules for the number and type of credits that can be created from undertaking conservation management at a BioBank site (offset).

The BioBanking method is focussed on trades of like for like habitats where higher credit scores are obtained for habitats in better ecological condition and where habitats are larger and better connected to other habitat areas. This is because the method is based upon the premise that larger better connected habitats will afford more habitat to threatened species.

Under Part 4 of the EP&A Act, there is no legal requirement for a proponent to undertake BioBanking assessments and Shenhua Watermark has not elected to have the Project assessed under BioBanking legislation. Nevertheless, BioBanking assessments have been undertaken for the Project to objectively assist in determining the quantum of offsets required. BioBanking surveys followed the methodology provided within the Biobanking Operational Manual (DECC 2009).

A conservative approach has been taken for the BioBanking Assessment, in that the impacts have been assessed for the entire Disturbance Boundary, not just the Disturbance Area. Ten BioBanking Vegetation Types were assessed as impacted within the Disturbance Boundary. All vegetation types and associated forms, including woodland, regenerating woodland and derived native grassland, were assessed as being in Moderate/Good condition. A summary of the ecosystem credits required for the Project is provided in **Table 8.2**. When assessed using the BBAM, the Project requires 71,272 ecosystem credits. Of this, 49,336 ecosystem credits are required for Box Gum Woodland and Derived Native Grassland, 6,208 ecosystem credits are required for other EECs and 15,728 ecosystem credits are required for other native vegetation.

As shown in **Table 8.2**, the Project requires 60 credits/hectare for Box Gum Woodland and Derived Native Grassland, 63 credits/hectare for other EECs and 55 credits/hectare for other native vegetation. If these average credits/hectare are were applied to the area of vegetation within the Disturbance Area, the Project would require 44,280 ecosystem credits for Box Gum Woodland and Derived Native Grassland, 3,213 ecosystem credits for other EECs and 8,140 ecosystem credits are required for other native vegetation.

Table 8.2 Total BioBanking Ecosystem Credits Required for the Project				
Vegetation Community	BioBanking Vegetation Type	Disturbance Boundary (ha)	Required Credits	Required Credits/ha
White Box Grassy Woodland (C/EEC)	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions - NA226	595.11	39,155	66
Regenerating White Box Grassy Woodland (CEEC)	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions - NA226	28.13	1,445	51
Blakely's Red Gum Grassy Woodland (C/EEC)	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion - NA237	89.12	4,900	55
Regenerating Blakely's Red Gum Grassy Woodland (CEEC)	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion - NA237	17.27	699	40
Yellow Box Grassy Woodland (C/EEC)	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion - NA237	15.84	871	55
Derived Native Grassland (C/EEC)	White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions - NA226	15.42	482	31
	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion - NA237	57.12	1,784	31
Subtotal Box Gum Woodland (C/EEC)		818.01	49,336	60
Inland Grey Box Grassy Woodland (EEC)	Inland Grey Box tall grassy woodland on clay soils in the Brigalow Belt South and Nandewar Bioregions (Benson 81) - NA146	55.36	3,443	62
Weeping Myall Woodland (EEC)	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions - NA219	11.58	536	46
Fuzzy Box Woodland (TSC - EEC)	Fuzzy Box on loams in the Nandewar Bioregion and northern Brigalow Belt South Bioregion - NA141	32.12	2,229	69
Subtotal Other EEC		99.06	6,208	63

Table 8.2 Total BioBanking Ecosystem Credits Required for the Project				
Vegetation Community	BioBanking Vegetation Type	Disturbance Boundary (ha)	Required Credits	Required Credits/ha
Poplar Box Woodland	Poplar Box - Belah woodland on clay-loam soils of the alluvial plains of north-central NSW (Benson 56) - NA182	140.00	8,201	59
Belah Woodland	Belah woodland on alluvial plains in central-north NSW - NA102	3.54	182	51
Whitewood Woodland	Whitewood open woodland of the subtropical sub-humid plains - NA234	18.79	700	37
Tumbledown Red Gum Grassy Open Woodland	White Cypress Pine - Silver-leaved Ironbark grassy woodland of the Nandewar Bioregion - NA230	31.59	1,623	51
White Box Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions - NA225	30.92	2,257	73
Regenerating White Box Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions - NA225	52.91	2,336	44
Blakely's Red Gum Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions - NA225	5.87	429	73
Subtotal Other Woodland		283.62	15,728	55
Low Diversity Grassland, Planted & Exotic Pasture	n/a	4,328.12	0	0
Cleared Areas (roads, dams, buildings, etc.)	n/a	100.86	0	0
Subtotal Other		4,428.98	0	0
TOTAL		1,200.69	71,272	59

iii. Consistency with OEH and SEWPaC Principles of Offsets

Principles for the use of biodiversity offsets have been developed by both OEH and SEWPaC. For biodiversity offsets to be considered 'appropriate', these principles must be adhered to where possible. Key offsetting principles considered in the development of the BOP include:

- Offsets should be targeted to the ecological communities and threatened species that will be impacted by the Project;
- Offsets should be commensurate with the magnitude of the impacts; and
- Offsets should aim to result in a net improvement in biodiversity over time.

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 8.9.3**.

8.3.2 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 BOP has been designed to meet State and Commonwealth offsetting requirements and protect and improve biodiversity within the locality with the most efficient utilisation of resources.

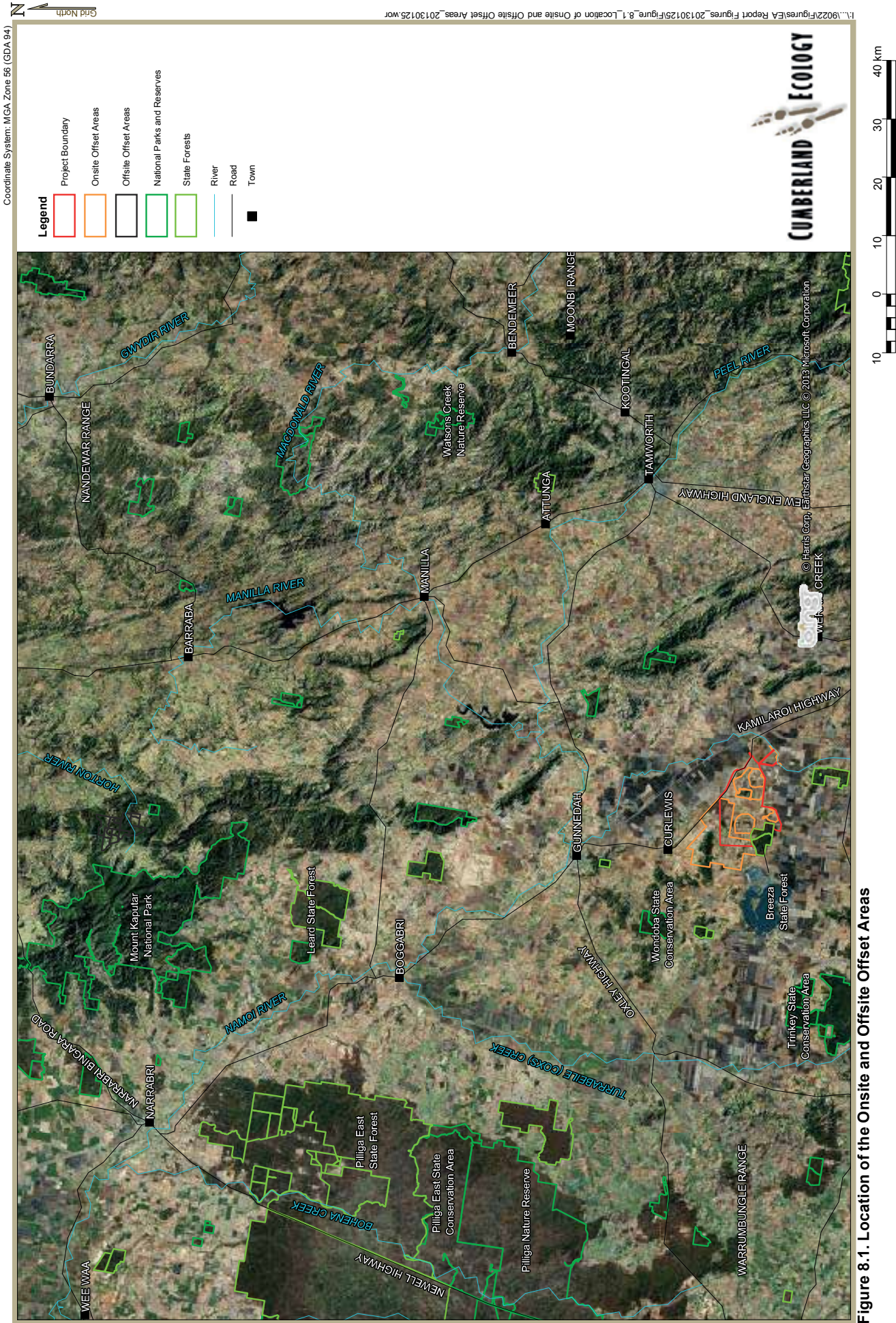
The current composition of the BOP includes:

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 8.4, 8.5 and 8.8**, 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 composition, design and management of the Onsite Offset Areas will assist in offsetting the direct, indirect and potential cumulative impacts of the Project. 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 Offset Areas and Offsite Offset Areas are shown in **Figure 8.1**.



8.4 Onsite Offset Areas

8.4.1 Location

The Onsite Offset Areas are located both within and immediately adjacent to the Project Boundary (see **Figure 8.1**). 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.

8.4.2 Vegetation

The vegetation within the Onsite Offset Areas has been subject to numerous site inspections and mapping. **Table 8.3** lists the vegetation communities currently occurring within the Onsite Offset Areas (excluding the Mine Rehabilitation Area), their TSC Act and 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 3.1.2**. One community not recorded within the Project Boundary was recorded within Offset Area 6 and is described below. The distribution of vegetation communities within the Onsite Offset Areas is shown in **Figure 8.2**.

i. Inclusion of Agricultural Land

The best quality Koala habitat occurs within fertile, relatively well watered landscapes that are also good farmland. This creates an issue for determining offsets for Koala habitat and for some types of EECs because to create such offsets requires revegetation and conservation management of good farmland.

DP&I has released a Strategic Regional Land Use Policy Package that includes mapping of Strategic Agricultural Land (SAL), highly productive land that has been deemed to have unique natural resource characteristics, across the Upper Hunter and New England North West regions of NSW (Department of Planning and Infrastructure 2012). The Onsite Offset Areas have 375 ha of validated and 321 ha of site verified Biophysical Strategic Agricultural Land (BSAL), meaning the land potentially has inherent high agricultural qualities, which may include certain land and soil capability standards and/or reliable water access (Department of Planning and Infrastructure 2012).

BSAL land within the Onsite Offset Areas occurs on the very western edge of the patch mapped south of Curlewis on the southern side of the Kamilaroi Highway. The rehabilitation

of BSAL land to woodland that will conform to TSC Act and EPBC Act ecological communities and Koala habitat is not considered a significant loss of agricultural productivity in a regional context, particularly when 1,525,462 ha of BSAL have been mapped across the New England North West region.

Avoiding locating the Onsite Offset Areas on BSAL land has been considered; however, as there are limited opportunities for conservation of large patches of high quality Koala habitat (including remnant Box Gum Woodland on fertile soils) elsewhere in the locality, options to recreate these communities within modified landscapes already owned by the Proponent, and subject to permanent biodiversity conservation and management, are viable options.

The entirety of Offset Areas 6, including BSAL areas, is included due to its inherent value in providing foundation areas for proposed revegetation works. As previously noted, a number of the EECs to be impacted by the Project are threatened because extensive areas of grassy woodland communities have historically been cleared and modified, largely as a result of agricultural practices. This is due to their higher soil fertility and typically flat or gently undulating land form, which is suitable for intensive cropping and grazing. In order to recover such EECs, including Box Gum Woodland and Derived Native Grassland, that occurs as isolated patches amidst an extensively cleared agricultural setting, and increase the ecological integrity and biodiversity of the locality and region it is essential to recover some farmlands. It should also be noted that restoration of these BSAL areas will also provide future habitat for species such as the Koala, which shows a strong association with feed trees growing on the more fertile slopes and plains of the Project Boundary.

Table 8.3 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)	
White Box Grassy Woodland (C/EEC)	166	451	0	617	
Blakely's Red Gum Grassy Woodland (C/EEC)	0	103	0	103	
Yellow Box Grassy Woodland (C/EEC)	0	37	0	37	
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*	
Fuzzy Box Woodland	0	4	0	4	
Subtotal Other EEC	0	46	0	46	
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	

Table 8.3 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)	
Blakely's Red Gum Motherumbah Shrubby Woodland	0	15	0	15	
Dwyer's Red Gum Woodland	0	13	0	13	
Subtotal Other Woodland	52	1,128	0	1,180	
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

a. Dwyer's Red Gum Woodland

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Dwyer's Red Gum woodland on siliceous substrates in the Brigalow Belt South Bioregion (Benson 187) (NA138)

Keith Vegetation Class: Western Slopes Dry Sclerophyll Forests

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 8.1**). 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 8.1 **Dwyer's Red Gum Woodland**

8.4.3 *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 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 4.1**.

The habitats available within the Onsite Offset Areas provide potential habitat for a suite of species listed under the TSC Act and/or EPBC Act. The following threatened fauna species have been recorded during surveys of the Onsite Offset Areas:

- Diamond Firetail (*Stagonopleura guttata*);
- Grey-crowned Babbler (*Pomatostomus temporalis temporalis*);
- Brown Treecreeper (*Climacteris picumnus*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Speckled Warbler (*Chthonicola sagittatus*);
- Little Eagle (*Hieraaetus morphnoides*)
- Spotted Harrier (*Circus assimilis*);
- Barking Owl (*Ninox connivens*);
- Koala (*Phascolarctos cinereus*); and
- South-eastern Long-eared Bat (*Nyctophilus corbeni*).

The locations of these species within the Onsite Offset Areas are provided in **Figure 8.3**. 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 properties provide potential shelter, roosting and nesting habitat for threatened microbats including the Large-eared Pied Bat (*Chalinolobus dwyeri*) and Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*). Foraging and nesting resources are also available for a range of threatened bird species such as the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*).





Figure 8.3. Threatened Species Recorded within the Onsite Offset Areas

8.5 Offsite Offset Areas

8.5.1 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 8.1**). 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.

8.5.2 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 8.4 lists the vegetation communities currently occurring within the Offsite Offset Areas, their TSC Act and 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 8.4**.

Table 8.4 Vegetation Communities Occurring within the Offsite Offset Areas			
Vegetation Community	Clonmeen Offset Area (ha)	Aandra Offset Area (ha)	Total Offsite Offset Areas (ha)
White Box/Blakely's Red Gum/Yellow Box Woodland (C/EEC)	130	144	274
Derived Native Grassland (C/EEC)	0	301	301
Subtotal Box Gum Woodland (C/EEC)	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 8.4 Vegetation Communities Occurring within the Offsite Offset Areas			
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 (EEC)

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (BR252)

Keith Vegetation Class: Western Slopes Grassy Woodlands

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 8.2** and **Photograph 8.3**.

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 8.2 **White Box, Yellow Box, Blakely's Red Gum Grassy Woodland (Clonmeen Offset Area)**



Photograph 8.3 **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

TSC Act Status: Not listed

BioBanking Metric: Blakely's Red Gum - Rough-barked Apple - Red Stringybark grassy open forest of the western New England Tablelands (BR114)

Keith Vegetation Class: New England Grassy Woodlands

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 8.4**.



Photograph 8.4 **Red Stringybark/Blakely's Red Gum Woodland**

iii. *Red Stringybark/Rough-barked Apple Woodland*

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Rough-barked Apple - Red Stringybark shrubby open forest of the western New England Tablelands (BR197)

Keith Vegetation Class: Northern Tableland Dry Sclerophyll Forests

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 8.5**.



Photograph 8.5 **Red Stringybark/Rough-barked Apple Woodland**

iv. *New England Blackbutt Woodland*

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Rough-barked Apple - Red Stringybark shrubby open forest of the western New England Tablelands (BR197)

Keith Vegetation Class: Northern Tableland Dry Sclerophyll Forests

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 8.6**.



Photograph 8.6

New England Blackbutt Woodland

v. *Orange Gum Woodland*

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Orange Gum - Caley's Ironbark - Red Stringybark shrub/grass open forest of the southern New England Tablelands (BR182)

Keith Vegetation Class: Northern Tableland Dry Sclerophyll Forests

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 ground layer 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 8.7**.



Photograph 8.7 **Orange Gum Woodland**

vi. *Manna Gum Riparian Woodland*

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast (BR153)

Keith Vegetation Class: Tableland Clay Grassy Woodlands

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 8.8**.



Photograph 8.8 **Manna Gum Riparian Woodland**

vii. *River Oak Riparian Woodland*

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions (Benson 84) (BR194)

Keith Vegetation Class: Eastern Riverine Forests

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 8.9**.



Photograph 8.9 **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)

TSC Act Status: White box Yellow box Blakely's Red Gum Woodland (EEC)

BioBanking Metric: Yellow Box – Blakely's Red Gum grassy woodland of the Nandewar Bioregion (BR252)

Keith Vegetation Class: Derived from Western Slopes Grassy Woodland

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 8.10**. 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 8.10 **Derived Native Grassland**

ix. Low Diversity Grassland

EPBC Act Status: Not listed

TSC Act Status: Not listed

BioBanking Metric: Not listed

Keith Vegetation Class: Derived from Western Slopes Grassy Woodland

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 or the EEC listed under the TSC 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 8.11**.



Photograph 8.11 **Low Diversity Grassland**

8.5.3 *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 properties 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 TSC Act and/or EPBC Act. The following fauna species, listed as Vulnerable under the TSC Act, have been recorded during surveys of the Offsite Offset Areas:

- Little Lorikeet (*Glossopsitta pusilla*);
- Brown Treecreeper (*Climacteris picumnus victoriae*);
- Speckled Warbler (*Chthonicola sagittatus*);
- Varied Sittella (*Daphoenositta chrysoptera*); and
- Scarlet Robin (*Petroica boodang*).

The locations of these species within the Offsite Offset Areas are provided in **Figure 8.5**. There is also the potential for other threatened fauna species known from the locality to occur within the properties, including threatened microbats, birds and mammals. The tree hollows and stags within the properties provide potential shelter, roosting and nesting habitat for threatened microbats including the Large-eared Pied Bat (*Chalinolobus dwyeri*), Greater Long-eared Bat (*Nyctophilus corbeni*), Yellow-bellied Sheath-tail-bat (*Saccolaimus flaviventris*). Foraging and nesting resources are also available for a range of threatened bird species such as the Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*).

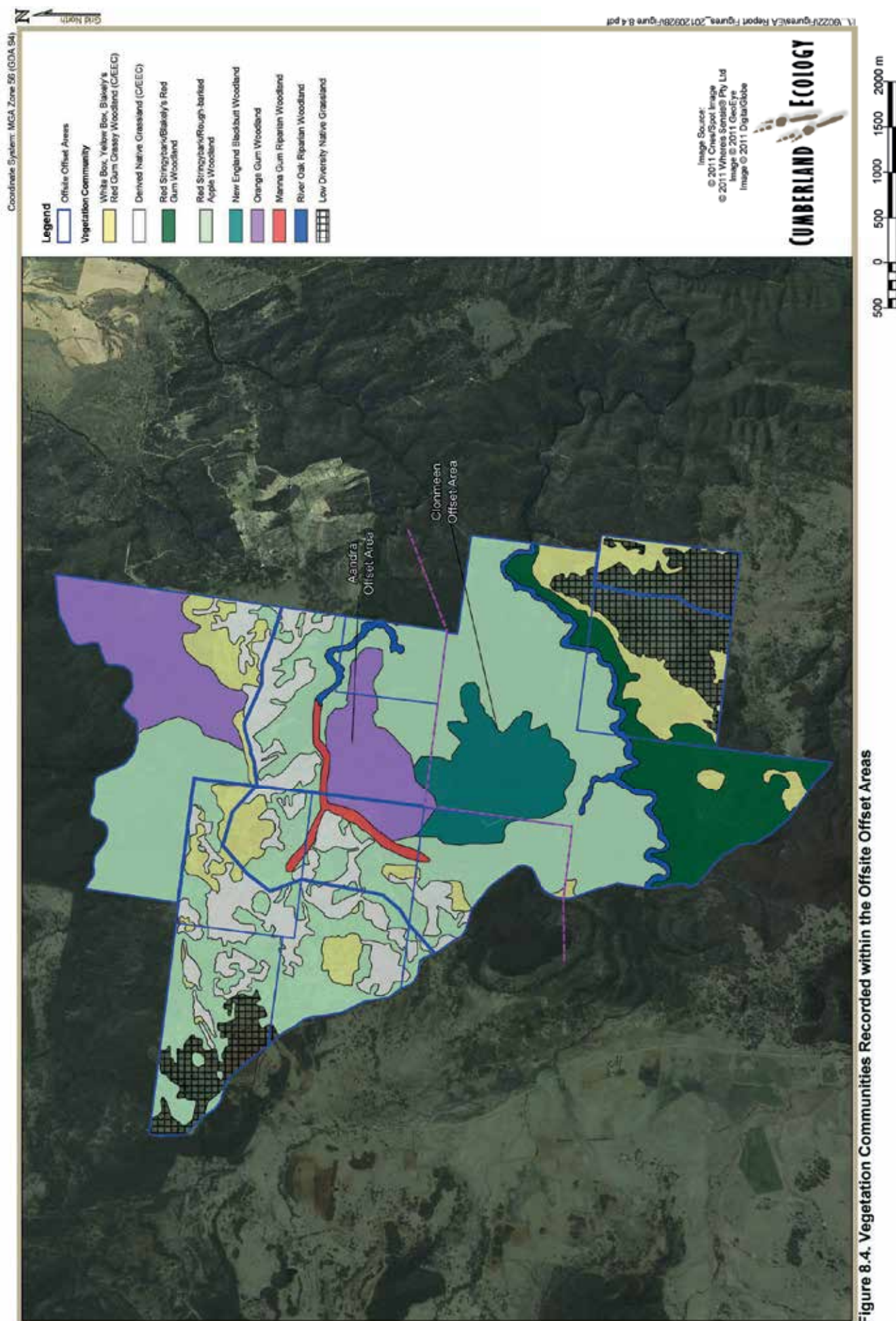


Figure 8.4. Vegetation Communities Recorded within the Offsite Offset Areas

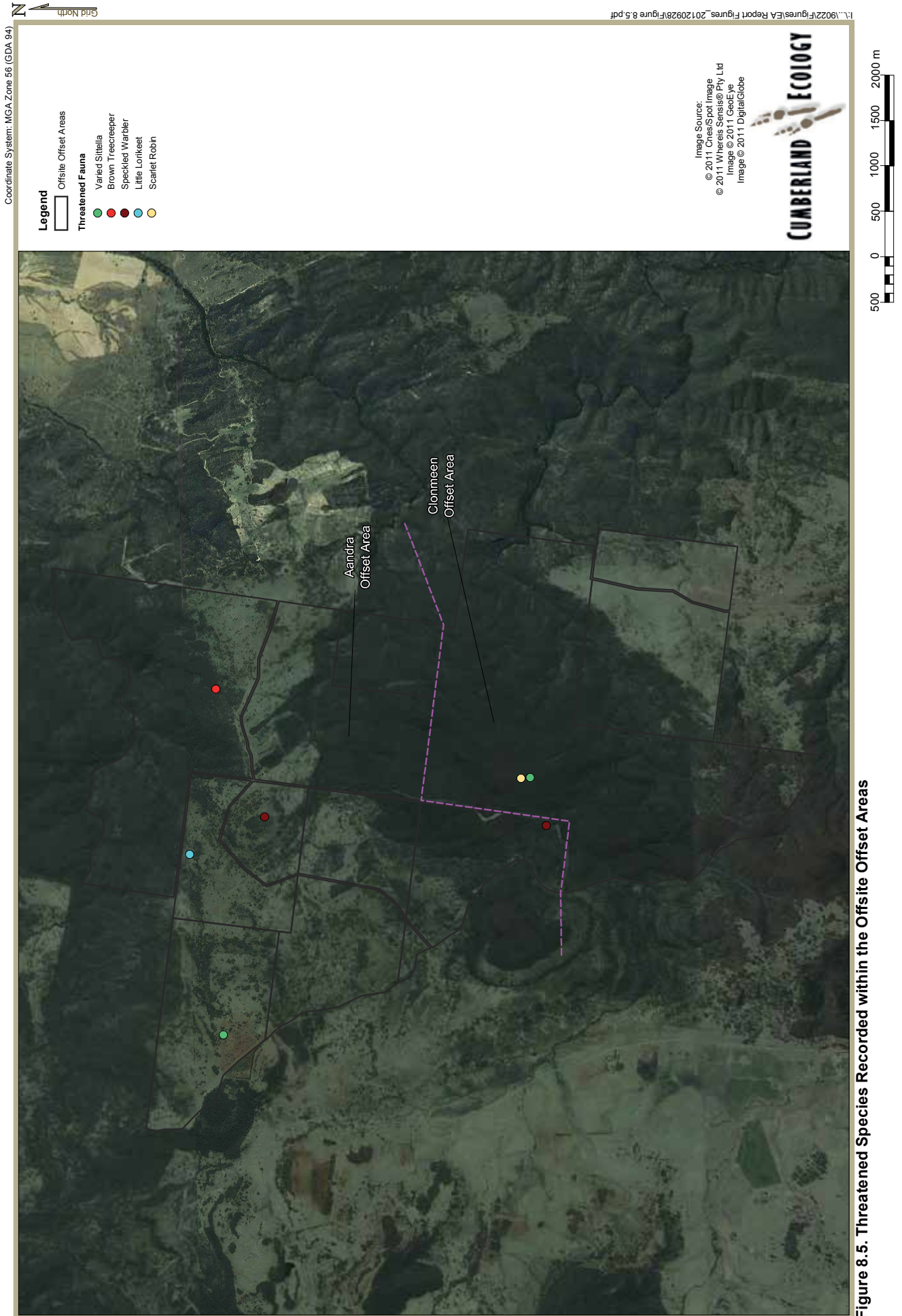


Figure 8.5. Threatened Species Recorded within the Offsite Offset Areas

8.6 Proposed Management of Offset Areas

The 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 7.4**).

8.6.1 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 8.6.2**); 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 Onsite and Offsite Offset Areas 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 Offset Areas will be provided as part of the BMP (see **Section 7.4**).

8.6.2 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 8.6** and **Figure 8.7**, respectively. The objectives for revegetation within the offsets are:

- Provide future habitat for the local population of the Koala;
- Restore extensive areas of C/EEC vegetation, including Box Gum Woodland;
- 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 7.4**).

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, such as threatened orchids, 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.



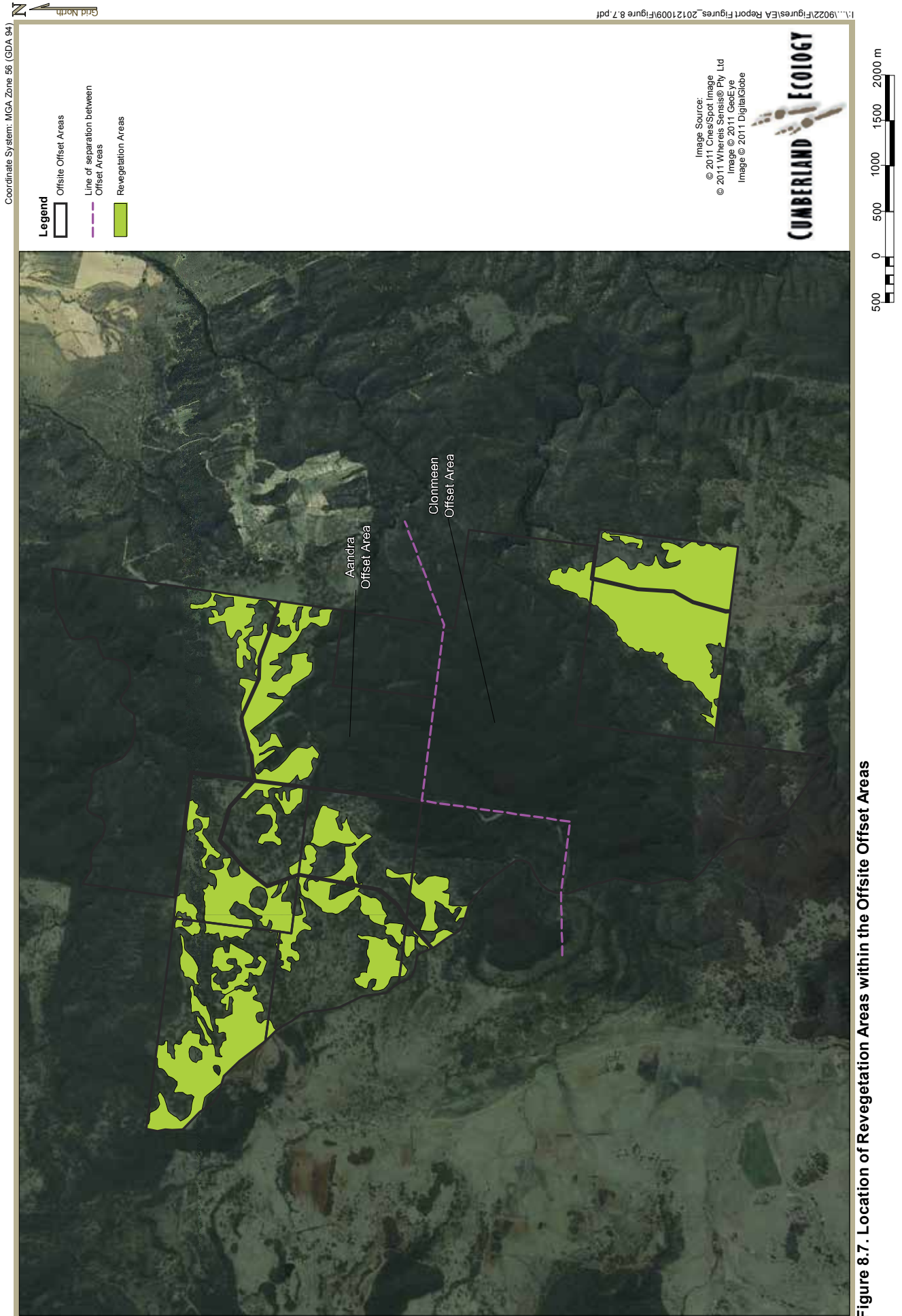


Figure 8.7. Location of Revegetation Areas within the Offsite Offset Areas

8.6.3 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 2,384 ha is proposed to be rehabilitated within the Disturbance Area. The location of rehabilitation areas are shown in **Figure 8.6**. Consideration has been given to the retention of land for agricultural purposes.

The principle objective of the Project site 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 should focus on the establishment of the threatened ecological communities, including Box Gum Woodland and Derived Native Grassland, Inland Grey Box Grassy Woodland and Fuzzy Box 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 should 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.

8.6.4 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.

8.6.5 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.

8.6.6 *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.

8.7 Summary of the Onsite and Offsite Offset Areas

8.7.1 Vegetation

Table 8.5 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 8.9**.

Table 8.5 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			Mine Rehabilitation Area		Clonmeen Offset Area			Aandra 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)	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	1,631	0	0	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	0	0	0	0	0	0	0	0
Blakely's Red Gum Grassy Woodland (C/EEC)	89	0	0	0	103	601	704	0	0	0	0	0	313	0	0	0	0	0	0	0	103	601	313	1,017	0
Regenerating Blakely's Red Gum Grassy Woodland (C/EEC)	17	0	0	0	0	0	0	0	0	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	31	0	0	0	0	0	0	37	780	31	780	31	848
Derived Native Grassland (C/EEC)	73	0	0	0	0	21	21	0	0	0	0	0	0	0	0	301	0	301	21	0	301	21	0	322	0
White Box/Blakely's Red Gum/Yellow Box Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	130	181	311	144	77	221	274	258	0	532	0	
Subtotal Box Gum Woodland (C/EEC)	738	166	47	213	591	2,754	3,345	0	0	0	0	0	1,975	130	181	311	445	77	522	1,332	3,059	1,975	3,225	4,890	6,366
Inland Grey Box Grassy Woodland (EEC)	30	0	0	0	21	640	661	0	0	0	0	0	46	0	0	0	0	0	21	640	46	707	46	707	0
Weeping Myall Woodland (EEC)	3	0	0	0	10	461	471	0	0	0	0	0	0	0	0	0	0	0	10	461	0	471	0	471	0
Brigalow (EEC)	0	0	0	0	11	340	351	0	0	0	0	0	0	0	0	0	0	0	11	340	0	351	0	351	0
Semi-Evergreen Vine Thicket (EEC)	0	n/a*	0	n/a*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	n/a*	0	0	0	n/a*	0	n/a*
Fuzzy Box Woodland (TSC - EEC)	18	0	0	0	4	190	194	0	0	0	0	0	36	4	190	230	0	0	4	190	36	230	4	190	36
Subtotal Other EEC	51	0	0	0	46	1,631	1,677	0	0	0	0	0	82	0	0	0	0	0	46	1,631	82	1,631	82	1,759	1,759
Poplar Box Woodland	45	0	0	0	49	293	342	0	0	0	0	0	73	0	0	0	0	0	49	293	73	415	73	415	0
Belian Woodland	1	0	0	0	37	970	1,007	0	0	0	0	0	0	0	0	0	0	0	37	970	0	1,007	37	970	0
Whitewood Woodland	13	26	31	57	99	0	99	0	0	0	0	0	27	0	0	0	0	0	125	31	27	183	31	27	183
Tumbledown Red Gum Grassy Open Woodland	16	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	39	0	39	39
White Box Shrubby Woodland	24	26	0	26	915	0	915	0	0	0	0	0	171	0	0	0	0	0	941	0	0	171	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	0	0	0	0	0	0	0	0
Blakely's Red Gum Shrubby Woodland	6	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	17	0	17	17
Blakely's Red Gum Motherbush Shrubby Woodland	0	0	0	0	15	0	15	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	15
Dwyer's Red Gum Woodland	0	0	0	0	13	0	13	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	13
River Red Gum Riparian Woodland	0	0	0	0	0	0	0	0	0	0	44	44	0	0	0	0	0	0	44	0	44	0	44	0	44
Red Stringybark/Blakely's Red Gum Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	244	0	244	0	0	244	0	0	0	0	244	244
Red Stringybark/Rough-barked Apple Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	389	0	389	828	0	828	0	0	0	0	828	1,217
New England Blackbutt Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	148	0	148	33	0	181	0	0	0	0	181	181
Orange Gum Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	320	0	320	0	0	0	0	320	322
Manna Gum Riparian Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	29	0	0	0	0	29	29
River Oak Riparian Woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	39	13	0	52	0	0	0	0	52	52
Subtotal Other Woodland	148	52	31	83	1,128	1,263	2,391	0	44	44	44	327	822	0	822	1,223	0	1,223	3,225	1,338	327	4,890	327	4,890	4,890
Low Diversity Grassland, Planted & Exotic Pasture	3,084	0	0	0	0	0	0	0	0	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	0	0	0	0	0	44	0	0	44	0	44	44
Subtotal Other	3,147	0	0	0	44	0	44	0	0	0	0	0	0	0	0	0	0	0	44	0	0	44	0	44	44
TOTAL	4,084.00	218	78	296	1,900	5,648	7,457	0	44	44	44	952	181	1,133	1,668	77	1,745	4,647	6,028	2,384	2,384	2,384	2,384	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 = Reclaimed; RV = Revegetated; RH = Rehabilitated

8.7.2 Vegetation/Habitat Condition Assessment

The results of the vegetation/habitat condition assessments for the Onsite and Offsite Offset Areas are shown in **Figure 8.8** and **Figure 8.9**, 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 8.8** and **Figure 8.9**. 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, 5,034 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 essentially, no other alternatives are available as the vast majority of remaining Box Gum Woodland and Derived Native Grassland is within farmland.

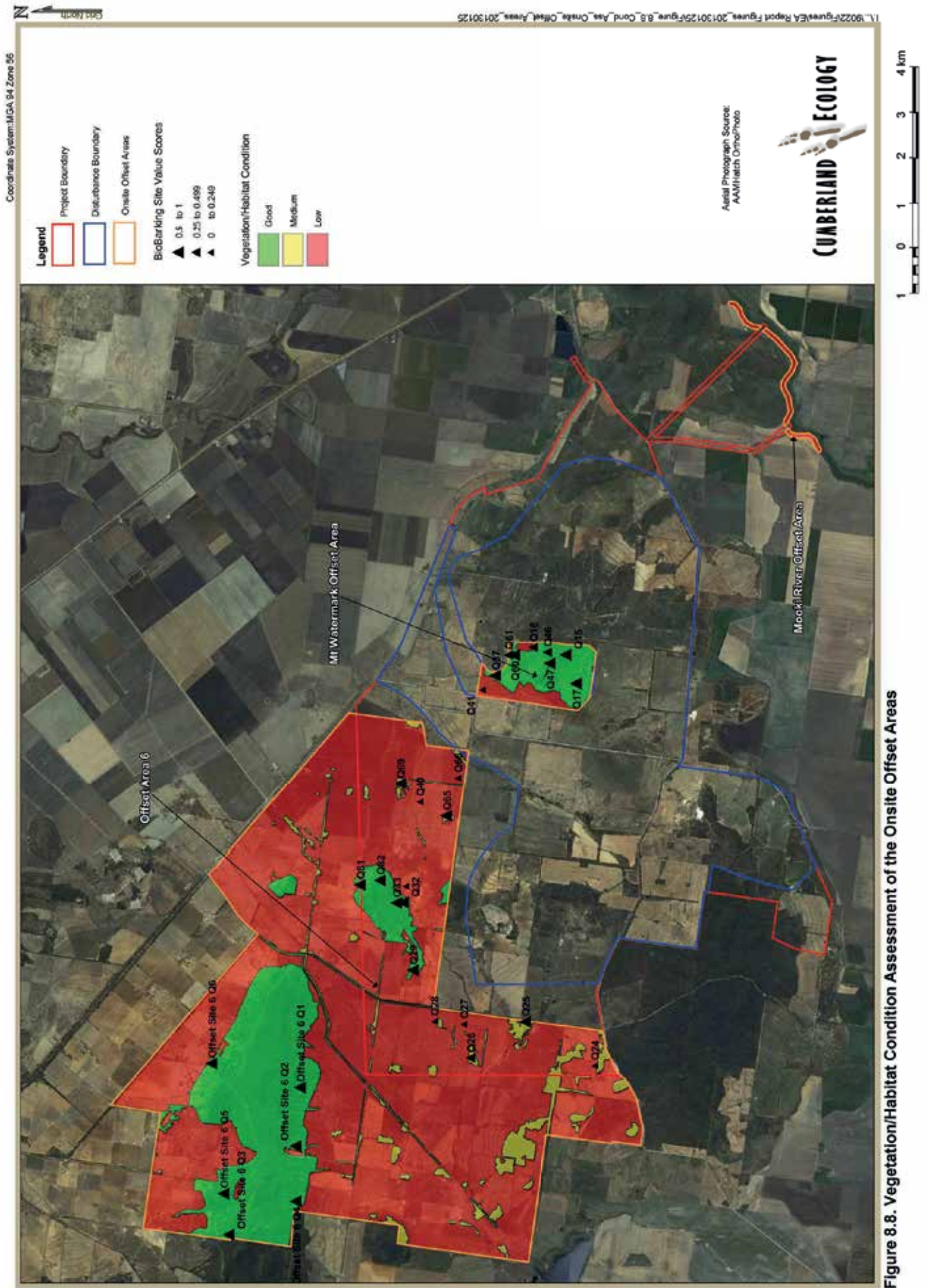


Figure 8.8. Vegetation/Habitat Condition Assessment of the Onsite Offset Areas

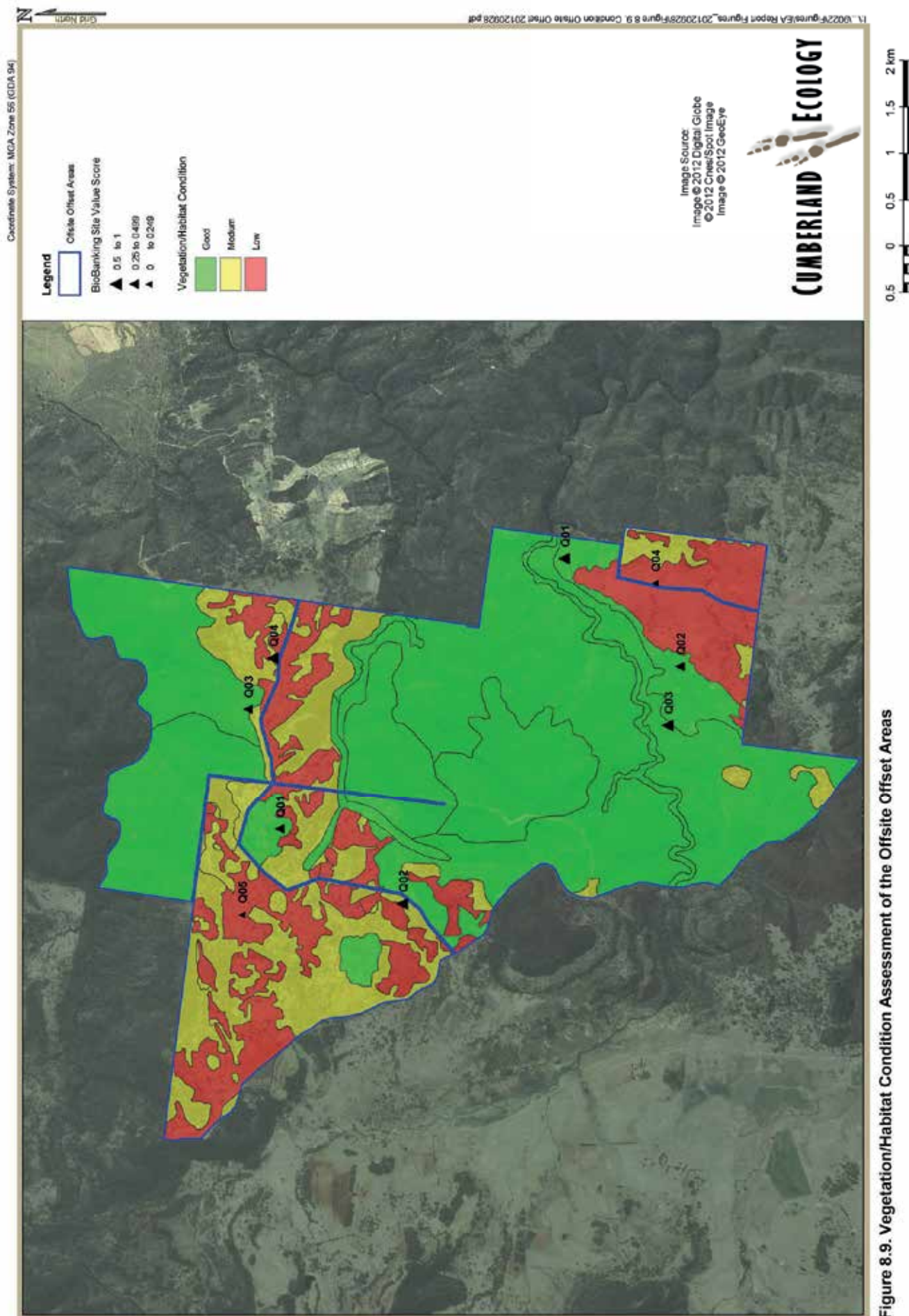


Figure 8.9. Vegetation/Habitat Condition Assessment of the Offsite Offset Areas

8.7.3 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. These areas would presumably provide habitat for the fauna assemblages 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 faunal 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. **Table 8.6** lists the threatened species known or potential occurring within the Project Boundary and their occurrence within the Onsite and Offsite Offset Areas.

Table 8.6 Threatened Species Occurrence within the Onsite and Offsite Offset Areas					
Threatened Species	TSC Act Status	EPBC Act Status	Occurrence within Project Boundary	Occurrence within Onsite Offset Areas	Occurrence within Offsite Offset Areas
FLORA					
Bothriochloa biloba	-	Vulnerable	Known	Potential	-
Dichanthium setosum	Vulnerable	Vulnerable	Potential	Potential	Potential
Digitaria porrecta	Endangered	Endangered	Potential	Potential	-
Cadellia pentastylis	Vulnerable	Vulnerable	Potential	Potential	-
Swainsona murrayana	Vulnerable	Vulnerable	Potential	Potential	-
BIRDS					
Little Lorikeet	Vulnerable	-	Known	Potential	Known
Brown Treecreeper	Vulnerable	-	Known	Known	Known
Speckled Warbler	Vulnerable	-	Known	Known	Known
Grey-crowned Babbler	Vulnerable	-	Known	Known	Potential
Diamond Firetail	Vulnerable	-	Known	Known	Potential
Spotted Harrier	Vulnerable	-	Known	Known	Potential
Little Eagle	Vulnerable	-	Known	Known	Potential
Barking Owl	Vulnerable	-	Known	Known	Potential
Painted Honeyeater	Vulnerable	-	Potential	Potential	Potential

Table 8.6 Threatened Species Occurrence within the Onsite and Offsite Offset Areas					
Threatened Species	TSC Act Status	EPBC Act Status	Occurrence within Project Boundary	Occurrence within Onsite Offset Areas	Occurrence within Offsite Offset Areas
Black-chinned Honeyeater	Vulnerable	-	Potential	Potential	Potential
Regent Honeyeater	Critically Endangered	Endangered, Migratory	Potential	Potential	Potential
Swift Parrot	Endangered	Endangered	Potential	Potential	Potential
Hooded Robin	Vulnerable	-	Potential	Potential	Potential
Varied Sittella	Vulnerable	-	Potential	Potential	Known
Turquoise Parrot	Vulnerable	-	Potential	Potential	Potential
Superb Parrot	Vulnerable	Vulnerable	Potential	Potential	-
Bush Stone-curlew	Endangered	-	Potential	Potential	Potential
Square-tailed Kite	Vulnerable	-	Potential	Potential	Potential
Black-breasted Buzzard	Vulnerable	-	Potential	Potential	Potential
Masked Owl	Vulnerable	-	Potential	Potential	Potential
MAMMALS					
Koala	Vulnerable	Vulnerable	Known	Known	Potential
Spotted-tailed Quoll	Vulnerable	Endangered	Potential	Potential	Potential
Squirrel Glider	Vulnerable	-	Potential	Potential	Potential
Yellow-bellied Sheath-tail Bat	Vulnerable	-	Known	Potential	Potential
Eastern Freetail-bat	Vulnerable	-	Potential	Potential	-
Little Pied Bat	Vulnerable	-	Potential	Potential	Potential
Eastern Cave Bat	Vulnerable	-	Potential	Potential	Potential
Large-eared Pied Bat	Vulnerable	Vulnerable	Potential	Potential	Potential
South-eastern Long-eared Bat	Vulnerable	Vulnerable	Potential	Known	Potential
REPTILES					
Border Thick-tailed Gecko	Vulnerable	Vulnerable	Potential	Potential	Potential
Five-clawed Worm-skink	Endangered	Vulnerable	Potential	Potential	-
Pink-tailed Legless Lizard	Vulnerable	Vulnerable	Potential	Potential	Potential
Pale-headed Snake	Vulnerable	-	Potential	Potential	Potential

8.7.4 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 C/EEC;
- 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.

8.8 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.

8.9 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, BioBanking assessments and consistency with OEH and SEWPaC principles for offsetting. The results of the assessments indicate that there is some variation between each of the assessment methodologies utilised.

8.9.1 Vegetation Removal and Offset Ratios

For the purpose of establishing minimum size thresholds for the BOP, a ratio of 5:1 for State and 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 8.7 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 8.7 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	46	3.1	2.4	1.2	1.2	1.2	1.2	0.9	0.9
Other Woodland	3,225	403.1	358.3	124.0	94.9	54.7	22.1	21.8	21.8
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 8.8**. 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, 1,759 ha of other EECs and 4,890 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;
- 33.7:1 for other EECs; and

- 31.9:1 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 8.8 Summary of Offset Ratios for the Project							
		Disturbance Area (ha)	Offsets – Retained (ha)	Offsets – Revegetated^ (ha)	Offsets – Rehabilitated (ha)	Offsets – Total (ha)	Ratio (Retained, Revegetation and Rehabilitation) – Rehabilitation discounted at 50%
Vegetation Community							
White Box Grassy Woodland (C/EEC)		517	617	1,399	1,631	3,647	
Regenerating White Box Grassy Woodland (CEEC)		28	0	0	0	0	
Blakely's Red Gum Grassy Woodland (C/EEC)		89	103	601	313	1,017	
Regenerating Blakely's Red Gum Grassy Woodland (CEEC)		17	0	0	0	0	
Yellow Box Grassy Woodland (C/EEC)		14	37	780	31	848	
Derived Native Grassland (C/EEC)		73	301	21	0	322	
White Box/Blakely's Red Gum/Yellow Box Woodland		0	274	258	0	532	
Subtotal Box Gum Woodland (C/EEC)		738	1,332	3,059	1,975	6,366	7.29
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	
Semi-evergreen Vine Thicket (EEC)		0	n/a*	0	0	n/a*	
Fuzzy Box Woodland (TSC - EEC)		18	4	190	36	230	
Subtotal Other EEC		51	46	1,631	82	1,759	33.7

Table 8.8 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) – Rehabilitated discounted at 50%
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	
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	

Table 8.8 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%
	River Oak Riparian Woodland	0	52	0	0	52	
	Subtotal Other Woodland	148	3,225	1,338	327	4,890	31.9
	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

8.9.2 BioBanking Assessment

BioBanking surveys and BioBank Credit Calculator assessments have been undertaken for the Project to allow an objective assessment of the suitability of the proposed offset areas. The process has been useful in gaining an understanding of the required offset area to development area ratio to act as a guide during negotiations with relevant governing bodies in the determination of the suitability of offset areas. BioBanking surveys followed the methodology provided within the BioBanking Operational Manual (DECC 2009).

A conservative approach has been taken for the BioBanking Assessment, in that the impacts have been assessed for the entire Disturbance Boundary, not just the Disturbance Area. Thirteen BioBanking Vegetation Types were identified as occurring, or proposed for revegetation/rehabilitation within the Onsite Offset Areas. An additional five BioBanking Vegetation Types were identified within the Offsite Offset Areas. All remnant vegetation types and associated forms, including woodland, regenerating woodland and derived native grassland, were assessed as being in Moderate/Good condition. Areas proposed for revegetation and rehabilitation were assigned as Low condition.

The results of the BioBanking assessments for the Disturbance Boundary and the Offset Areas are provided in **Table 8.9**. Results indicate that the Project will require 71,272 ecosystem credits to offset the impacts within the Disturbance Boundary and that the proposed Offset Areas offer a total number of ecosystem credits of 160,770. Unlike the calculation of offset ratios, a discount has not been applied to the mine rehabilitation area. This is due to the BBAM taking into account the current condition of the vegetation (ie. no value will be present within the mine rehabilitation area, therefore current site data for the rehabilitation areas were entered as nil values). The default increase in site values takes the nil values into account for these areas. A default increase in site values within the remaining vegetation within the BioBanking sites was also used in this assessment.

The BOP provides a substantial amount of ecosystem credits and beyond the amount of ecosystem credits required for the Project. The results of the BioBanking assessment indicate that the BOP provides:

- 27,853 more ecosystem credits for Box Gum Woodland and Derived Native Grassland than is required;
- 20,195 more ecosystem credits for other EECs than is required; and
- 41,450 more ecosystem credits for other woodland vegetation than is required.

The proposed revegetation and rehabilitation will contribute a substantial amount of ecosystem credits due to the amount of improvement.

Table 8.9 Total BioBanking Ecosystem Credits Generated by the Project

[illegible]

Table 8.9 Total BioBanking Ecosystem Credits Generated by the Project

Cumberland Ecology Vegetation Community	BioBanking Vegetation Type	Condition*	Retained			Revegetated			Rehabilitated			Total		
			Area	Credits	Credits/ha	Area	Credits	Credits/ha	Area	Credits	Credits/ha	Area	Credits	Credits/ha
Blakely's Red Gum Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Mod/Good										0.00	0	
Blakely's Red Gum Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Low							17.28	154	9	17.28	154	8.91
Poplar Box Woodland	Poplar Box - Belah woodland on clay-loam soils of the alluvial plains of north-central New South Wales	Mod/Good	48.67	683	14							48.67	683	14.03
Poplar Box Woodland	Poplar Box - Belah woodland on clay-loam soils of the alluvial plains of north-central New South Wales	Low				293.47	4,426	15	72.65	660	9	366.12	5,086	13.89
Regenerating White Box Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Mod/Good - Medium										0.00	0	
Tumbledown Red Gum Grassy Open Woodland	White Cypress Pine - Silver-leaved Ironbark grassy woodland of the Nandewar Bioregion	Mod/Good										0.00	0	
Tumbledown Red Gum Grassy Open Woodland	White Cypress Pine - Silver-leaved Ironbark grassy woodland of the Nandewar Bioregion	Low							39.05	363	9	39.05	363	9.30
White Box Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Mod/Good	941.31	11,316	12							941.31	11,316	12.02
White Box Shrubby Woodland	White Box - White Cypress Pine shrubby open forest of the Nandewar and Brigalow Belt South Bioregions	Low							171.48	1,564	9	171.48	1,564	9.12
Dwyer's Red Gum Woodland	Dwyer's Red Gum woodland on siliceous substrates in the Brigalow Belt South Bioregion (Benson 187)	Mod/Good	12.75	191	15							12.75	191	14.98
Whitewood Woodland	Whitewood open woodland of the subtropical sub-humid plains (BBS and eastern DRIP Bioregions)	Mod/Good	124.71	1,685	14							124.71	1,685	13.51
Whitewood Woodland	Whitewood open woodland of the subtropical sub-humid plains (BBS and eastern DRIP Bioregions)	Low				31.12	305	10	27.43	253	9	58.55	558	9.53
Red Stringybark/Blakely's Red Gum Woodland	Blakely's Red Gum - Rough-barked Apple - Red Stringybark grassy open forest of the western New England Tablelands	Moderate/Good	243.85	2,304	9							243.85	2,304	9.45
New England Blackbutt Woodland	Rough-barked Apple - Red Stringybark shrubby open forest of the western New England Tablelands	Moderate/Good_Medium	181.47	1,388	8							181.47	1,388	7.65
Red Stringybark/Rough-barked Apple Woodland	Rough-barked Apple - Red Stringybark shrubby open forest of the western New England Tablelands	Moderate/Good	1,216.99	12,479	10							1,216.99	12,479	10.25
Manna Gum Riparian Forest	Manna Gum - Rough-barked Apple - Yellow Box grassy woodland/open forest of the New England Tablelands and North Coast	Moderate/Good	28.74	220	8							28.74	220	7.65
Orange Gum Woodland	Orange Gum - Caley's Ironbark - Red Stringybark shrub/grassy open forest of the southern New England Tablelands	Moderate/Good	322.23	3,392	11							322.23	3,392	10.53
River Oak Riparian Forest	River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions (Benson 84)	Low				51.51	394	8				51.51	394	7.65
Red Gum Riparian Woodland	River Red Gum open forest and woodland mainly of the Darling Riverine Plains and South West Slopes Bioregions (Benson 36)	Low				43.93	267	6				43.93	267	6.08
Subtotal Other Native Vegetation			3,173.43	34,411	11	1,389.62	19,773	14	327.89	2,994	9	4,890.94	57,178	12
GRAND TOTAL			4,574.04	50,120	11	6,058.83	88,832	15	2,385.76	21,818	9	13,018.64	160,770	12.35

*Low condition represents areas proposed for revegetation or rehabilitation

8.9.3 Compliance with OEH and SEWPaC Offsetting Principles

In order to achieve the best environmental outcomes, the BOP for the Project aims to meet NSW and Commonwealth standards in offsetting. **Table 8.10** and **Table 8.11** below shows how the NSW and Commonwealth principles for offsetting have been addressed by the Watermark BOP. The tables have been derived from the NSW Government principles for the use of biodiversity offsets in NSW (DECC 2008b) and the Commonwealth *Draft Policy Statement: Use of environmental offsets under the Environment Protection and Biodiversity Conservation Act 1999* (DEWR 2007).

Table 8.10 Compliance with OEH Offsetting Principles	
NSW Offset Principles	Justification
1. Impacts must be avoided first by using prevention and mitigation measures. Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.	Changes have been made to the design of the Project to minimise disturbance to established woodland areas, in particular Mt Watermark and Breeza State Forest. The predicted impacts of the Project will be offset by the proposed biodiversity offsets as discussed in the previous sections of this chapter.
2. All regulatory requirements must be met. Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).	All regulatory requirements for the BOP will be met.
3. Offsets must never reward ongoing poor performance. Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.	The offset areas will be managed in accordance with the BMP to increase their ecological values over time and will not be deliberately degraded or mismanaged.
4. Offsets will complement other government programs. A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.	The BOP will complement other government programs for conservation in that it will address the goals of recovery plans for threatened species and recommendations for management of weeds and feral animals.

Table 8.10 Compliance with OEH Offsetting Principles	
NSW Offset Principles	Justification
5. Offsets must be underpinned by sound ecological principles. Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.	The BOP will: - Enhance and manage existing habitat and secure these habitats for biodiversity; - Regenerate new areas of habitat that will be strategically located near existing habitat to effectively provide larger intact areas of habitat in the longer term; - Reconstruct and enhance new and existing woodland corridors to connect offset areas.
Offsets must: - Include the consideration of structure, function and compositional elements of biodiversity, including threatened species	The BOP will enhance, regenerate and protect woodland community types that will be lost, thus ensuring that ecological structure and function of representative communities in the locality will be maintained and improved. This includes replanting with local or endemic species, and protecting and enhancing habitat for a range of threatened species including threatened flora and fauna.
- Enhance biodiversity at a range of scales	The BOP will enhance biodiversity at a landform scale. The proposed Offset Areas, in conjunction with areas of regenerated woodland, will form a large viable woodland area supporting habitat for a wide variety of species. The BOP will link the proposed Offset Areas to existing conservation areas and to other habitat areas in the locality to enhance ecological function of habitats. The BOP will also enhance biodiversity at the local scale by protecting a diversity of habitat types across the Project Boundary, including riparian, forest and woodland vegetation. Under the BOP, understorey complexity and other habitat features such as logs, stags and tree hollows will be preserved and protected to encourage fauna and flora use of these habitats.
- Consider the conservation status of ecological communities	The BOP will maintain and improve occurrences of endangered ecological communities and regionally significant plant communities and includes targeted preservation of remaining and regenerated Box Gum

Table 8.10 Compliance with OEH Offsetting Principles	
NSW Offset Principles	Justification
	Woodland and Derived Native Grassland.
- Ensure the long-term viability and functionality of biodiversity.	Offsets will be conserved in perpetuity and will be actively managed during the life of the Project.
6. Offsets should aim to result in a net improvement in biodiversity over time. Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site. Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation. Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.	The BOP will result in a net improvement in woodland and open forest communities over time, with commensurate benefits to threatened species. The BOP will protect areas of intact vegetation via an appropriate land zoning or other alternative means for the life of the impact. The BOP will also enhance existing vegetation through management actions that include removal of grazing, translocation of threatened species to protected areas, and reconstructing habitat corridors to link areas of habitat. The BOP makes provisions for the regeneration of ecological communities, strategically placed to add to the areas of existing habitat to be protected and enhanced. Under the BOP, revegetation and rehabilitation works will be implemented progressively over the life of the Project to minimise the impacts of progressive mining across the Disturbance Area.
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs. As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.	The proposed Offset Areas will be secured by an appropriate land zoning or other alternative means for the life of the impact.
8. Offsets should be agreed prior to the impact occurring. Offsets should minimise ecological risks from	The nature and extent of the offsets will be agreed prior to commencement of the Project. The disturbance will be staged over the life of the

Table 8.10 Compliance with OEH Offsetting Principles	
NSW Offset Principles	Justification
time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.	Project. Thus, the BOP will be progressively implemented over the life of the Project to ensure that at every stage of disturbance, impacts are minimised.
9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.	The Project impacts and BOP have been assessed using Geographic Information Systems and ortho-rectified aerial photography. The methodology uses ground truthed data to allow for accurate and reliable quantification of the biodiversity losses and gains for the Project.
Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include: - The area of impact; - The types of ecological communities and habitat/species affected; - Connectivity with other areas of habitat/corridors; - The condition of habitat; - The conservation status and/or scarcity/rarity of ecological communities; - Management actions; and - Level of security afforded to the offset site.	The area of impact, types of communities and species to be impacted, extent of existing and future connectivity, condition of habitat and conservation status of ecological communities have been documented within Chapters 3-6 of this EIA. The BOP makes provisions for the management of the offset areas to ensure that there will be a net benefit in biodiversity values. The Offset Areas will be conserved in perpetuity and will be actively managed during the life of the Project, ensuring that there is a net gain in biodiversity in the wider locality in the long term.
The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:	

Table 8.10 Compliance with OEH Offsetting Principles

NSW Offset Principles	Justification
- They protect land with high conservation significance	The proposed Offset Areas have high conservation significance in that they contain endangered ecological communities, habitat for threatened species, known occurrences of threatened species and significant riparian habitats.
- Management actions have greater benefits for biodiversity	The management actions that are proposed, such as cessation or reduction of cattle grazing, revegetation, weed control and feral animal control have a high probability of providing a significant conservation benefit.
- The offset areas are not isolated or fragmented	The habitat within the locality is largely fragmented in its current state. The BOP aims to reverse fragmentation effects by locating the Offset Areas strategically to effectively provide larger areas of habitat.
- The management for biodiversity is in perpetuity (e.g. secured through a conservation agreement).	The proposed offsets will be secured by an appropriate land zoning or other alternative means for the life of the impact.
10. Offsets must be targeted. They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.	The offsets are targeted and will deliver a like-for-like or better conservation outcome for endangered ecological communities and threatened species. Under the BOP, Endangered Ecological Communities will be targeted, including Box Gum Woodland. Derived grassland will be offset by their woodland community types as woodland habitats have a higher conservation value. Habitat for threatened species identified within the Project Boundary will also be targeted, including the Koala.
11. Offsets must be located appropriately. Wherever possible, offsets should be located in	The proposed offsets are located appropriately within the landscape. The BOP includes offset areas that are located adjacent to the Project Boundary. Thus, the

Table 8.10 Compliance with OEH Offsetting Principles	
NSW Offset Principles	Justification
areas that have the same or similar ecological characteristics as the area affected by the development.	ecological characteristics of these offset areas will be the same as, or very similar to that of the impact areas. Other offsets are located further away, but share the same general characteristics as the Project Boundary and support a similar suite of threatened species.
12. Offsets must be supplementary. They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.	The proposed offsets are supplementary in that they are proposed exclusively for the Project and are not already funded or being managed for biodiversity value for another development proposal.
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract. Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.	The proposed offsets will be enforceable through development consent conditions and will be auditable to ensure that actions have been carried out.

Table 8.11 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

Table 8.11 Compliance with the EPBC Act Environmental Offset Policy	
Offset Principles	Justification
	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.
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

Table 8.11 Compliance with the EPBC Act Environmental Offset Policy	
Offset Principles	Justification
	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 9

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 up to 937 ha of native woodland and derived native grassland, including several communities listed as threatened under the EPBC Act and/or the TSC Act. This includes approximately 738 ha of Box Gum Woodland and Derived Native Grassland, 30 ha of Inland Grey Box Woodland, 3 ha of Weeping Myall Woodland and 18 ha of Fuzzy Box Woodland.

The woodland vegetation within the Project Boundary provides habitat for a range of threatened species, including several fauna species as listed under the TSC Act and/or 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. A total of five threatened plant species listed under the TSC Act and/or EPBC Act are known to occur in the region and have potential habitat within the Project Boundary and one (*Bothriochloa biloba* – EPBC Act only) has been recorded. Given the scale of the Project's potential impacts on flora and fauna listed by the EPBC Act, the Project was deemed to be a controlled action under the EPBC Act.

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, 1,759 ha of other listed EECs and 4,890 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 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.

References

- AGE Consultants. 2012. Watermark Coal Project Groundwater Assessment. Australasian Groundwater and Environmental Consultants Pty Ltd, Bowen Hills, QLD.
- Aitken, K. E. H. and K. Martin. 2007. The importance of excavators in hole-nesting communities: availability and use of natural tree holes in old mixed forests of western Canada. *Journal of Ornithology* **148** (Suppl 2):S425-S434.
- Aitken, K. E. H. and K. Martin. 2008. Resource selection plasticity and community responses to experimental reduction of a critical resource. *Ecology* **89**:971-980.
- AMEC Americas Limited. 2005. Mackenzie Gas Project: Effects of Noise on Wildlife. AMEC Americas Limited.
- Andrews, A. 1990. Fragmentation of Habitat by Roads and Utility: A Review. *Australian Zoologist* **26**:130-141.
- ANZECC. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - Chapter 3. Australian and New Zealand Environment Conservation Council (ANZECC), Canberra.
- Barma Water Resources and L. Thurtell, Wettin, P., 2012. Environmental Water Delivery: Namoi River. Canberra, ACT.
- Baumgartner, L., Reynoldson, N., Cameron, L., Stanger, J., . 2007. The effects of selected irrigation practices on fish of the Murray-Darling Basin. NSW Department of Primary Industries, Narrandera, NSW.
- Baumgartner, L. J., Reynoldson, N. K., Cameron, L., Stanger, J. G.,. 2009. Effects of irrigation pumps on riverine fish. *Fisheries Management and Ecology* **16**:429 - 437.
- Bennett, A. F. 1990. Habitat Corridors: Their role in wildlife management and conservation. Department of Conservation and Environment, Melbourne, Australia.
- Benson, J. S. 2008. New South Wales Vegetation Classification and Assessment: Part 2 Plant communities of the NSW South-western Slopes Bioregion and update of NSW Western Plains plant communities, Version 2 of the NSWVCA database. *Cunninghamia* **10**:599-673.
- Benson, J. S., C. B. Allen, C. Togher, and J. Lemmon. 2006. New South Wales Vegetation Classification and Assessment: Part 1 Plant communities of the NSW Western Plains. *Cunninghamia* **9**:383-450.
- Birds Australia. 2011. Birds Australia [Electronic resource].
- Blackmore, C. J., R. Peakall, and R. Heinsohn. 2011. The absence of sex-biased dispersal in the cooperatively breeding Grey-crowned Babbler. *Journal of Animal Ecology* **80**:69-78.
- Boland, D. J., M. I. H. Brooker, G. M. Chippendale, N. Hall, B. P. M. Hyland, R. D. Johnston, D. A. Kleinig, and J. D. Turner, editors. 1984. *Forest Trees of Australia*. Thomas Nelson Australia & CSIRO, Melbourne, Australia.
- BOM. 2011. New South Wales Rainfall and River Conditions. Commonwealth of Australia Bureau of Meteorology.
- Botanic Gardens Trust. 2012. PlantNET.
- Braun-Blanquet, J. 1927. *Pflanzensoziologie* Wien Springer.
- Brawn, J. D. and R. P. Balda. 1988. Population biology of cavity nesters in Northern Arizona: do nest sites limit breeding densities? *The Condor* **90**:61-71.
- Brooker, M. and D. Kleinig. 1990. *Field guide to eucalypts of south eastern Australia*, Volume 2. Inkata, Melbourne.
- Cameron, M. 2006. Nesting habitat of the glossy black-cockatoo in central New South Wales. *Biological Conservation* **127**:402-410.

- Carbon Based Environmental Pty Ltd. 2011. Environmental Monitoring: Dust Deposition Gauges, High Volume Air Samplers, Surface Water and Meteorological Stations. Prepared for Shenhua Watermark Coal Pty Limited. Cessnock, NSW.
- Cardno Ecology Lab. 2012. The Macquarie River to Orange Pipeline Project: Aquatic Ecology Assessment. St Leonards, NSW.
- Chessman, B. 2003. SIGNAL 2.iv A Scoring System for Macroinvertebrates ('water bugs') in Australian Rivers: User Manual. Department of Environment and Heritage, Canberra.
- Churchill, S. 2008. Australian Bats. Second edition. Allen & Unwin, Crowes Nest, NSW.
- Cockle, K., K. Martin, and K. Wiebe. 2008. Availabilities of cavities for nesting birds in the Atlantic forest, Argentina. **19**:269-278.
- Cockle, K. L., K. Martin, and M. C. Drever. 2010. Supply of tree-holes limits nest density of cavity-nesting birds in primary and logged subtropical Atlantic forest. *Biological Conservation* **143**:2851-2859.
- Cogger, H. G. 2000. Reptiles and Amphibians of Australia. Reed New Holland Publishers.
- Cooper, C. B., J. R. Walters, and H. Ford. 2002. Effects of remnant size and connectivity on the response of Brown Treecreepers to habitat fragmentation. *Emu* **102**:249-256.
- Cumberland Ecology. 2012. Maules Creek Coal Project: Biodiversity Offsets Management Plan. Final Draft. Cumberland Ecology Pty Ltd, Carlingford Court, NSW.
- Cumberland Ecology. 2013. Watermark Coal Project. Koala Plan of Management. Cumberland Ecology Pty Ltd, Carlingford Court, NSW.
- Debus, S. J. S. 1984. Biology of the Little Eagle on the Northern Tablelands of New South Wales. *Emu* **84**:87 – 92.
- Debus, S. J. S. and G. V. Czechura. 1989. The Square-tailed Kite *Lophoictinia isura*: A Review. *Australian Bird Watcher* **13**:81-97.
- DEC (NSW). 2004. Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft). New South Wales Department of Environment and Conservation, Hurstville, NSW.
- DEC (NSW). 2005a. Barking Owl - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005b. Bluegrass - profile. Department of Environment and Climate Change (NSW), Hurstville, NSW.
- DEC (NSW). 2005c. Border Thick-tailed Gecko - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005d. *Digitaria porrecta* - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005e. Eastern Cave Bat - Profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005f. Greater Long-eared Bat (south eastern form) - profile. Department of Environment and Conservation, Hurstville, NSW.
- DEC (NSW). 2005g. Hooded robin (south eastern form) - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005h. Large-eared Pied Bat - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005i. Masked Owl - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005j. Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2005k. Pale-headed Snake - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005l. Pest Management in NSW National Parks: Feral Pigs Fact Sheet. Department of Environment and Conservation NSW, Sydney.
- DEC (NSW). 2005m. Regent Honeyeater - profile. Department of Environment and Conservation (NSW), Hurstville.

- DEC (NSW). 2005n. Slender Darling Pea - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005o. Spotted-tailed Quoll - profile. Department of Environment and Conservation, Hurstville, NSW.
- DEC (NSW). 2005p. Squirrel Glider - profile. Department of Environment and Conservation (NSW).
- DEC (NSW). 2005q. Superb Parrot - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005r. Swift Parrot - profile. Department of Environment and Conservation (NSW), Hurstville.
- DEC (NSW). 2005s. Yellow-bellied Sheath-tail-bat - profile. Department of Environment and Conservation (NSW), Hurstville, NSW.
- DEC (NSW). 2006. Painted Honeyeater - profile. Department of Environment and Conservation (NSW), Hurstville.
- DECC. 2008a. Approved Recovery Plan for the Koala (*Phascolarctos cinereus*). Department of Environment and Climate Change, Hurstville, NSW.
- DECC. 2008b. Principles for the use of biodiversity offsets in NSW. Department of Environment and Climate Change, Hurstville, NSW.
- DECC. 2009. BioBanking Assessment Methodology and Credit Calculator Operational Manual. Department of Environment and Climate Change, Hurstville, NSW.
- DECC (NSW). 2008. Recovery Plan for the Koala (*Phascolarctos cinereus*). Department of Environment and Climate Change, Sydney, NSW.
- DECC (NSW). 2009. Brigalow and Nandewar western regional assessment. Department of Environment and Climate Change, Hurstville, NSW.
- DECCW. 2007. Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Penplain, Nandewar and Brigalow Belt South Bioregions - profile. Department of Environment, Climate Change and Water, Hurstville, NSW.
- DECCW. 2009. New South Wales State of the Environment 2009. Department of Environment, Climate Change and Water, Hurstville, NSW.
- DECCW. 2010. State of the Catchments 2010: Namoi Region - Groundwater. Department of Environment, Climate Change and Water, Sydney South, NSW.
- DECCW (NSW). 2010. Draft National Recovery Plan for White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland. NSW DECCW, Sydney.
- DEH. 2005. Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs. Department of Environment and Heritage, Canberra.
- DEH. 2006. EPBC Act Policy Statement 3.5 - White Box - Yellow Box - Blakely's Red Gum grassy woodland and derived grasslands. Department of Environment and Heritage, Canberra, ACT.
- Department of Planning and Infrastructure. 2012. Strategic Regional Land Use Policy. State of NSW.
- Department of Planning NSW. 1995. State Environmental Planning Policy No. 44- Koala Habitat Protection, Circular No. B35.
- DEWHA. 2009. National Koala Conservation and Management Strategy 2009-2014. Endorsed by the Natural Resource Management Ministerial Council. Department of Environment; Heritage; Water and the Arts, Canberra, ACT.
- DEWHA. 2010a. Survey guidelines for Australia's threatened bats. Commonwealth Department of Environment, Water, Heritage and the Arts, Canberra, ACT.
- DEWHA. 2010b. Survey guidelines for Australia's threatened birds. Commonwealth Department of Environment, Heritage, Water and the Arts, Canberra, ACT.
- DEWR. 2007. Draft Policy Statement: Use of environmental offsets under the *Environment Protection and Biodiversity Conservation Act 1999*.
- DIPNR. 2004. A Guide to the Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Sources. Department of Infrastructure, Planning and Natural Resources.

- DIPNR. 2005. A Guide to the Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources. Department of Infrastructure, Planning and Natural Resources.
- Doerr, V. A. J., E. D. Doerr, and M. J. Davies. 2011. Dispersal behaviour of Brown Treecreepers predicts functional connectivity for several other woodland birds. *Emu* **111**:71-83.
- DSE (VIC). 2008. Land and Biodiversity at a time of Climate Change – Green Paper. Improving ecological connectivity Department of Sustainability and Environment, Victoria.
- Eamus, D. and R. Froend. 2006. Groundwater-dependent ecosystems: The where, what and why of GDEs. *Australian Journal of Botany* **54**:91-96.
- Eco Logical Australia. 2011. Proposed Framework for Assessing the Cumulative Risk of Mining on Natural Resource Assets in the Namoi Catchment. Eco Logical Australia.
- Fahrig, L. 2003. Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology Evolution and Systematics* **34**:487–515.
- Farmer, A. 1993. The Effects of dust on vegetation - a review. *Environmental Pollution* **79**.
- Fischer, J. and D. B. Lindenmayer. 2002. The conservation value of paddock trees for birds in a variegated landscape in southern New South Wales. 2. Paddock trees as stepping stones. *Biodiversity and Conservation* **11**:833-849.
- Florabank. 2012. Florabank.
- Ford, H. A. 2011. The causes of decline of woodland birds of eucalypt woodlands: advances in our knowledge over the last 10 years. *Emu* **111**:1-9.
- Franks, D., D. Brereton, and C. Moran. 2008. Managing the cumulative impacts of multiple mines on regional communities and environments in Australia. Paper Submitted to the International Association for Impact Assessment, Assessing and Managing Cumulative Environmental Effects Special Topic Meeting, Calgary, Canada, 6-9 November, 2008.
- Gardner, J. L. and R. G. Heinsohn. 2007. Probable consequences of high female mortality for speckled warblers living in habitat remnants. *Emu* **135**:473-483.
- Garnett, S. T. and G. M. Crowley. 2000. The Action Plan for Australian Birds. Environment Australia, Canberra.
- Gehrke, P. C. and H. J. H. 2001. Regional-scale Effects of Flow Regulation on Lowland Riverine Fish Communities in New South Wales Australia. *Regulated Rivers: Research and Management* **17**:369-391.
- GHD. 2009. Report of Review of Environmental Factors. Stages 1, 2 and 3 Exploration Drilling. Prepared for Shenhua Watermark Pty Ltd. GHD.
- Gibbons, P. and D. B. Lindenmayer. 2002. Tree Hollows and Wildlife Conservation in Australia. CSIRO Publishing, Melbourne.
- Gibbons, P., D. B. Lindenmayer, S. C. Barry, and M. T. Tanton. 2002. Hollow selection by vertebrate fauna in forests of southeastern Australia and implications for forest management. *Biological Conservation* **103**:1-12.
- Goldingay, R. L. and B. D. Taylor. 2009. Gliding performance and its relevance to gap crossing by the squirrel glider (*Petaurus norfolcensis*). *Australian Journal of Zoology*:99-104.
- Halford, D. 1995. *Digitaria porrecta* S.T. Blake (Poaceae). A Conservation statement. Queensland Department of Environment and Heritage, Brisbane.
- Harden, G. J. 1990-1993. Flora of NSW Volumes 1-4. New South Wales University Press, Kensington.
- Harpstead, M., T. Sauer, and W. Bennett. 2001. Soil Science Simplified, 4th Edition. Iowa State University Press.
- Hatton, T. and R. Evans. 1998. Dependence of Ecosystems on Groundwater and its Significance to Australia. Land and Water Resources Research and Development Corporation Canberra
- Hawking, J. H. and F. J. Smith, editors. 1997. Colour Guide to Invertebrates of Australian Inland Waters. Co-operative Research Centre for Freshwater Ecology, Albury.

- Heinsohn, R., S. Murphy, and S. Legge. 2003. Overlap and competition for nest holes among eclectus parrots, palm cockatoos and sulphur-crested cockatoos. *Australian Journal of Zoology* **51**:81-94.
- Higgins, P. J. and J. M. Peter. 2002. *Handbook of Australian, New Zealand and Antarctic Birds Volume 6*. Oxford University Press, Melbourne.
- International Council on Mining and Metals. 2006. *Good Practice Guidance for Mining and Biodiversity*. ICMM.
- Jacobs, S. W. L., R. D. B. Whalley, and D. J. B. Wheeler. 2008. *Grasses of New South Wales*. Fourth Edition. University of New England.
- Keith, D. A. 2004. *Ocean Shores to Desert Dunes. The Native Vegetation of NSW and ACT*. NSW Department of Environment and Conservation, Hurstville.
- Kennedy, S. and C. Tzaros. 2005. Foraging ecology of the swift parrot *Lathamus discolor* in the Box-Ironbark forests and woodlands of Victoria. *Pacific Conservation Biology* **11**:158-173.
- Lindenmayer, D., A. Bennett, and R. Hobbs. 2010. *Temperate Woodland Conservation and Management*. CSIRO Publishing, Collingwood.
- Lindenmayer, D. B., R. B. Cunningham, M. T. Tantaon, A. P. Smith, and H. A. Nix. 1990. The conservation of arboreal Marsupials in the Montane Ash Forests of the Central Highlands of Victoria, South East Australia: I. Factors influencing the occupancy of trees with hollows. *Biological Conservation* **54**:111-131.
- Lindenmayer, D. B. and J. Fischer. 2006. *Habitat fragmentation and landscape change*. Island Press, Washington D.C.
- Longcore, T. and C. Rich. 2004. Ecological Light Pollution. *Frontiers in Ecology and the Environment* **2**:191-198.
- Longcore, T. and C. Rich. 2010. Light Pollution and Ecosystems. *ActionBioscience.org* original article.
- Luck, G. W. 2002. The habitat requirements of the Rufous Treecreeper (*Climacteris rufa*)-Preferential habitat use demonstrated at multiple spatial scales. *Biological Conservation* **105**:383-394.
- Lunney, D., A. L. Curtin, D. Ayers, H. G. Cogger, C. R. Dickman, W. Maitz, B. Law, and D. Fisher. 2000. The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. NPWS, Sydney.
- Mackowski, C. M. 1984. The ontogeny of hollows in Blackbutt (*Eucalyptus pilularis*) and its relevance to the management of forests for possums, gliders and timber. Pages 553-567 in A. P. Smith and I. D. Hume, editors. *Possums and Gliders*. Surrey Beatty and Sons, Chipping Norton.
- Maher, W. A. and R. H. Norris. 1990. Water Quality Assessment Programs in Australia. Deciding What to Measure, and How and Where to use Bioindicators. *Environmental Monitoring and Assessment* **14**:115-130.
- Marchant, S. and P. J. Higgins. 1993. *Handbook of Australian, New Zealand and Antarctic Birds Volume 2*. Oxford University Press, Melbourne.
- Maron, M., A. Main, M. Bowen, A. Howes, J. Kath, C. Pillette, and C. A. McAlpine. 2011. Relative influence of habitat modification and interspecific competition on woodland bird assemblages in eastern Australia. *Emu* **111**:40-51.
- Marsden, S. J. and J. D. Pilgrim. 2003. Factors influencing the abundance of parrots and hornbills in pristine and disturbed forest on New Britain, PNG. *Ibis* **145**:45-53.
- McIntyre, S., J. G. Mclvor, and K. M. Heard. 2002. *Managing and Conserving Grassy Woodlands*. CSIRO Publishing, Collingwood.
- Murphy, S. A. and S. M. Legge. 2007. The gradual loss and episodic creation of Palm Cockatoo (*Probosciger aterrimus*) nest-trees in a fire- and cyclone-prone habitat. *Emu* **107**:1-6.
- Namoi CMA. 2010. *Weed control in regionally significant vegetation 2010/2011 Guidelines for applications*. Namoi Catchment Management Authority, NSW.
- Namoi CMA. 2011a. *Namoi Catchment Action Plan 2010-2020 (Pending Ministerial Approval)*. Namoi Catchment Management Authority, NSW.

- Namoi CMA. 2011b. Namoi Catchment Management Authority Biodiversity Offsets Policy. Namoi Catchment Management Authority, Gunnedah, NSW.
- Newton, I. 1994. The role of nest sites in limiting the numbers of hole-nesting birds: a review. *Biological Conservation* **70**:265-276.
- Newton, I., R. Kavanagh, J. Olsen, and I. Taylor, editors. 2002. *Ecology and Conservation of Owls*. CSIRO Publishing, Collingwood.
- Nichols, O. G. 2005. Development of Rehabilitation Completion Criteria for Native Ecosystem Establishment on Coal Mines in the Hunter Valley. Final Report. Australian Coal Association Research Program, Brisbane, QLD.
- Nichols, O. G., C. Grant, and L. C. Bell. 2005. Developing ecological completion criteria to measure the success of forest and woodland establishment on rehabilitated mines in Australia.
- NSW Department of Primary Industries. 2006. The Assessment and Modification of Barriers to Fish Passage in the Namoi Catchment. Department of Primary Industries (Aquatic Habitat Rehabilitation Unit), Tamworth, NSW.
- NSW Department of Primary Industries. 2013. Factsheet finder - Fishing and aquaculture.
- NSW NPWS. 1999a. Threatened Species Information: Spotted-tailed Quoll. NSW National Parks and Wildlife Service, Hurstville.
- NSW NPWS. 1999b. Threatened Species Information: Square-tailed Kite. NSW National Parks and Wildlife Service, Hurstville.
- NSW NPWS. 2003. Threatened Species Information: Barking Owl NSW National Parks and Wildlife Service, Hurstville.
- NSW NPWS. 2005. Identification Guidelines for Endangered Ecological Communities: White Box Yellow Box Blakely's Red Gum Woodland (Box-Gum Woodland). National Parks and Wildlife Service, Hurstville NSW.
- NSW Scientific Committee. 2009. Turquoise Parrot *Neophema pulchella*. Review of current information in NSW. June 2009. Unpublished report arising from the Review of the Schedules of the Threatened Species Conservation Act 1995. Department of Environment, Climate Change and Water, Hurstville, NSW.
- NSW Scientific Committee. 2001a. Black-chinned Honeyeater (eastern subspecies) - vulnerable species listing. Department of Environment and Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2001b. Diamond Firetail - vulnerable species listing. NSW National Parks and Wildlife Service, Hurstville.
- NSW Scientific Committee. 2001c. Grey-crowned babbler (eastern subspecies) - vulnerable species listing. Department of Environment and Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2001d. Speckled Warbler - vulnerable species listing. Department of Environment and Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004a. Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands - key threatening process declaration. Department of Environment & Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004b. *Bothriochloa biloba* (a grass) - removal of vulnerable species listing. Department of Environment, Climate Change and Water, Hurstville NSW.
- NSW Scientific Committee. 2004c. Brown Treecreeper (eastern subspecies) - vulnerable species listing. Department of Environment and Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004d. Bushrock removal - key threatening process declaration. Department of Environment & Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004e. Clearing of native vegetation - key threatening process declaration. Department of Environment and Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004f. *Dichanthium setosum* - vulnerable species listing. Department of Environment and Conservation (NSW), Hurstville, NSW.
- NSW Scientific Committee. 2004g. Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions - endangered ecological community listing. Department of Environment and Conservation (NSW), Hurstville.

- NSW Scientific Committee. 2004h. Removal of dead wood and dead trees - key threatening process declaration. Department of Environment & Conservation (NSW), Hurstville.
- NSW Scientific Committee. 2004i. White box yellow box Blakely's red gum woodland - endangered ecological community listing. Department of Environment and Conservation (NSW), Hurstville, NSW.
- NSW Scientific Committee. 2006. Loss of hollow-bearing trees - key threatening process declaration. Department of Environment and Climate Change (NSW).
- NSW Scientific Committee. 2009. Little Lorikeet - vulnerable species listing. Department of Environment and Climate Change, Hurstville, NSW.
- NSW Scientific Committee. 2010. Varied Sittella - vulnerable species listing. Department of Environment, Climate Change and Water, Hurstville, NSW.
- OEH. 2012. Atlas of NSW Wildlife.
- Oliver D. L. 1998. Short Communication: Roosting of Non-breeding Regent Honeyeaters *Xanthomyza phrygia*. *Emu* **98**:65-69.
- Oliver D. L. 2000. Foraging behaviour and resource selection of the Regent Honeyeater *Xanthomyza phrygia* in Northern New South Wales. *Emu* **100**:12-30.
- Olsen, J., D. Judge, E. Fuentes, A. B. Rose, and S. J. S. Debus. 2010. Diets of Wedge-tailed Eagles (*Aquila audax*) and Little Eagles (*Hieraaetus morphinoides*) breeding near Canberra, Australia. *Journal of Raptor Research* **44**:50-61.
- Phillips, S. and J. Callaghan. 2011. The Spot Assessment Technique: a tool for determining localised levels of habitat use by Koalas *Phascolarctos cinereus*. *Australian Zoologist* **35**:774-780.
- Phillips, S., M. Hopkins, and J. Warnken. submitted. Splines in the sand: modelling metapopulation distribution across the landscape to provide greater conservation and planning certainty for an arboreal marsupial (Koala *Phascolarctos cinereus*).
- Pizzey, G. and F. Knight. 2003. The Field Guide to the Birds of Australia. 7th edition. HarperCollins Publishers Pty Ltd, Australia.
- Primack, R. B. 1993. Essentials of Conservation Biology. Sinauer Associates Inc, Sunderland.
- Quinn, F. C., J. B. Williams, C. L. Gross, and J. J. Bruhl. 1995. Report on Rare and Threatened Plants of North East New South Wales.
- RACAC. 2000. Preliminary Overview of the Brigalow Belt South Bioregion (Stage 1). Resource and Conservation Assessment Council, Hurstville, NSW.
- Rawlings, K., D. Freudenberger, and D. Carr. 2010. A Guide to Managing Box Gum Grassy Woodlands. Caring for our Country Environmental Stewardship.
- Reid, J. R. W. 1999. Threatened and declining birds in the New South Wales sheep-wheat belt: I Diagnosis, characteristics and management. CSIRO Wildlife and Ecology, Canberra.
- Richardson, F. J., R. G. Richardson, and R. C. H. Shepherd, editors. 2006. Weeds of the South-east: An identification guide for Australia. R.G. and F.J. Richardson, Victoria.
- Saleh, T. 2007. Effects of Artificial Lighting on Wildlife. The Road-RIPorter (Summer Solstice Issue) **12**.
- Saunders, D. L. and R. Heinsohn. 2008. Winter habitat use by the endangered, migratory Swift Parrot (*Lathamus discolor*) in New South Wales, Australia. *Emu* **108**:81-89.
- Schrader, N. 1980. A review of the distribution of the Superb Parrot in New South Wales. *Australian Birds* **14**:45-50.
- SEWPaC. 2009. Water resources - Overview - New South Wales. Australian Natural Resources Atlas. Department of Sustainability Environment Water Population and Communities.
- SEWPaC. 2010. Invasive Species Fact Sheet. European Red Fox (*Vulpes vulpes*). Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- SEWPaC. 2011a. *Anomalopus mackayi* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.

- SEWPaC. 2011b. *Aprasia parapulchella* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SEWPaC. 2011c. *Dichanthium setosum* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- SEWPaC. 2011d. *Digitaria porrecta* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- SEWPaC. 2011e. *Lathamus discolor* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- SEWPaC. 2011f. Survey guidelines for Australia's threatened mammals. Commonwealth Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SEWPaC. 2011g. Survey guidelines for Australia's threatened reptiles. Commonwealth Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SEWPaC. 2012a. *Anthochaera phrygia* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SEWPaC. 2012b. EPBC Protected Matters Search Tool. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SEWPaC. 2012c. *Haliaeetus leucogaster* in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra.
- SEWPaC. 2012d. *Phascogale cinereus* (combined populations of Qld, NSW and the ACT) in Species Profile and Threats Database. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.
- SKM. 2010. Mapping Groundwater Dependent Ecosystems in the Namoi Catchment. Application of Sebal Remotely Sensed Evapotranspiration Measurement. Sinclair Knight Mertz.
- Strahan, R. 1995. The Mammals of Australia. Reed Books, Chatswood.
- Sunnucks, P. 2011. Towards modelling persistence in woodland birds: the role of genetics. *Emu* **111**:19-39.
- Taylor, B. D. and R. L. Goldingay. 2010. Roads and wildlife: impacts, mitigation and implications for wildlife management in Australia. *Wildlife Research* **37**:320-331.
- Taylor, R. and M. Drielsma. 2012. Western Woodlands Way. Volume 2: Priorities for investment in remnant vegetation and connectivity. NSW Office of Environment and Heritage, Dubbo, NSW.
- Thoms, M., R. Norris, J. Harris, D. Williams, and P. Cottingham. 1999. Environmental Scan of the Namoi River Valley. Cooperative Research Centre for Freshwater Ecology, Canberra, ACT.
- Threatened Species Scientific Committee. 2006. Commonwealth Listing Advice on White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Department of Environment and Heritage, Canberra.
- Threatened Species Scientific Committee. 2008a. Approved Conservation Advice for *Cadellia pentastylis* (Ooline). Department of Environment, Water, Heritage and the Arts, Canberra, ACT.
- Threatened Species Scientific Committee. 2008b. Approved Conservation Advice for *Digitaria porrecta* (Finger Panic Grass). Department of the Environment, Water, Heritage and the Arts, Canberra.
- Threatened Species Scientific Committee. 2008c. Approved Conservation Advice for *Swainsona murrayana* (Slender Darling-pea). Department of Environment, Water, Heritage and the Arts, Canberra, ACT.
- Threatened Species Scientific Committee. 2008d. Commonwealth Conservation Advice on *Bothriochloa biloba* (Lobed Blue-grass). Department of Environment, Water, Heritage and the Arts, Canberra.

- Threatened Species Scientific Committee. 2008e. Weeping Myall Woodlands Listing Advice. Department of Environment, Heritage and the Arts, Canberra, ACT.
- Threatened Species Scientific Committee. 2010. Commonwealth Listing Advice on Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia. Department of Environment, Water, Heritage and the Arts, Canberra, ACT.
- Turak, E. and N. Waddell. 2001a. Development of AUSRIVAS models for New South Wales. NSW EPA, Sydney.
- Turak, E. and N. Waddell. 2001b. New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual. NSW EPA, Sydney.
- Turnpenny, A. W. H., Struthers, G, Hanson, K P,. 1998. A UK Guide to Intake Fish-Screening Regulations, Policy and Best Practice.
- Umwelt. 2009. Review of Environmental Factor for Caroon Exploration Program. Exploration Drilling and Associated Activities 2009 to 2011. Umwelt (Australia) Pty Limited, Toronto, NSW.
- Van Dyck, S. and R. Strahan, editors. 2008. The Mammals of Australia, 3rd edition. Reed New Holland, Sydney.
- von der Ohe, P. C. and M. Liess. 2004. Relative sensitivity distribution of aquatic invertebrates to organic and metal compounds. *Environmental Toxicology and Chemistry* **23**:150–156.
- Watson, D. M. 2011. A productivity-based explanation for woodland bird declines: poorer soils yield less food. *Emu* **111**:10-18.
- Whitten, S. M., D. Freudenberger, C. Wyborn, V. Doerr, and E. Doerr. 2011. A compendium of existing and planned Australian wildlife corridor projects and initiatives, and case study analysis of operational experience. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities. CSIRO Ecosystem Sciences.
- Yahner, R. H. 1988. Changes in wildlife communities near edges. *Conservation Biology* **2**:333-339.
- Zhang, L., M. Stauffacher, W. G. R., and P. Dyce. 1997. Recharge Estimation in the Liverpool Plains (NSW) for input Groundwater Models Technical Report. CSIRO Land & Water.

Appendix A

Compliance with Assessment Requirements

The purpose of this section is to demonstrate compliance with appropriate legislation and policies that have been developed by a range of stakeholders in relation to mining developments in New South Wales and Australia. This includes government agencies such as SEWPaC, DTIRIS, EPA, NOW and the Namoi CMA. Submissions were received by these agencies in relation to the development of DGRs for the Project, and these submissions have been used as the basis for the information contained in this section.

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
DGRs from DP&I	
Measures taken to avoid, reduce or mitigate impacts on biodiversity	Avoidance and mitigation measures for the Project are outlined in Chapter 7.
Accurate estimates of proposed vegetation clearing	A summary of vegetation clearance within the Project Boundary is provided in Section 6.1.
A detailed assessment of potential impacts of the development on any: terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems	A comprehensive terrestrial and aquatic impact assessment, including EECs, threatened species and GDEs, is provided in Chapter 6.
regionally significant remnant vegetation, or vegetation corridors	A comprehensive impact assessment is provided in Chapter 6, including consideration of the impact to corridors and regional vegetation communities.
A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term	A substantial Biodiversity Offsets Package (BOP) has been developed to offset the residual impacts of the Project. Details of the BOP are provided in Chapter 8.
Namoi CMA	
Project Area	

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
Identification of all vegetation communities along with condition assessments of communities in accordance with a recognised methodology. Details of methodology to be included in EIS;	Vegetation communities identified within the Project Boundary are described within Section 3.1. A vegetation/habitat condition assessment was undertaken for the vegetation occurring within the Project Boundary. The methodology utilised for the condition assessment is described in Section 2.2.2.iv and results are provided in Section 3.1.3.
Maps to be included in EIS depicting vegetation communities with various condition ratings. Maps to depict non vegetated areas;	The distribution of vegetation communities occurring within the Project Boundary is shown in Figure 3.1. The results of the vegetation/habitat condition assessments of the Project Boundary are shown in Figure 3.2.
Potential impacts on both fauna and flora from clearing, specifically impacts resulting from fragmentation of vegetation, destruction of habitat, corridor loss, edge effects, increased predation and weed introduction;	A comprehensive impact assessment is provided in Chapter 6.
An alignment of the mapped vegetation communities with Regional Vegetation Communities (RVC) (NCMA 2009) and assessment against RVC ecological condition benchmarks and CAP 2010-2020 critical thresholds;	An alignment of the vegetation community nomenclature with the Namoi CMA Regional Vegetation Communities is provided in Table 3.2. Condition data collected from the Project Boundary was compared to BioBanking benchmark data. The methodology describing how the data was compared to the benchmark data is provided in Section 2.2.2.iv).
All riparian areas need to be identified, terrestrial and aquatic impacts assessed and mitigation measures and safeguards addressed;	Terrestrial and aquatic biodiversity values of the Project Boundary are described within Chapters 3- 5. A comprehensive impact assessment is provided in Chapter 6. Mitigation measures are identified in Chapter 7.
Significant natural features including threatened species, geological features and aboriginal cultural heritage issues.	Natural features of the Project Boundary are described in Section 1.3. Details regarding threatened species recorded, or potentially occurring, within the Project Boundary are provided in Chapters 3-5.

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
	Aboriginal cultural heritage issues are beyond the scope of this EIA.
<i>Biodiversity Offset Areas</i>	
Biodiversity offset areas need to comply with requirements contained within the NSW and Commonwealth Government's approaches to biodiversity offsets along with the Namoi CMA Biodiversity Offset Policy;	The BOP was developed to be consistent with the State and Commonwealth principles for biodiversity offsets. An assessment of consistency with these principles is provided in Table 8.10 and Table 8.11.
Vegetation communities within offset areas need to be identified, mapped and assessed for condition, ranked against ecological benchmarks and assessed against critical thresholds;	Vegetation communities identified within the Onsite and Offsite Offset Areas are described within and Section 8.4.2 and Section 8.5.2, respectively. A vegetation/habitat condition assessment was undertaken for the vegetation occurring within the Onsite and Offsite Offset Areas and the results are provided in Section 8.7.2.
Agricultural suitability needs to undertaken for offset areas to identify any prime agricultural land and any other areas not suitable or not to be used for replanting;	This is beyond the scope of this EIA.
Details need to be provided for revegetation measures, management actions and security arrangements for offset areas	Details regarding the management of the Onsite and Offsite Offset Areas are provided in Section 8.6.
The EIS needs to consider the ecological impacts, safeguards and contributions especially in consideration of the Catchment Targets within the Namoi CAP (2010-2020);	
Biodiv 1: By 2020 there is an increase in native vegetation extent and vegetation does not decrease to less than 70% in less cleared sub catchments and 30% in over cleared sub catchments and no further Regional Vegetation Community decreases to less than 30% extent as identified by 2010 baseline.	With the implementation of the offset measures described in Chapter 8, it is considered that there will be no net loss in vegetation in the Namoi Catchment.
Biodiv 2: By 2020 maintain sustainable populations of a range of fauna species by ensuring that	The conservation of native vegetation within the offset areas will ensure

Table A.1 Compliance with Assessment Requirements		
	Assessment Requirement	Assessment of Compliance
	no further Regional Vegetation Community decreases to less than 30% extent as identified by 2010 baseline.	fauna habitat is maintained in the Namoi Catchment and sustainable populations of fauna are maintained. The BOP is described within Chapter 8.
	Biodiv 3: By 2020 contribute to the recovery of priority viable threatened species, populations and communities.	The conservation of significant areas of land in the BOP will contribute to the recovery of threatened species populations and communities. The BOP is described within Chapter 8.
	Biodiv 4: By 2020 no new invasive species are established in the Catchment and the spread of key emerging invasive plants and animals is limited.	A BMP will be implemented that will manage the risk of invasive species and weeds (see Section 7.4).
	The EIS needs to undertake a thorough and rigorous pre and post mining risk assessment with respect to long term site specific and cumulative impacts on the ecology both within the project area, the Breeza to Curlewis area and within the Catchment.	This has been addressed in Appendix E of the EIS for the Project, which is being prepared by Hansen Bailey.
	The EIS also needs to provide details on clearing and offset ratios and balances based on both extent and condition.	Details of clearing and offset ratios are provided in Section 8.7 and Section 8.9.1.
	Significant weed species and risks within the proposed development footprint and develop weed suppression, management and containment strategies to ensure they are not spread. Particular attention should be paid to soil stockpiles, roadsides and disturbed areas.	A BMP will be implemented that will manage the risk of invasive species and weeds (see Section 7.4).
	The use of biodiversity offsets on Agricultural land needs to be explored. The tying up of current and future productive agricultural land under biodiversity offsets is not in the interest of the agricultural community.	This is beyond the scope of this EIA.
DPI Fisheries (Division of DTIRIS)		
<i>General Aquatic Ecological Assessment</i>		

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
An aquatic ecological assessment should be made of the impacts of the pipeline on the Mooki River & Native Dog Gully & include the following information;	
Area which may be affected either directly or indirectly should be identified and shown on a map (and aerial photographs) including the proposed location of all pipelines to waterways within the project area.	The Project Boundary and Disturbance Area are shown in Figure 1.2. This map shows all areas that may be affected including the proposed location of all pipelines and the location of waterways.
Description and quantification of aquatic and riparian vegetation in this area should be presented and mapped. This should include an assessment of the extent and condition of riparian vegetation and the extent and condition of freshwater aquatic vegetation including the presence of significant habitat features (e.g. gravel beds, snags, reed beds, etc)	The results of the aquatic assessment are provided in Chapter 5. This includes consideration of aquatic habitat features and riparian vegetation.
Quantification of the extent of aquatic and riparian habitat removal or modification which will result from the proposed development.	A description of the impacts to aquatic and riparian habitats is presented in Chapter 7.
<i>Hydrological Impacts</i>	
The impacts of altered hydrology on associated aquatic & riparian ecosystems such as floodplain wetlands & riparian vegetation. Changes in flow patterns may result in the death of aquatic and riparian vegetation that relies on surface water/shallow ground water flows; and	The hydrological impacts of the Project are considered in Section 6.8.
Monitoring of groundwater and surface water interactions to ensure that no negative impacts on surface water quantity or quality	This is beyond the scope of this EIA.
<i>Pump Extraction Screen Technology</i>	
The department has been collaboratively working with the irrigation industry for several years to reduce the impacts of irrigation infrastructure removing and damaging juvenile/adult fish from river systems through the use of extraction screen technology on irrigation pump inlet valves. The EA should address the use of pump extraction screen technology for water extraction from the	The Mooki river does not have a resident population of fish as it periodically dries out. Accordingly this point is not considered relevant.

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
Mooki River to minimise the impacts of fish mortality.	
<i>Threatened Species, Populations and Ecological Communities; Fisheries Management Act 1994</i>	
The proposal should include a threatened aquatic species assessment (as per part 7A Fisheries Management Act 1994) to address whether there are likely to be any significant impacts on listed threatened species, populations or ecological communities listed under the Fisheries Management Act 1994. Species, populations and ecological communities likely to be present within this catchment include:	
- The olive perchlet <i>Ambassis agassizii</i> listed under Schedule 4, (Endangered populations) of the FM Act.	Although this species is present in the Namoi Catchment, it is unlikely to be present within the Project Boundary or in the portion of the Mooki River adjacent to the Project Boundary. Accordingly no significant impacts are likely and an impact assessment is not considered necessary.
- The silver perch <i>Bidyanus bidyanus</i> listed under Schedule 5 (Vulnerable species) of the FM Act.	Although this species is present in the Namoi Catchment, it is unlikely to be present within the Project Boundary or in the portion of the Mooki River adjacent to the Project Boundary. Accordingly no significant impacts are likely and an impact assessment is not considered necessary.
- The eel tail catfish <i>Tandanus tandanus</i> listed under Schedule 4 (Endangered population within the Murray-Darling Basin) of the FM Act.	Although this species is present in the Namoi Catchment, it is unlikely to be present within the Project Boundary or in the portion of the Mooki River adjacent to the Project Boundary. Accordingly no significant impacts are likely and an impact assessment is not considered necessary.
- The purple-spotted gudgeon <i>Mogurnda adspersa</i> is listed under Schedule 4, (Endangered species) of the FM Act.	Although this species is present in the Namoi Catchment, it is unlikely to be present within the Project Boundary or in the portion of the Mooki River adjacent to the Project Boundary. Accordingly no significant impacts are likely and an impact assessment is not considered necessary.

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
- The Murray cod <i>Maccullochella peelii peellii</i> are nationally listed as vulnerable under the EPBC Act.	Although this species is present in the Namoi Catchment, it is unlikely to be present within the Project Boundary or in the portion of the Mooki River adjacent to the Project Boundary. Accordingly no significant impacts are likely and an impact assessment is not considered necessary.
- The aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River is listed as an Endangered Ecological Community under Schedule 4, of the FM Act and includes all tributaries under 500 m altitude such as the Mooki River.	Potential impacts to this aquatic community have been assessed in Section 6.8.
NSW EPA	
1. A field survey of the site should be conducted and documented in accordance with the gazetted draft Guideline for Threatened Species Assessment and the document "Threatened Biodiversity Assessment - Guidelines for Developments and Activities" (Working Draft) (DEC 2004);	A field survey of the Project Boundary has been conducted according to these guidelines. The methodology and survey locations are presented in Chapter 2.
2. Likely impacts on threatened species and their habitat need to be assessed, evaluated and reported on. The assessment should specifically report on the considerations listed in Step 3 of the draft guideline. These are:	A comprehensive impact assessment has been prepared and is provided in Chapter 6.
Devise technical objectives	The technical objectives of this report are identified in Section 1.1. These are to determine whether a significant impact is likely to occur to threatened biodiversity as a result of the Project.
Recognising and dealing with potential constraints	The potential constraints to this assessment have been acknowledged and the surveys designed to deal with them (Chapter 2). The remaining limitations of the assessment have been identified and considered in Section 2.5.

Table A.1 Compliance with Assessment Requirements		
	Assessment Requirement	Assessment of Compliance
	Adopt the Precautionary Principle	The precautionary principle has been adopted in this EIA, and threatened species not recorded from the Project Boundary, but considered to have potential to occur on the basis of suitable habitat have been identified and presumed to occur (see Chapter 4).
	Set timeframe	The timeframe of the surveys was considered during the planning of this assessment, and surveys were conducted in appropriate times of year to record the majority of taxa present (see Chapter 2).
	3. Describe the actions that will be taken to avoid or mitigate impacts or compensate for unavoidable impacts of the project on threatened species and their habitat. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Chapter 7 provides details of the actions taken to avoid or mitigate impacts. Chapter 8 provides details of the BOP that has been developed to compensate for the unavoidable impacts on threatened species and their habitat.
	4. Describe the extent of loss of any native vegetation and a strategy to offset any losses to ensure maintenance of, or improved outcome for biodiversity.	The extent of loss of native vegetation has been quantified in Chapter 6. A detailed BOP has been developed to offset any losses in diversity and is provided in Chapter 8.
	5. The EA needs to clearly state whether it meets each of the key thresholds set out in Step 5 of the guideline.	Step 5 of the guideline does not refer to key thresholds. It refers to "key attributes of the proposal". These are discussed below.
	The location of the proposal and any additional areas which are likely to be affected by the proposal. These should be delineated on a map showing the proposal in both a local and regional context	The regional context is shown in Figure 1.1 and the Project layout is shown in Figure 1.2.
	The type of development, activity or action including any ancillary works and intrinsic work stages	This information is provided in Section 1.2.
	The duration and timing of the proposal, including staging	This information is provided in Section 1.2.
	The area affected by the proposal (directly and indirectly) in hectares.	The area directly impacted by the Project is provided in Section 6.1.

Table A.1 Compliance with Assessment Requirements		
Assessment Requirement	Assessment of Compliance	
The EA must consider the corridor values or connective importance of any vegetation on the subject land. The EPA prefers that vegetation on adjoining land that exhibits these corridor values should be retained and, where necessary, rehabilitated. The final rehabilitation objectives, with appropriate performance monitoring against rehabilitation objectives, should be clearly defined in the EA.	The values of corridors and connectivity on the subject land have been considered in Section 4.1.5. No rehabilitation is proposed to occur on adjoining land.	
The impact on Koala habitat is obviously a key concern. It noted that work has been commenced on identifying and protecting Koala's and their habitat in the proposed mine area. Management of Koala and their habitat will need to be fully assessed and impacts avoided / mitigated in accord with Best Practice.	Management of Koalas should be undertaken in accordance with a KPOM, which is provided in Appendix L of the EIS.	
Impacts of the Project on Native Vegetation		
The EA needs to address the potential impact on native vegetation, specifically:		
1. The hectares of native vegetation that will have to be cleared to accommodate mining for the extension project;	The extent of loss of native vegetation has been quantified in Section 6.1.	
2. The floristics of the botanical communities of native vegetation that will need to be cleared;	A floristic description of the native vegetation communities to be cleared is provided in Section 3.1.	
3. The extent of native vegetation on the site which may be remnant vegetation, protected regrowth or non-protected regrowth as defined by the Native Vegetation Act 2003; and	The native vegetation within the Project Boundary primary comprises remnant vegetation with some areas of confirming to the regrowth category. The extent of vegetation within the Project Boundary is provided in Section 3.1.	
4. The requirement to develop suitable offset(s) to improve or maintain environmental outcomes for the lawful clearing of native vegetation, in relation to four environmental values: water quality, soils, salinity and biodiversity (including threatened species).	A detailed BOP has been development for the Project and is presented in Chapter 8. This considers biodiversity only, as water quality, soils, and salinity are beyond the scope of this EIA.	

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
NSW Office of Water	
<i>Groundwater Dependent Ecosystems</i>	
The NSW Groundwater Dependent Ecosystem Policy provides principles for the management of groundwater dependent ecosystems (GDEs). The EIS is required to demonstrate how the project is consistent with these principles, especially Principle 5, relate to protection of species and ecosystems which are dependent on maintenance and quality within adjacent groundwaters to the mining proposal. The EIS must provide the following information:	
- Identification of potential GDEs within the study area;	Potential GDEs within the Project Boundary have been identified in Section 3.2.
- Details of current GDE condition, and water quantity and quality required by the GDEs (based on minimum 2 year fortnightly baseline data);	The quantity and quality of groundwater required by vegetation within the Project Boundary is unknown and this degree of baseline data is currently unavailable.
- Details of a flora and fauna assessment for all GDEs, which includes, macroinvertebrate and macrophyte diversity and abundance assessments within all watercourses within and adjacent to the mining area;	An aquatic ecology assessment has been conducted and the results are presented in Chapter 5. This includes assessment of macroinvertebrate diversity and abundance, and consideration of macrophytes as a component of aquatic habitat.
- Stygofauna within any aquifer which will be potentially impacted during mining;	Stygofauna are beyond the scope of this EIA and are addressed in the Stygofauna Assessment undertaken for the Project by Eco Logical Australia Pty Limited.
- Details of critical thresholds for negligible impacts;	Negligible impacts would be those that reduce that viability of GDEs, but not significantly. The degree of dependence of the vegetation within the Project Boundary on groundwater cannot be conclusively determined, however it is not considered likely that the Project will significantly impact on GDEs.

Table A.1 Compliance with Assessment Requirements	
Assessment Requirement	Assessment of Compliance
The EIS must also demonstrate the following:	
- That, where possible, natural patterns of groundwater flow will be maintained;	This is beyond the scope of this EIA.
- That groundwater extraction will be managed within defined limits, so that groundwater levels which are critical for GDEs will not be disrupted and that there is sufficient flow to sustain ecological processes and maintain biodiversity;	This is beyond the scope of this EIA.
- That the project will not cause adverse changes in groundwater quality, leading to degradation of existing beneficial use class(es) of groundwater and that sufficient groundwater of suitable quality is available to GDEs when needed.	This is beyond the scope of this EIA.
- That the precautionary principle is applied in the protection of GDEs, particularly with regard to the dynamics of flow and availability, and the species reliant on these attributes.	This is beyond the scope of this EIA
- Protective measures will minimise any impacts on GDEs and potential offset areas will be monitored and protected.	A range of measures have been proposed to minimise impacts on ecosystems within the Project Boundary, including GDEs, and these are presented in Chapter 7. Specifications for the protection and monitoring of offset areas are detailed in Chapter 8.
<i>Watercourse Protection</i>	
To ensure the sustainable and integrated management of surface water sources which may be affected by this project, and to protect waterfront land from impacts arising from controlled activities which form part of this project, the Office of Water requires the following:	
- Identification of watercourses	Watercourses within or near the Project Boundary are identified in Figure 1.1 and Figure 1.2.
- Remediation and rehabilitation requirements for the long term integrity of watercourses which are disturbed	This is beyond the scope of this EIA.

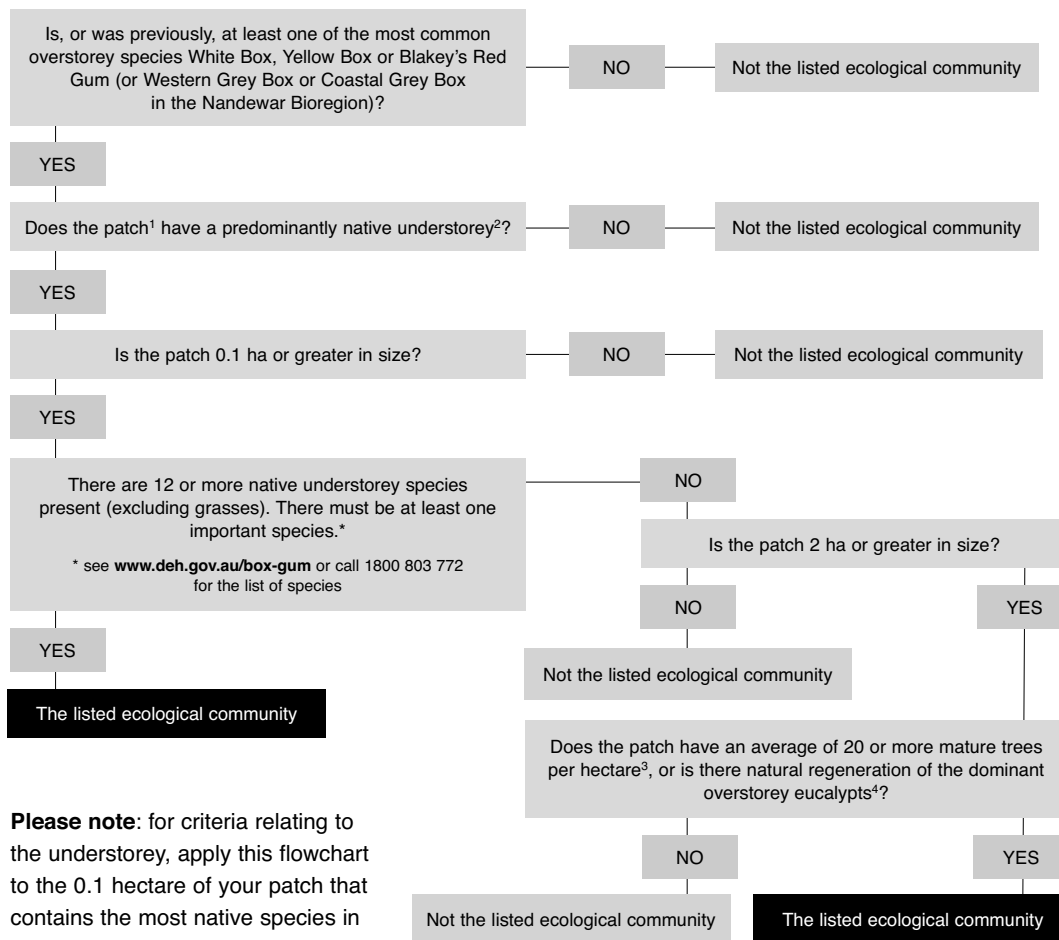
Table A.1 Compliance with Assessment Requirements		
	Assessment Requirement	Assessment of Compliance
<i>Riparian Protection</i>	Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions.	No riparian corridors are present within the Project Boundary. Although some watercourses are present, the riparian vegetation has been removed.

Appendix B

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



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 is 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 C

Flora Quadrat Data

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1	Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

Family	Scientific Name	Common Name
Polygonaceae	Rumex tenax	
Portulacaceae	Calandrinia eremaea	
* Portulacaceae	*	Portulaca oleracea
Ranunculaceae	Ranunculus pentadactylus	
Ranunculaceae	Ranunculus sessiliflorus var sessiliflorus	
Rubiaceae	Asperula conferta	
Rubiaceae	Gallium leptogonion	
Rubiaceae	Gallium microlobum	
Rubiaceae	Gallium polyanthum	
Rubiaceae	Gallium sp. A	
Rubiaceae	Opercularia diphylla	
Rubiaceae	Pomax umbellata	
Rubiaceae	* Linaria arvensis	
* Scrophulariaceae	* Misopates orontium	
* Scrophulariaceae	* Verbascum virgatum	
* Scrophulariaceae	* Veronica arvensis	
Solanaceae	Nicotiana simulans	
Solanaceae	Physalis viscosa	
* Solanaceae	* Solanum nigrum	
Stackhouseiaceae	Stackhouisia viminea	
Steruliaceae	Brachychiton populneus subsp. popluneus (seedling)	
Urticaceae	Parietaria debilis	
Urticaceae	Urtica incisa	
Urticaceae	Urtica sp.	
Verbenaceae	Phytla nodiflora	
Verbenaceae	* Verberna bonariensis	
Verbenaceae	* Verberna hispida	
Verbenaceae	* Verberna officinalis	
Verbenaceae	* Verberna tenuisecla	
Zygophyllaceae	Tribullius macrococcus	
Zygonphyllaceae	* Tribullus terrestris	
Zygonphyllaceae	Zygyphylum apiculatum	
Herbs - Monocots	(Grasses)	
Poaceae	sp.	
Poaceae	Agrostis venusta	
Poaceae	Ancistrachne uncinulada	
Poaceae	Aristida acuta	
Poaceae	Aristida calycina var. calycina	
Poaceae	Aristida calycina var. praeailta	
Poaceae	Aristida caput-medusae	
Poaceae	Aristida leptomoda	
Poaceae	Aristida personata	
Poaceae	Aristida ramosa	
Poaceae	Aristida sp.	
Poaceae	Austrodanthonia bipartita	
Poaceae	Austrodanthonia caespitiosa	
Poaceae	Austrodanthonia fulva	
Poaceae	Austrodanthonia racemosa var. obtusala	
Poaceae	Austrodanthonia racemosa var. racemosa	
Poaceae	Austrodanthonia richardsonii	
Poaceae	Austrodanthonia sp.	
Poaceae	Austrodanthonia tenerior	
Poaceae	Austroriviera castaneipes	

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

[illegible]

Table C.1 Flora Quadrat Data (Quadrats 1-45)

Table C.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	Q45			
Anthericaceae	<i>Artropodium</i> sp. B																																																	
Anthericaceae	<i>Laxmannia gracilis</i>	Slender Wire-lily																																																
Anthericaceae	<i>Tricoryne elatior</i>							2																																										
Anthericaceae	<i>Bulbine elatior</i>							2																																										
Asphodelaceae	<i>Bulbine bulbosa</i>																																																	
Asphodelaceae	<i>Bulbine semibarbata</i>																																																	
Commelinaceae	<i>Commelina cyanea</i>	Native Wandering Jew																																																
Commelinaceae	<i>Commelina graminea</i>	Grass Lily																																																
Cyperaceae	<i>Carex inversa</i>																																																	
Cyperaceae	<i>Cyperus bifax</i>																																																	
Cyperaceae	<i>Cyperus difformis</i>																																																	
Cyperaceae	<i>Cyperus fulvus</i>	Sticky Sedge																																																
Cyperaceae	<i>Cyperus gracilis</i>	Slender Flat-sedge																																																
Cyperaceae	<i>Cyperus squarrosus</i>	Bearded Flat-sedge																																																
Cyperaceae	<i>Eleocharis acuta</i>																																																	
Cyperaceae	<i>Fimbristylis dichotoma</i>																																																	
Cyperaceae	<i>Gahnia aspera</i>	Rough Saw-sedge																																																
Cyperaceae	<i>Lepidosperma laterale</i>																																																	
Cyperaceae	<i>Schoenus apogon</i>	Common Bog-rush																																																
Cyperaceae	<i>Melichrus urceolatus</i>	Urn-heath																																																
Cyperaceae	<i>Hypoxis hygrometrica</i> var. <i>villosisepala</i>																																																	
Cyperaceae	<i>Hypoxis hygrometrica</i> var. <i>villosisepala</i>																																																	
Cyperaceae	<i>Hypoxis praterensis</i> var. <i>pratensis</i>	Golden Weather-grass																																																
Cyperaceae	<i>Juncus australis</i>																																																	
Cyperaceae	<i>Juncus bufonius</i>	Toad Rush																																																
Cyperaceae	<i>Juncus ochrocoleus</i>																																																	
Cyperaceae	<i>Juncus remotiflorus</i>																																																	
Cyperaceae	<i>Juncus sp.</i>																																																	
Cyperaceae	<i>Juncus subsecundus</i>																																																	
Cyperaceae	<i>Juncus usitatus</i>																																																	
Cyperaceae	<i>Lomandra bracteata</i>																																																	
Cyperaceae	<i>Lomandra filiformis</i> ssp. <i>filiformis</i>	Wattle Mat-rush																																																
Cyperaceae	<i>Lomandra multiflora</i> ssp. <i>multiflora</i>	Many-flowered Mat-rush																																																
Cyperaceae	<i>Lomandra sp.</i>																																																	
Cyperaceae	<i>Cymbidium canaliculatum</i>	Tiger Orchid																																																
Cyperaceae	<i>Microtis unifolia</i>																																																	
Cyperaceae	<i>Thelymitra</i> sp.																																																	
Cyperaceae	<i>Dianella longifolia</i> var. <i>longifolia</i>																																																	
Cyperaceae	<i>Dianella revoluta</i> var. <i>revoluta</i>	Blue Flax-lily																																																
Vines																																																		
Apocynaceae	<i>Parsonsia eucalyptophylla</i>	Gargaloo																																																
Araliaceae	<i>Hedera helix</i>	English Ivy																																																
Bignoniaceae	<i>Pandorea pandorana</i> subsp. <i>pandorana</i>	Wonga Wonga Vine																																																
Lauraceae	<i>Cassytha glabella</i>	Slender Devil's Twine																																																
Ranunculaceae	<i>Clematis microphylla</i>	Small-leaved Clematis																																																

* denotes exotic species

Table C.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table C.2 Flora Quadrat Data (Quadrats 46-90)

Table C.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table C.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table C.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

Table C.2 Flora Quadrat Data (Quadrats 46-90)

Table C.2 Flora Quadrat Data (Quadrats 48-90)		
Family	Scientific Name	Common Name
Chenopodiaceae	<i>Eriada sp.</i>	
	<i>Eriada trigonos</i>	Fishweed
	<i>Eriada trigonos</i> subsp. <i>stellata</i>	Fishweed
Chenopodiaceae		
Chenopodiaceae	<i>Enchylaena tomentosa</i>	Ruby Sailbush
Chenopodiaceae	<i>Maireana decalvans</i>	
Chenopodiaceae	<i>Salsola tragus</i>	
Chenopodiaceae	<i>Scleroalea birchii</i>	Galvanized Burr
Chenopodiaceae	<i>Scleroalea diacantha</i>	Grey Copperburr
Chenopodiaceae	<i>Scleroalea divaricata</i>	Tangled Copperburr
Chenopodiaceae	<i>Scleroalea intricata</i>	
Chenopodiaceae	<i>Scleroalea muricata</i> var. <i>muricata</i>	Black Rolypoly
Chenopodiaceae	<i>Scleroalea muricata</i> var. <i>semiglabra</i>	Black Rolypoly
Chenopodiaceae	<i>Scleroalea muricata</i> var. <i>villosa</i>	Black Rolypoly
Chenopodiaceae	<i>Scleroalea sp.</i>	
Chenopodiaceae	<i>Scleroalea ventricosa</i>	
Chenopodiaceae	<i>Tectaria triandra</i>	
Chenopodiaceae		
Chenopodiaceae	<i>Hypericum gramineum</i>	Small St. John's Wort
Chenopodiaceae	<i>Convolvulus angustissimus</i> ssp. <i>angustissimus</i>	
Chenopodiaceae		
Chenopodiaceae	<i>Dichondra repens</i>	Kidney Weed
Chenopodiaceae	<i>Dichondra repens</i> glabrous	
Chenopodiaceae		
Chenopodiaceae	<i>Dichondra</i> sp. A	
Chenopodiaceae	<i>Evavilus alsinoides</i> var. <i>decumbens</i>	
Chenopodiaceae		
Chenopodiaceae	<i>Bryophyllum delagoense</i>	Mother-of-millions
Chenopodiaceae	<i>Crassula seiberiana</i>	
Chenopodiaceae	<i>Citrullus colocynthis</i>	Bitter Apple/ Cucumber
Chenopodiaceae	<i>Cucumis myriocarpus</i> subsp. <i>leptodermis</i>	Paddy Melon
Chenopodiaceae		
Chenopodiaceae	<i>Hibbertia obtusifolia</i>	Hoary Guniea Flower
Chenopodiaceae	<i>Chamaesyce drummondii</i>	Caustic Weed
Chenopodiaceae	<i>Chamaesyce</i> sp. A	
Chenopodiaceae	<i>Euphorbia lammensis</i>	
Chenopodiaceae	<i>Phyllanthus hebecarpus</i>	
Chenopodiaceae	<i>Poranthura micophylla</i>	
Chenopodiaceae	<i>Petalostylis labcheoides</i>	
Chenopodiaceae		
Chenopodiaceae	<i>Cullen australasicum</i>	
Chenopodiaceae	<i>Cullen tenax</i>	Tough-scurf Pea
Chenopodiaceae	<i>Desmodium brachypodium</i>	Large tick-trefoil
Chenopodiaceae	<i>Desmodium varians</i>	Tick-trefoil
Chenopodiaceae	<i>Glycine clandestina</i>	
Chenopodiaceae	<i>Glycine labacina</i>	
Chenopodiaceae	<i>Medicago minima</i>	Woolly Burr-Medic
Chenopodiaceae	<i>Medicago polymorpha</i>	
Chenopodiaceae	<i>Medicago sativa</i>	Lucerne
Chenopodiaceae	<i>Medicago truncatula</i>	
Chenopodiaceae	<i>Onobrychis vicifolia</i>	Sainfoin
Chenopodiaceae	<i>Rhynchosia minima</i>	
Chenopodiaceae	<i>Swainsona cadellii</i>	
Chenopodiaceae	<i>Tephrosia brachyodon</i>	
Chenopodiaceae	<i>Tribilium angustifolium</i>	Narrow-leaved Clover
Chenopodiaceae	<i>Tribilium arvense</i>	Haresfoot Clover
Chenopodiaceae	<i>Tribilium campestre</i>	Hop Clover
Chenopodiaceae	<i>Tribilium glomeratum</i>	Cluster Clover
Chenopodiaceae	<i>Tribilium scabrum</i>	
Chenopodiaceae	<i>Tribilium</i> sp.	Clover

Table C.2 Flora Quadrat Data (Quadrats 46-90)

[illegible]

[illegible]

Table C.2 Flora Quadrat Data (Quadrats 46-90)

Table C.2 Flora Quadrat Data (Quadrats 46-90)																																																						
Family	Scientific Name	Common Name	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90							
Poaceae	<i>Austrostipa densiflora</i>																																																					
Poaceae	<i>Austrostipa ramosissima</i>	Spout Bamboo Grass																																																				
Poaceae	<i>Austrostipa scabra subsp. scabra</i>	Speargrass	2		3	3	2	2	1	2								2	2							2						2	2	2	2																			
Poaceae	<i>Austrostipa setacea</i>	Corkscrew Grass																						2		3	3																											
Poaceae	<i>Austrostipa sp.</i>																																																					
Poaceae	<i>Austrostipa verticillata</i>	Slender Bamboo Grass	2	X	2		X	4		3				2			2	2															2																					
Poaceae	* <i>Avena sp.</i>	Oats																					2																															
Poaceae	<i>Bothriochloa bieberi</i>																																																					
Poaceae	<i>Bothriochloa decipiens</i> var. <i>decipiens</i>	Red Grass					4			2			5	5			2							2																														
Poaceae	<i>Bothriochloa macra</i>	Red-leg Grass																	6	5	2																																	
Poaceae	<i>Bothriochloa sp.</i>						2		3	4	5																																											
Poaceae	* <i>Bromus arenarius</i>																																																					
Poaceae	* <i>Bromus catharticus</i>	Prairie Grass									1																																											
Poaceae	* <i>Bromus hordeaceus</i>												2											2																														
Poaceae	* <i>Bromus racemosus</i>	Bald Brome																																																				
Poaceae	* <i>Cenchrus echinatus</i>	Messman River Grass																																																				
Poaceae	* <i>Chloris gayana</i>	Rhodes Grass																																																				
Poaceae	<i>Chloris truncata</i>	Windmill Grass																																																				
Poaceae	<i>Chloris verticosa</i>	Plump Windmill Grass																																																				
Poaceae	* <i>Chloris virgata</i>	Feathertop Rhodes Grass																																																				
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass	2	2																																																		
Poaceae	* <i>Cynodon dactylon</i>	Common Couch																																																				
Poaceae	<i>Dactyloctenium radicans</i>	Button Grass																																																				
Poaceae	<i>Dichanthium sericeum</i> ssp. <i>sericeum</i>	Silky Blue-grass																																																				
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass																																																				
Poaceae	<i>Dichelachne sieberiana</i>																																																					
Poaceae	<i>Digitaria breviglumis</i>																																																					
Poaceae	<i>Digitaria brownii</i>																																																					
Poaceae	* <i>Digitaria ciliaris</i>	Summer Grass																																																				
Poaceae	<i>Digitaria diffusa</i>	Open Summer-grass																																																				
Poaceae	<i>Digitaria divaricatissima</i>	Umbrella Grass																																																				
Poaceae	<i>Digitaria ramularis</i>																																																					
Poaceae	<i>Diplachne fusca</i>																																																					
Poaceae	<i>Diplachne fusca</i>	Panic Veldtgrass																																																				
Poaceae	* <i>Ehrharta erecta</i>	Goose Grass																																																				
Poaceae	* <i>Eleusine tristachya</i>																																																					
Poaceae	<i>Elymus scaber</i> var. <i>scaber</i>	Common Wheatgrass																																																				
Poaceae	<i>Elymus sp.</i>																																																					
Poaceae	<i>Elymus sp. A</i>																																																					
Poaceae	<i>Enneapogon gracilis</i>	Slender Bottle-washers																																																				
Poaceae	<i>Enneapogon sp.</i>		1		2				2																																													
Poaceae	<i>Enneapogon sp.</i>																																																					

Table C.2 Flora Quadrat Data (Quadrats 46-90)

Family	Scientific Name	Common Name	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90										
Anthericaceae	<i>Arthropodium</i> sp. B			1																																																					
	<i>Laxmannia gracilis</i>	Slender Wire-lily																																																							
	<i>Tricoryne elatior</i>																																																								
	<i>Bulbine bulbosa</i>																																																								
Asphodelaceae	<i>Bulbine semibarbata</i>																																																								
	<i>Commelina cyanea</i>	Native Wandering Jew																																																							
	<i>Murdannia graminea</i>	Grass Lily																																																							
	<i>Carex inversa</i>																																																								
Cyperaceae	<i>Cyperus bifax</i>																																																								
	<i>Cyperus difformis</i>																																																								
	<i>Cyperus furvus</i>	Sticky Sedge																																																							
	<i>Cyperus gracilis</i>	Slender Flat-sedge																																																							
Cyperaceae	<i>Cyperus squarrosus</i>	Bearded Flat-sedge																																																							
	<i>Eleocharis acuta</i>																																																								
	<i>Fimbristylis dichotoma</i>																																																								
	<i>Gahnia aspera</i>	Rough Saw-sedge																																																							
Cyperaceae	<i>Lepidosperma laterale</i>																																																								
	<i>Schoenus apogon</i>	Common Bog-rush																																																							
	<i>Meibomia urceolatus</i>	Urn-heath																																																							
Ericaceae																																																									
(Slyphelloideae)																																																									
Hypoxidaceae																																																									
Hypoxidaceae																																																									
Juncaceae																																																									
Juncaceae																																																									
Juncaceae																																																									
Juncaceae																																																									

* denotes exotic species

Appendix D

Flora Species List

Table D.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</i> var. <i>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	

Table D.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 conica</i>	Fuzzy Box			X	X
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	

Table D.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>Cassinia uncata</i>	Sticky Cassinia			X	
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

Table D.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 (Caesalpinoideae)		<i>Senna aciphylla</i>	Sprawling Cassia			X	
Fabaceae (Caesalpinoideae)		<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 sp.</i>					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 sp.</i>					X
Lamiaceae	*	<i>Marrubium vulgare</i>	Horehound			X	X

Table D.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)
Loranthaceae		<i>Lysiana subfalcata</i>				X	
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 coronandellianum</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>					

Table D.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>	Native Olive			X	
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

Table D.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 ferocissimum</i>	Spiny Potato-bush				X
Solanaceae		<i>Solanum parvifolium</i>				X	
Solanaceae		<i>Solanum parvifolium subsp. parvifolium</i>				X	
Sterculiaceae		<i>Brachychiton populneus subsp. populneus (seedling)</i>	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 rutifolius</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 galericulata 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

Table D.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>Amaranthus hybridus</i>	Slim Amaranth			X	
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>Cyclosporum 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	

Table D.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>Calotis sp.</i>	Burr-daisy				X
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 involucratus</i>	Star Cudweed			X	
Asteraceae		<i>Euchiton japonicus spp. complex</i>				X	

Table D.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>Euchiton sphaericus</i>				X	
Asteraceae		<i>Gnaphalium africanum</i>	Cud Weed			X	
Asteraceae		<i>Glossocardia bidens</i>	Cobblers Tack			X	
Asteraceae	*	<i>Hedynois 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 panetoides</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	

Table D.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>Senecio tenuiflorus</i>				X	
Asteraceae		<i>Sigesbeckia australiensis</i>				X	
Asteraceae		<i>Solenogyne bellioides</i>				X	
Asteraceae	*	<i>Soliva sessilis</i>	Bindyji			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 porifolius</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	

Table D.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>Xerochrysium bracteatum ssp. bracteatum</i>	Golden Everlasting			X	X
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	

Table D.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 luteola</i>				X	
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 Wort			X	
Caryophyllaceae		<i>Paronychia brasiliiana</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

Table D.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 pumilio</i>	Small Crumbweed			X	X
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	

Table D.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 muricata</i> var. <i>villosa</i>	Black Rolypoly			X	
Chenopodiaceae		<i>Sclerolaena</i> sp.				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</i> sp. A				X	
Convolvulaceae		<i>Evolvulus alsinoides</i> var. <i>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</i> sp. A				X	
Euphorbiaceae		<i>Cullen tenax</i>	Tough-scurf Pea			X	X
Euphorbiaceae		<i>Euphorbia tannensis</i>				X	
Euphorbiaceae		<i>Phyllanthus hebecarpus</i>				X	

Table D.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>Phyllanthus virgatus</i>				X	X
Euphorbiaceae		<i>Poranthura 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>	Wooly Burr-Medic			X	
Fabaceae (Faboideae)	*	<i>Medicago sativa</i>	Lucerne			X	
Fabaceae (Faboideae)		<i>Onobrychis viciifolia</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	

Table D.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 sp.</i>				X	
Gentianaceae	*	<i>Centaurium spicatum</i>				X	
Geraniaceae		<i>Erodium cicutarium</i>	Blue Storksbill			X	
Geraniaceae		<i>Geranium solanderi var. solanderi</i>	Native Geranium			X	
Geraniaceae		<i>Geranium sp.</i>				X	
Goodeniaceae		<i>Goodenia glabra</i>				X	
Goodeniaceae		<i>Goodenia pinatifida</i>				X	
Goodeniaceae		<i>Goodenia sp.</i>				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 sativoides</i>	Native Pennyroyal			X	
Lamiaceae		<i>Oncinocalyx 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 sp. D</i>				X	
Lobeliaceae		<i>Isotoma axillaris</i>	Showy Isotome			X	

Table D.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)
Lobeliaceae		<i>Pratia sp.</i>				X	
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 anvensis</i>	Scarlet/Blue Pimpernel			X	
Nyctaginaceae		<i>Boerhavia domini</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

Table D.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)
Oxalidaceae		<i>Oxalis thompsoniae</i>				X	
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	

Table D.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)
Ranunculaceae		<i>Ranunculus sessilifloris var sessiliflora</i>				X	
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	

Table D.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)
Urticaceae		<i>Urtica incisa</i>	Stinging Nettle			X	
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</i> (Syn <i>Aristida ramosa</i> var. <i>speciosa</i>)	Purple Wiregrass			X	

Table D.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 ramosa</i>	Purple Wiregrass			X	X
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

Table D.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 macra</i>	Red-leg Grass			X	
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

Table D.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 breviglumis</i>				X	
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 ciliaris</i>	Stinkgrass			X	X
Poaceae	*	<i>Eragrostis curvula</i>	African Lovegrass			X	

Table D.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 elongata</i>				X	
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</i> (syn. <i>Agrostis avenacea</i>)				X	
Poaceae		<i>Lamarkia aurea</i>	Goldentop			X	
Poaceae		<i>Leptochloa asthenes</i> (syn. <i>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	

Table D.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>Notodanthonia longifolia</i>	Long-leaved Wallaby Grass			X	
Poaceae		<i>Notodanthonia semicanularis</i>				X	
Poaceae		<i>Panicum bruncei</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>	Knottybutt 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	

Table D.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>Poa sieberiana var. sieberiana</i>	Snowgrass			X	
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)							

Table D.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)
Amaryllidaceae		<i>Crinum flaccidum</i>	Darling Lily			X	
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

Table D.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>Fimbristylis dichotoma</i>				X	
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	

Table D.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)
Phormiaceae		<i>Dianella sp.</i>				X	
Vines							
Marsileaceae		<i>Marsilia 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 E

Flora Likelihood of Occurrence

Table E.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	TSC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence
Artesian Springs Ecological Community	EEC	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 Penneplain 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	EEC	The Brigalow community is a low woodland or forest community dominated by <i>Brigalow Acacia harpophylla</i> , with pockets of <i>Belah Casuarina cristata</i> and Poplar Box <i>Eucalyptus populinea 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 3.1).
Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South bioregion		EEC	The Ooline community is an unusual and distinctive forest community with the canopy dominated by the tree Ooline (<i>Cadellia pentastylis</i>). Other canopy species include White Box (<i>Eucalyptus albens</i>), Ironbarks (<i>E. beyeriana</i> and <i>E. melanophloia</i>), Dirty Gum (<i>E. chloroclada</i>), Narrow-leaved Grey Box (<i>E. pilligaensis</i>), Green Mallee (<i>E. viridis</i>) and White Cypress Pine (<i>Callitris glaucophylla</i>). The understory is made up of a range of shrubs such as Wattles and grasses. Known from only seven main locations on the North West Slopes in New South Wales, between Narrabri and the Queensland border. Usually occurs on undulating terrain on a variety of soil types, between 300-450 m altitude.	Potential to occur. Not detected during surveys within the Project Boundary.
Carbeen Open Forest community in the Darling		EEC	Previously an open forest community of flora and fauna that may now exist as woodland or as remnant trees. Characteristic tree species are Carbeen (<i>Corymbia tessellaris</i>) and White Cypress-	Potential to occur. Not detected during

Table E.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	TSC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence
Riverine Plains and Brigalow Belt South Bioregions			pine (<i>Callitris glaucophylla</i>). Associated trees include <i>Corymbia dolichocarpa</i> , <i>Eucalyptus populnea</i> , <i>E. camaldulensis</i> , <i>Casuarina cristata</i> and <i>Allocasuarina leuhmannii</i> . Found on riverine plains of the Meehi, Gwydir, Macintyre and Barwon Rivers and in small remnants farther south.	surveys within the Project Boundary.
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	EEC	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.
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions		EEC	Tall woodland or open forest dominated by Fuzzy Box <i>Eucalyptus conica</i> , often with Grey Box <i>Eucalyptus microcarpa</i> , Yellow Box <i>Eucalyptus melliodora</i> , or Kurrajong <i>Brachychiton populneus</i> . Buloke <i>Allocasuarina leuhmannii</i> is common in places. Alluvial soils of the South West Slopes, Brigalow Belt South and Darling Riverine Plains Bioregions. Community occurs on brown loam or clay, alluvial or colluvial soils on prior streams and abandoned channels or slight depressions on undulating plains or flats of the western slopes.	Present. Detected during surveys within the Project Boundary (see Figure 3.1).
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobarr Penepine, Nandewar and Brigalow	EEC	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. bimbii</i> (Bimble or Poplar Box), <i>Callitris glaucophylla</i> (White Cypress Pine), <i>Brachychiton populneus</i> (Kurrajong), <i>Allocasuarina leuhmannii</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	Present. Detected during surveys within the Project Boundary (see Figure 3.1).

Table E.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	TSC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence
Belt South Bioregions			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.	
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Penepplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions	EEC	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 3.1).
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	CEEC	EEC	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 soils of the Liverpool Plains.	Potential to occur adjacent to the pipeline easements to the Mooki River.
Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar	EEC	EEC	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	Present. Small area recorded from Mt Watermark in an area

Table E.1 Likelihood of Occurrence of Threatened Ecological Communities Known or Predicted to Occur within the Liverpool Plains Sub-region				
Common Name	EPBC Act Status	TSC Act Status	Description, Distribution and Habitat	Likelihood of Occurrence
Bioregions			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 Warialda 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.	outside of the Disturbance Area (see Figure 3.1).
White Box Yellow Box Blakely's Red Gum Woodland	CEEC	EEC	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 3.1).

Table E.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	TSC 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</i> spp., and <i>Casuarina</i> spp.	Not likely to occur. Although known to occur within the Gunnedah LGA, the Project Boundary is situated beyond known populations. Not detected during surveys.
Fabaceae - Faboideae	<i>Swainsona murrayana</i>	Slender Darling Pea	V	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	Potential to occur. Although it was not recorded during surveys, the species is known to occur within the Gunnedah LGA and suitable habitat occurs in the Project Boundary.

Table E.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	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						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. The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated.	
Orchidaceae	<i>Prasophyllum</i> sp. <i>Wybong</i>		CE		0	<i>Prasophyllum</i> sp. <i>Wybong</i> (C. Phelps ORG 5269) is endemic to New South Wales. It is known from seven populations in eastern New South Wales near Ilford, Premier, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield. Leek orchids are generally found in shrubby and grassy habitats in dry to wet soil.	Not likely to occur. Not known within the Gunnedah LGA. The Project Boundary is situated beyond known populations. Not detected during surveys.
Orchidaceae	<i>Pterostylis cobarensis</i>	Greenhood Orchid / Cobar Rustyhood	V	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	Unlikely to occur. No suitable habitat was recorded during surveys of the Project Boundary. Not recorded within the Gunnedah LGA.

Table E.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	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						microgranite. Associated species include <i>Eucalyptus morrisii</i> , <i>E. viridis</i> , <i>E. intertexta</i> , <i>E. vicina</i> , <i>Calitris glaucophylla</i> , <i>Geijera parviflora</i> , <i>Casuarina cristata</i> , <i>Acacia doratoxylon</i> , <i>Senna sp.</i> and <i>Eremophila sp.</i>	
Poaceae	<i>Bothriochloa biloba</i>	Lobed Blue Grass	V		21	Commonly found on clay soils in woodlands and grasslands in the following New South Wales botanical regions: North Coast, Central Coast, Northern Tablelands, North West Slopes, Central West Slopes, North West Plains, South West Plains.	Recorded along Court Lane and The Dip Road within the Project boundary.
Poaceae	<i>Dichanthium setosum</i>	Bluegrass	V	V	9	Grows in woodland. New South Wales 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	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 targeted surveys.
Proteaceae	<i>Hakea pulvinifera</i>	Lake Keepit Hakea	E	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

Table E.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	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
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 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> .	Not likely to occur. Not known within the Gunnedah LGA. No suitable habitat or vegetation type recorded during surveys.
Santalaceae	<i>Thesium australe</i>	Austral Toadflax	V	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.

Table E.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	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Surianaceae	<i>Cadellia pentastylis</i>	Ooline	V	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 F

Fauna Species List

Table F.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 Dtelia			X	
Gekkonidae	<i>Oedura lesueurii</i>	Lesueur's Velvet Gecko			X	
Gekkonidae	<i>Oedura robusta</i>	Robust Velvet Gecko			X	
Gekkonidae	<i>Underwoodisaurus miltii</i>	Thick-tailed Gecko			X	
Pygopodidae	<i>Lialis burtonis</i>	Burton's Legless Lizard			X	

Table F.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 F.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>Aegotheles 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>Elseoyornis 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 Lorieet			X	X
Psittacidae	<i>Glossopsitta pusilla</i>	Little Lorieet		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 haematonotus</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 F.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

Table F.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)
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>Gralina 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 melanorhaphos</i>	White-winged Chough			X	X
Corcoracidae	<i>Struthidea cinerea</i>	Apostlebird			X	X
Petroicidae	<i>Microeca fascians</i>	Jacky Winter				X

Table F.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
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	Vulnerable	Vulnerable	X	X
Phalangeridae	<i>Trichosurus vulpecula</i>	Common Brushtail Possum			X	X

Table F.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 Sheathtail Bat		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 balstoni</i>	Inland Broad-nosed Bat			X	X
Vespertilionidae	<i>Vespadelus vulturnus</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 F.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 G

Fauna Likelihood of Occurrence

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Amphibians							
Hylidae	<i>Litoria booroolongensis</i>	Booroolong Frog	E	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	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							
Acanthizidae	<i>Pyrholaemus sagittatus</i>	Speckled Warbler		V	30	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground.	Present. This species was observed and recorded during field surveys.
Accipitridae	<i>Circus assimilis</i>	Spotted Harrier		V	4	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast and	Present. This species was observed during field

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						ranges. Individuals disperse widely in New South Wales and occur in grassy open woodland including acacia and mallee remnants, inland riparian woodland and grassland. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	surveys.
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. Farm dams within the Project Boundary are small and would provide only occasional forage habitat for this species.
Accipitridae	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		V	1	Distributed throughout most of inland Australia and prefers arid scrubland, and open woodlands. Feeds on small mammals and birds.	Potential to occur. Habitat exists within the Project Boundary. This species was not recorded during field surveys, and is an infrequent

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Accipitridae	<i>Hieraaetus morphnoides</i>	Little Eagle		V	7	Distributed throughout the Australian mainland except in the most densely forested parts of the Dividing Range. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior New South Wales are also used. For nest sites it requires a tall living tree within a remnant patch. It feeds on birds, reptiles and mammals.	vagrant in the locality. Present. This species was recorded during field surveys
Accipitridae	<i>Lophoictinia isura</i>	Square-tailed Kite		V	5	This species hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects. Seems to prefer structurally diverse landscapes.	Potential to occur. This species has previously been recorded in the locality. Suitable forage and breeding habitat present within the Project Boundary.
Anatidae	<i>Stictonetta naevosa</i>	Freckled Duck		V	1	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hypersaline wetlands that are densely	Unlikely to occur. There is no preferred habitat available for this species in the Project Boundary. This species was not recorded during field surveys within the Project

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						vegetated with Lignum (<i>Muehlenbeckia cunninghamii</i>) within which they build their nests.	Boundary. Only OEH record for this species in the Gunnedah LGA is from nearby Lake Goran.
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 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	Likely to occur. Suitable habitats are available for this species within the Project Boundary in the form of farm dams. Extensive suitable

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						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.	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.
Burhinidae	<i>Burhinus grallarius</i>	Bush Stone-curlew		E	1	Require sparsely grassed, lightly timbered, open forest or woodland. In southern Australia they often occur where there is a well structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots.	Potential to occur. There is potentially suitable habitat available for this species in the Project Boundary. This species was not recorded during field surveys.
Cacatuidae	<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo		V	11	Occurs in eucalypt woodland and forest with suitable forage Casuarina/ Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species.	Unlikely to occur. There is no preferred habitat available for this species in the Project Boundary. This species was

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows.	not recorded during field surveys. Locality records are likely to occur well to the east of the Project Boundary.
Climacteridae	<i>Climacteris picumnus victoriae</i>	Brown Treecreeper		V	35	Occurs in eucalypt woodland and adjoining vegetation. Feeds on ants, beetles and larvae on trees and from fallen timber and leaf litter. Usually nests in hollows. The Brown Treecreeper is a resident species that stays in the same area all year round.	Present. This species was observed within the Project Boundary and the adjacent Breeza State Forest 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 Project Boundary.
Estrildidae	<i>Stagonopleura guttata</i>	Diamond Firetail		V	6	Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range. Feed on seeds, mostly of grasses.	Present. This species was observed during field surveys.
Meliphagidae	<i>Grantiella picta</i>	Painted Honeyeater		V	1	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus <i>Amyema</i> , though it will take some nectar and insects. Its breeding distribution is dictated by	Potential to occur. This species was not recorded during field surveys.

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Meliphagidae	<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater		V	1	presence of mistletoes which are largely restricted to older trees. Less likely to be found in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks. Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps.	Suitable habitats are available for this species, including a number of preferred forage species. Potential to occur. This species was not recorded during field surveys. Suitable habitat present within the Project Boundary and adjacent areas.
Meliphagidae	<i>Anthochaera phrygia</i>	Regent Honeyeater	E, M	CE	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 Casuarina cunninghamiana and Amyema cambagei 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. leucoxydon</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	Likely to occur. This species was not recorded within the Project Boundary during field

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella		V	5	wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings. The Varied Sittella is sedentary and inhabits most of mainland Australia with a nearly continuous distribution in New South Wales from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticated bark, dead branches and twigs in the tree canopy.	surveys. Suitable forage habitat present within the Project Boundary. Potential to occur. This species was not recorded during field surveys. Known from the locality, and suitable habitat found within the Project Boundary.
Petroicidae	<i>Melanodryas cucullata cucullata</i>	Hooded Robin		V	11	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia.	Potential to occur. This species was not observed during field surveys. Known from the locality, and suitable habitat occurs within the Project Boundary.
Pomatostomidae	<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler		V	35	Found throughout western slopes and plains, southern and central tablelands and occurring in Northern Rivers area, mid-north coast and the Hunter Valley of New	Present. This species was observed during field surveys within the Project

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						South Wales. Lives in open forest and woodland, acacia shrubland and adjoining farmland. Large stick dome nest with spout-like entrance.	Boundary.
Psittacidae	<i>Glossopsitta pusilla</i>	Little Lorikeet		V	29	Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria.	Present. This species was recorded during field surveys within the Project Boundary.
Psittacidae	<i>Lathamus discolor</i>	Swift Parrot	E	E	1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern New South Wales, but also south-eastern Queensland. Swift 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 New South Wales. 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	Potential to occur. Suitable habitats are available for this species. This species was not recorded during field surveys.

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						year.	
Psittacidae	<i>Neophema pulchella</i>	Turquoise Parrot		V	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	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 forage and feed within box woodland, mostly nesting in dead trees.	Potential to occur. Suitable habitats are available for this 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	E	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>	Unlikely to occur. There is no preferred habitat available for this species in the Project Boundary. This species was

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						(Lignum) or <i>Sarcocornia quinqueflora</i> (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest.	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 to breed.	Unlikely to occur. There is no preferred habitat available for this species in the Project Boundary. This species was not recorded during field surveys.
Strigidae	<i>Ninox connivens</i>	Barking Owl		V	6	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season.	Present. This species was recorded by GHD during field surveys.
Tytonidae	<i>Tyto novaehollandiae</i>	Masked Owl		V	3	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for	Potential to occur. This species was not recorded during field surveys. Suitable habitat occurs within

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves.	the Project Boundary, with larger areas of suitable habitat present in the adjacent Breeza State Forest.
Mammals							
Burramyidae	<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V	1	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds nests and shredded bark in the fork of trees.	Unlikely to occur. Not recorded during current surveys. There is no preferred habitat available for this species within the Project Boundary.
Dasyuridae	<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	E	V	11	Occurs from the Bundaberg area in south-east Queensland, south through New South Wales to western Victoria and Tasmania. In New South Wales, it occurs on both sides of the Great Dividing Range and north-east New South Wales 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	Potential to occur. Suitable habitats are available for this species within the Project Boundary. This species was not recorded during field surveys.

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						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.	
Macropodidae	<i>Macropus dorsalis</i>	Black-striped Wallaby		E	1	The preferred habitats for the species is forest with a dense shrub layer including rainforest margins; Brigalow scrub, particularly in a phase of regrowth; open forest with a thick acacia or other shrub understorey; and lantana thickets.	Unlikely to occur. Some suitable habitat available for this species within the Project Boundary. Very rare in the locality. This species was not recorded during field surveys.
Macropodidae	<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	E	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 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.	Unlikely to occur. There is only marginal habitat available for this species within the Project Boundary. This species was not recorded during field surveys.
Petauridae	<i>Petaurus norfolcensis</i>	Squirrel Glider		V	4	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and	Potential to occur. Suitable habitats are available for this

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	V	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 New South Wales 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, Tallowood (<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.	species. This species was not recorded during field surveys. Present. Recorded during field surveys within the Project Boundary.
Muridae	<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	4	Restricted to unique habitat known as Pilliga scrub, which occurs on deep, low nutrient sand in the Pilliga region of New South Wales (south of Narrabri). Specifically, Pilliga	Unlikely to occur. There is no preferred habitat available for this species within the

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						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.	Project Boundary. This species was not recorded during field surveys.
Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat		V	20	Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts in tree hollows. Thought to be a migratory species.	Present. This species was recorded during field surveys.
Molossidae	<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat		V	1	Occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roosts mainly in tree hollows but will also roost under bark or in man-made structures. Usually solitary but also recorded roosting communally, probably insectivorous.	Potential to occur. Generally not associated with habitats west of the Great Dividing Range, however nearby records from Gunnedah in similar habitats to those occurring within the Project Boundary indicate potential

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence	
Vespertilionidae	<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	6	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle shaped 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.	occurrence of this species. This species was not recorded during field surveys.
Vespertilionidae	<i>Chalinolobus picatus</i>	Little Pied Bat		V	3	The species roosts in trees, caves, and abandoned mines and houses. Roost sites in caves are usually warm and dry but they can tolerate roost temperatures of more than 40 degrees Celsius. Has been recorded in dry open forest, open woodland, Mulga woodlands, chenopod shrublands, Callitris forest and mallee.	Potential to occur. Suitable forage and roosting habitat available for this species within the Project Boundary. This species was not recorded during field surveys.	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>	South-eastern Long-eared Bat	V	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 swamps.	Potential to occur. Suitable forage and roosting habitat available for this species	Potential to occur. Suitable forage and roosting habitat available for this species

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence	
							within the Project Boundary. This species was not recorded within the Project Boundary during field surveys, but was recorded in adjacent lands	
Vespertilionidae	<i>Vespertilio troughtoni</i>	Eastern Cave Bat		V	5	A cave-dwelling species found in eastern Australia from Cape York to New South Wales. They inhabit tropical mixed woodland and wet sclerophyll forests on the coast and the dividing range, but extend into drier forests on the western slopes.	Potential to occur. Suitable forage and roosting habitat available for this species within the Project Boundary. No recent LGA records but historical records combined with records from adjacent LGAs indicate a potential for this species to occur. This species was not recorded during field surveys.	
Reptiles								
Chelidae	<i>Elseya belli</i>	Bell's Turtle	V	V	0	Found in upper reaches of rivers overlying granite, on the western slopes of the Northern New South Wales	Unlikely to occur. There is no preferred habitat available	

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
Elapidae	<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V	1	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.	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	V	2	A partly arboreal, nocturnal species found in a range of habitats from rainforest and wet sclerophyll forest to the drier eucalypt forests of the western slopes. Feeds largely on frogs and lizards.	Potential to occur. Suitable forage and shelter habitat present within the Project Boundary. This species was not recorded during field surveys.
Scincidae	<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	V	E	0	Found only on the tablelands and slopes of northern New South Wales 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 timber and deep leaf litter.	Potential to occur. Suitable habitats for this species are present in the higher rocky outcrops within the Project Boundary. This species was not recorded during field surveys within the Project Boundary.
						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	Potential to occur. Suitable habitat for this species occurs within the Project

Table G.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 Status	TSC Act Status	LGA Count	Habitat	Likelihood of Occurrence
						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.	Boundary. This species was not recorded within the Project Boundary during field surveys.
Scincidae	Aprasia parapulchella	Pink-tailed Legless Lizard	V	V	1	Inhabits sloping, open woodland areas with predominantly native grassy ground layers, 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 often still inhabited by small black ants and termites. Feeds on the larvae and eggs of the ants with which it shares its burrows.	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.

Notes: V = Vulnerable; E = Endangered; CE = Critically Endangered; M = Migratory

Appendix H

Threatened Flora and Fauna of Box Gum
Woodland

Table H.1 Threatened Species that May Occur in Box Gum Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List ¹									
SPECIES	COMMON NAME	IUCN ¹	Cwlth ²	ACT ³	NSW ⁴	Qld ⁵	Vic ⁶		
Flora									
<i>Acacia atrox</i>	Myall Creek Wattle				E				
<i>Acacia omalophylla</i>	Yarran Wattle						E		
<i>Ammobium craspedioides</i>	Yass Daisy		V		V				
<i>Bothriochloa biloba</i>	Lobed Redgrass		V			V		V	
<i>Dichanthium setosum</i>	Bluegrass		V		V	R			
<i>Digitaria porrecta</i>	Finger Panic Grass		E		E	R			
<i>Discaria pubescens</i>	Australian Anchor Plant					R		V	
<i>Diuris pedunculata</i>	Small Snake Orchid		E		E				
<i>Diuris punctata</i> var. <i>punctata</i>	Purple Diuris							V	
<i>Goodenia macbarronii</i>	Narrow Goodenia				V			V	
<i>Glycine canescens</i>	Silky Glycine							E	
<i>Hibbertia humifusa</i> ssp. <i>erigens</i>	Euroa Guinea-flower		V					V	
<i>Homopholis belsonii</i>	Belson's Panic		V			E			
<i>Leucochrysum albicans</i> var. <i>tricolor</i>	Hoary Sunray (white form)	E	E						
<i>Picris evae</i>	a hawkweed		V		V				
<i>Prasophyllum petilum</i>	Tarengo Leek Orchid		E	E					
<i>Rutidosis leptorrhynchoides</i>	Button Wrinklewort		E	E				E	

Table H.1 Threatened Species that May Occur in Box Gum Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List ¹								
SPECIES	COMMON NAME	IUCN ¹	Cwlth ²	ACT ³	NSW ⁴	Qld ⁵	Vic ⁶	
<i>Senecio garlandii</i>	Woolly Ragwort		V		V		E	
<i>Swainsona recta</i>	Small Purple Pea		E	E	E		E	
<i>Swainsona sericea</i>	Silky Swainson-pea				V		V	
<i>Thesium australe</i>	Austral Toadflax		V		V	V	V	
Fauna								
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink		V		E	E		
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard		V		V		E	
<i>Burhinus grallarius</i>	Bush Stone-curlew	NT			E		E	
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)			V	V			
<i>Chthonicola sagittata</i>	Speckled Warbler	LC			V		V	
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	NT	E	V	V	V	E	
<i>Delma impar</i>	Striped Legless Lizard	V	V	V	V		E	
<i>Geophaps scripta</i>	Squatter Pigeon	LC			E	V		
<i>Grantiella picta</i>	Painted Honeyeater	NT		V	V	R	V	
<i>Hieraaetus morphnoides</i>	Little Eagle	LC						
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake				V			
<i>Lathamus discolor</i>	Swift Parrot	E	E	V	E	E	E	
<i>Lophoictinia isura</i>	Square-tailed Kite	LC			V	R	V	
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	LC		V	V			

Table H.1 Threatened Species that May Occur in Box Gum Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List ¹									
SPECIES	COMMON NAME	IUCN ¹	Cwlt ²	ACT ³	NSW ⁴	Qld ⁵	Vic ⁶		
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	LC			V	R			
<i>Neophema pulchella</i>	Turquoise Parrot	LC			V	R	NT		
<i>Ninox connivens</i>	Barking Owl	LC			V		E		
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	E	V						
<i>Pedionomus torquatus</i>	Plains Wanderer	E	V		E	V			
<i>Perunga ochracea</i>	Perunga Grasshopper			V					
<i>Petaurus norfolcensis</i>	Squirrel Glider	LC			V		E		
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	NT			E		V		
<i>Phascogale cinereus</i>	Koala	LC			V	V			
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	V	V		E		
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	LC			V		E		
<i>Saccolaimus flaviventris</i>	Yellow-bellied Shearwater	LC			V				
<i>Stagonopleura guttata</i>	Diamond Firetail	NT			V		V		
<i>Suta flagellum</i>	Little Whip Snake				V				
<i>Synemon plana</i>	Golden Sun Moth		CE	E	E		E		
<i>Tympanocryptis pinguicollis</i>	Grassland Earless Dragon		E	E		E	CE		
<i>Tyto novaehollandiae</i>	Masked Owl	LC			V		E		
<i>Underwoodisaurus sphyrurus</i>	Border Thick-tailed Gecko	NT	V		V	R			
<i>Varanus rosenbergi</i>	Rosenberg's Goanna				V		V		

Table H.1 Threatened Species that May Occur in Box Gum Woodland Listed Under Commonwealth, State And Territory Legislation and/or on IUCN Red List ¹								
SPECIES	COMMON NAME	IUCN ¹	Cwlth ²	ACT ³	NSW ⁴	Qld ⁵	Vic ⁶	
<i>Anthochaera phrygia</i>	Regent Honeyeater	E	CE	E	E	E	CE	

(Reproduced from NSW DECCW, 2010) **CE:** Critically Endangered; **E:** Endangered; **V:** Vulnerable; **NT:** Near Threatened; **LC:** Least Concern; **R:** Rare.

1 **IUCN:** 2008 Red List of Threatened Species

2 **Cwlth:** Environment Protection and Biodiversity Conservation Act 1999

3 **ACT:** Nature Conservation Act 1980

4 **NSW:** Threatened Species Conservation Act 1995

5 **Qld:** Nature Conservation Act 1992

6 **Vic:** Flora and Fauna Guarantee Act 1988

Appendix I

Assessments of Significance

I.1 Introduction

This appendix contains formal Assessments of Significance according to Section 5A of the EP&A Act. The Assessments of Significance provide a means by which to gauge the significance of predicted impacts to threatened species, populations and ecological communities listed under the TSC Act. They have been prepared to help examine the magnitude of impacts to local occurrences of 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 (as described within **Section 6.3**) 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.

Assessments of Significance have been provided for communities and species listed as vulnerable, endangered or critically endangered under the TSC Act or EPBC Act. Each Assessment of Significance is a series of questions (shown as italicised text below) for which a response has been supplied beneath 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 onsite mitigation measures, such as rehabilitation and erosion control, and provision of both onsite and offsite offsets. The ultimate conclusions to this ecological assessment report take such measures into consideration when assessing the long term implications for flora and fauna.

I.2 Ecological Communities

I.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 an Endangered Ecological Community (EEC) under the TSC Act, and 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 New South Wales 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 intergraded 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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

The Project will result in the clearing of 738 ha of Box Gum Woodland and Derived Native Grassland. Due to the already reduced extent and degraded nature of this community, and as the 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 the recovery of the community. As a result, any clearance of Box Gum Woodland and Derived Native Grassland is considered likely adversely impact on overall conservation efforts. However 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 area of Box Gum Woodland and Derived Native Grassland within the Disturbance Area will be cleared, and therefore this constitutes a substantial modification of this area of this community. However, as indicated above there are extensive areas in the locality that will remain such that the local occurrence of this community is unlikely to be placed at risk of extinction.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will remove approximately 738 ha of Box Gum Woodland and Derived Native Grassland.

The Box Gum Woodland and Derived Native Grassland in the locality of the Project Boundary are already highly fragmented and surrounded by agricultural lands. The Project will increase the amount of overall fragmentation, but it will not result in the isolation of important areas of habitat.

The Project will result in the clearance of some areas of Box Gum Woodland and Derived Native Grassland, however large areas of this community in similar condition to that which occurs within the Project Boundary will remain in the locality. Therefore, although the Project will result in an overall decline in the extent of the community in the locality, it is not considered to be important for the ongoing survival of this community in the locality.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Box Gum Woodland and Derived Native Grassland has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

As the Project will require the direct removal of 738 ha and additional indirect impacts on the community are expected, the Project will not be consistent with the National Recovery Plan. However, a Biodiversity Offset Package, which is proposed to compensate for the Project impacts, will be consistent with the plan 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.
- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Box Gum Woodland and Derived Native Grassland:

- Clearing of native vegetation as this reduces the area habitat available for this EEC;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources.

Continued clearance for agriculture and grazing, roadwork, edge effects and invasive feral animals are also considered major threats to this EEC as these actions destroy and degrade suitable habitat and prevent natural regeneration.

Conclusion

The Project is expected to result in the direct loss of 738 ha of Box Gum Woodland and Derived Grassland and will also indirectly impact this community, the extent of which has already been significantly reduced due to past clearing. Without the implementation of avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 the Project would result in a significant impact to the community.

1.2.2 Inland Grey Box Woodland

Inland Grey Box Woodland corresponds to the description of an EEC listed under both the TSC and EPBC Acts. Approximately 55 ha of this community is found within the Project Boundary, of which 30 ha is proposed to be cleared.

Inland Grey Box Woodland is open woodland that occurs on relatively fertile soils of the western slopes and plains of New South Wales. Grey Box (*E. Microcarpa*) is the characteristic canopy species, although co-dominants include Bimbil Box, White Cypress Pine, Kurrajong, Yellow Box and Bulloak (DECCW 2007). 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 82% to 85% since pre-settlement, primarily as a result of clearing for agriculture.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

The area of Inland Grey Box Woodland within the Disturbance Area will be cleared, which constitutes a substantial modification of this area of this community. However, there are extensive areas in the locality that will remain such that the local occurrence of this community is unlikely to be placed at risk of extinction

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will remove approximately 30 ha of Inland Grey Box Woodland.

The Inland Grey Box Woodlands in the locality of the Project Boundary are already highly fragmented and surrounded by agricultural lands. The Project will increase the amount of overall fragmentation, but it will not result in the isolation of important areas of habitat.

The Project will result in the clearance of some areas of Inland Grey Box Woodlands, however large areas of this community in similar condition to that which occurs within the

Project Boundary will remain in the locality. Therefore, although the Project will result in an overall decline in the extent of the community in the locality, it is not considered to be important for the ongoing survival of this community in the locality.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Inland Grey Box Woodland has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this community. No threat abatement plans are relevant to this community.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Inland Grey Box Woodland:

- Clearing of native vegetation as this directly removes and reduces the extent of this ecological community, and reduces the area of forage and nesting habitat available for various flora and fauna species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of Inland Grey Box fauna;
- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance of Inland Grey Box wildlife;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Altered fire regimes, as the lack of fire can affect the germination of key species.

Conclusion

The Project is expected to result in the direct loss of 30 ha of Inland Grey Box Woodland and will also indirectly impact this community. The community is recognised to have suffered a large reduction in extent through past clearing. Without the implementation of mitigation and offset measures detailed within Chapter 7 and Chapter 8 the Project would result in a significant impact to the community.

1.2.3 Weeping Myall Woodland

Weeping Myall Woodland is listed as an EEC under both the TSC and EPBC Acts. 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 (DEC (NSW) 2005j).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

The Project will result in the clearing of a 3 ha of Weeping Myall Woodland; however there are larger areas of this community in the locality that will remain, and some areas are being retained within the Project Boundary. The local occurrence of this community is unlikely to be placed at risk of extinction.

The area of Weeping Myall Woodland within the Disturbance Area will be cleared, however the remaining areas will not be adversely modified. Accordingly, the local occurrence of this community is unlikely to be placed at risk of extinction.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
 - (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will remove approximately 3 ha of Weeping Myall Woodland.

The areas of Weeping Myall Woodland within the Project Boundary and in the locality are already highly fragmented and surrounded by agricultural lands. The Project will increase the amount of overall fragmentation, but it will not result in the isolation of important areas of habitat.

The Project will result in the clearance of some areas of Weeping Myall Woodland, however some areas will remain within the Project Boundary and in the locality. Therefore, although the Project will result in an overall decline in the extent of the community in the locality, it is not considered to be important for the ongoing survival of this community in the locality.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Weeping Myall Woodland has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this community. No threat abatement plans are relevant to this community.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Weeping Myall Woodland:

- Clearing of native vegetation as this directly removes and reduces the extent of this ecological community, and reduces the area of forage and nesting habitat available for various flora and fauna species;
- Loss of hollow-bearing trees as this directly removes remnant trees of this community and reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this removes structural components of the community and reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this impacts regeneration capabilities and results in loss of structural complexity and of key food plants and habitat;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to result in the direct loss of 3 ha of Weeping Myall Woodland and will also indirectly impact this 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. Without the implementation of avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 the Project would result in a significant impact to the community.

1.2.4 Brigalow

Brigalow vegetation within the Project Boundary corresponds to communities listed as an EEC under both the TSC and EPBC Acts. Approximately 9 ha of this community is found within the Project Boundary, of which none is proposed to be cleared.

The Brigalow community 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 New South Wales 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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

No areas of Brigalow will be cleared or modified for the Project and therefore the local occurrence of this community is unlikely to be placed at risk of extinction.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

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.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Brigalow community has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this community. No threat abatement plans are relevant to this community.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Brigalow community:

- Clearing of native vegetation as this reduces the area habitat available for this EEC;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a threat to the survival of Brigalow fauna;
- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance of Brigalow wildlife;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Altered fire regimes.

Continued clearance for agriculture and grazing, roadwork, edge effects and invasive feral animals are also considered major threats to this EEC as these actions destroy and degrade suitable habitat and prevent natural regeneration.

Conclusion

The Project not result in the loss of any of the Brigalow community and indirect impacts are considered to be minimal. This community is recognised to have suffered a substantial reduction in extent through past clearing, however the Project is unlikely to result in a significant impact on this community.

1.2.5 Semi-evergreen Vine Thicket

Semi-evergreen Vine Thicket within the Project Boundary corresponds to communities listed as an EEC under both the TSC Act and EPBC Act. This community was recorded at two locations within the Project Boundary on Mt Watermark, neither of which is proposed to be cleared.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

No areas of Semi-evergreen Vine Thicket will be cleared or modified for the Project and therefore the local occurrence of this community is unlikely to be placed at risk of extinction.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will not remove or modify any areas of Semi-evergreen Vine Thicket.

No areas of Semi-evergreen Vine Thicket will become fragmented or isolated from other areas of habitat as a result of the Project.

The area of Semi-evergreen Vine Thicket 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 (two pockets <0.1ha in size) 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.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Semi-evergreen Vine Thicket community has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

A national recovery plan has been prepared for this community. No threat abatement plans are relevant to this community.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Semi-evergreen Vine Thicket community:

- Clearing of native vegetation as this reduces the area habitat available for this EEC;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a threat to the survival of Brigalow fauna;

- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance of Brigalow wildlife;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Altered fire regimes.

Continued clearance for agriculture and grazing, roadwork, edge effects and invasive feral animals are also considered major threats to this EEC as these actions destroy and degrade suitable habitat and prevent natural regeneration.

Conclusion

The Project not result in the loss of any of the Semi-evergreen Vine Thicket community, however it may be indirectly impacted given its proximity to the Disturbance Area. This community is recognised to have suffered a substantial reduction in extent through past clearing, however the Project is unlikely to result in a significant impact on this community.

1.2.6 Fuzzy Box Woodland

Fuzzy Box Woodland is listed as an Endangered Ecological Community (EEC) under the TSC Act. Approximately 36 ha of this community is found within the Project Boundary, of which 18 ha is proposed to be cleared.

Fuzzy Box Woodland is a tall woodland or open forest found on alluvial loam or clay soils in the listed bioregions. The community occurs on soils on prior streams and abandoned channels or slight depressions on undulating plains or flats of the western slopes. It is dominated by Fuzzy Box (*Eucalyptus conica*), often with Inland Grey Box (*Eucalyptus microcarpa*), Yellow Box (*Eucalyptus melliodora*), or Kurrajong (*Brachychiton populneus*). Shrubs are generally sparse and the groundcover is typically moderately dense depending on the season.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to ecological communities.

(c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

The Project will result in the clearing of 18 ha of Fuzzy Box Woodland. This community has suffered a significant decline in its distribution, with less than 5% of the original extent estimated to remain. Due to the very small amount of this community remaining, in the absence of mitigation measures, the Project has the potential to place the local occurrence of this community at risk of extinction.

Some areas of this community will be removed for the Project, but the remaining areas will not be adversely modified.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will remove approximately 18 ha of Fuzzy Box Woodlands.

The areas of Fuzzy Box Woodland in the Project Boundary and in the locality are already highly fragmented and surrounded by agricultural lands. The Project will increase the amount of overall fragmentation, but it will not result in the isolation of important areas of habitat.

The Project will result in the clearance of the majority of Fuzzy Box Woodland within the Project Boundary, however some areas will remain within the Project Boundary and in the locality. Due to the very small amount of this community remaining, this is likely to be a relatively important area of habitat for this community.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Fuzzy Box Woodland community has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this community. No threat abatement plans are relevant to this community.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Fuzzy Box Woodland:

- Clearing of native vegetation as this directly removes and reduces the extent of this ecological community, and reduces the area of forage and nesting habitat available for various flora and fauna species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of Fuzzy Box Woodland fauna;
- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance of Fuzzy Box Woodland wildlife;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Altered fire regimes as the lack of fire can affect the germination of key species.

Conclusion

The Project is expected to result in the direct loss of 18 ha of Fuzzy Box Woodland and will also indirectly impact this community. This community is recognised to have suffered a substantial reduction in extent through past clearing and the amount remaining within the Project Boundary is likely to be important for this community. Without the implementation of avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 the Project would result in a significant impact to the community.

I.3 Flora

I.3.1 *Bothriochloa biloba* (Lobed Blue-grass)

Bothriochloa biloba (Lobed Blue-grass) is listed as Vulnerable under the EPBC Act, however it has been de-listed from the TSC Act due to the discovery of numerous large populations. The species was recorded within the Project Boundary during targeted field surveys. Suitable habitat exists within the Project Boundary, Breeze State Forest and other lands adjacent to the Project.

Lobed Blue-grass is 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 2004b). It also occurs west to Dubbo and around the Hunter Valley (Quinn et al. 1995).

Lobed Blue-grass 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*. Lobed Blue-grass prefers heavier-textured soils such as brown or black clay soils.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove areas of known and potential habitat for this species. This is not expected to place a viable local population at risk of extinction and large areas of suitable habitat for this species will remain in the locality. This species is known to be widespread in NSW similar habitats to those within the Project Boundary.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of potential woodland and grassland habitat is proposed to be removed as part of the Project.

In addition to specimens recorded within the Project Boundary during recent surveys, the closest known populations are approximately 18 km away from the Project Boundary. It is not considered likely that the Project will fragment or isolate areas of known habitat for this species.

The Project will impact on known habitat for this species, however similar habitat will be retained in Breeza State Forest and other lands adjacent to the Project. The habitat to be removed is not considered to be important for this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Lobed Blue-grass has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Lobed Blue-grass:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources; and
- Clearing and habitat fragmentation, roadwork, fire, trampling and grazing by livestock, physical disturbance by machinery, and urban expansion (DEC (NSW), 2005k) are also considered threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

This species has been recorded from the Project Boundary. The Project is expected to remove approximately 4,021 ha of potential woodland and grassland habitat for this species and indirectly impact remaining individuals and habitat. The species has previously been recorded elsewhere in the Gunnedah LGA (approximately 18 km from the Project Boundary) and these populations will not be impacted by the Project. This will ensure the viability of known and potentially occurring regional populations.

Without the implementation of avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 the Project would result in a significant impact to the community.

1.3.2 *Dichanthium setosum* (Bluegrass)

Dichanthium setosum (Bluegrass) is listed as Vulnerable under both the TSC and EPBC Acts. There are nine Atlas of NSW Wildlife records of this species within the Gunnedah LGA, and the species has been recorded within the Project Boundary. Suitable habitat exists for this species in most areas of the Project Boundary.

Bluegrass is an erect, perennial grass with limited distribution in New South Wales and Queensland. In New South Wales the species occurs within the Border Rivers–Gwydir, Central West, Northern Rivers and Namoi regions (NSW Scientific Committee 2004f). 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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential habitat for *Dichanthium setosum*, however large areas of similar habitat occur in the locality that will remain. The species has not been recorded within the Project Boundary by Cumberland Ecology despite targeted searches. Although

this species has potential to occur, it is not likely to occur in high abundance and therefore the Project is unlikely to place the local population of the species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

The Project will remove approximately 4,021 ha of woodland and grassland that provides known and potential habitat for this species.

Large areas of similar habitat for this species occur in the locality of the Project Boundary and therefore it is unlikely that areas of habitat will become fragmented by the Project.

The area of habitat to be removed by the Project is unlikely to be important for this species as it is known to occur in degraded habitat including cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. Large areas of this kind of habitat are present in the locality that will not be disturbed by the Project.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for *Dichanthium setosum* has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species, although approved conservation advice has been issued under the EPBC Act. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Dichanthium setosum*:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources; and
- Clearing and habitat fragmentation, roadwork, fire, trampling and grazing by livestock, physical disturbance by machinery, and urban expansion are also considered major threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

The Project is expected to directly impact 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. The Project is not considered likely to have a significant impact on *Dichanthium setosum*.

1.3.3 *Digitaria porrecta* (Finger Panic Grass)

Finger Panic Grass (*Digitaria porrecta*) is listed as Endangered under both the TSC and EPBC Acts. 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.

Finger Panic Grass is a perennial grass that occurs over an area of approximately 1,000 km in four disjunct areas in Queensland and New South Wales. In New South Wales, 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).

The species 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) 2005d). 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) 2005d).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential habitat for *Digitaria porrecta*, however it has not been recorded within the Project Boundary. Large areas of similar habitat occur in locality that will not be disturbed by the Project and therefore a viable local population of this species is not likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of potential woodland and grassland habitat will be removed as part of the Project, although this species was not recorded from the Project Boundary and this does not comprise known habitat.

Large areas of similar vegetation occur in the locality and it is not expected that the Project will result in the fragmentation of an area of habitat for this species.

The potential habitat to be removed is not considered to be important habitat for this species as it has not been recorded and has only the potential to occur. Large areas of similar habitat will remain in the locality outside of the Project Boundary.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for *Digitaria porrecta* has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species, although approved conservation advice has been issued under the EPBC Act. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to *Digitaria porrecta*:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources; and
- Clearing and habitat fragmentation, roadwork, fire, trampling and grazing by livestock, physical disturbance by machinery, and urban expansion (DEC (NSW), 2005k) are also considered major threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of potential habitat for this species. No known populations of the species will be impacted by the Project, and Breeza State Forest will continue to provide a large area of suitable habitat for the species. Accordingly, the Project is not considered likely to have a significant impact on *Digitaria porrecta*.

1.3.4 *Cadellia pentastylis* (Ooline)

Cadellia pentastylis (Ooline) is listed as Endangered under both the TSC and EPBC Acts. 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.

Ooline occurs on the western edge of the New South Wales 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).

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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

No known individuals will be impacted by the Project, however suitable habitat for Ooline will be removed. This is not expected to place a viable local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the*

endangered population such that a viable local population of the species is likely to be placed at risk of extinction

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

(c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential woodland habitat is proposed to be removed as part of the Project.

The closest known populations are approximately 20 km away from the Project Boundary and it is not considered likely that the Project will fragment or isolate areas of known habitat for this species.

The Project will not impact on known habitat for this species and therefore the habitat to be removed is not considered to be important for this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Ooline has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Ooline:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources; and
- Clearing and habitat fragmentation; roadwork; fire; trampling and grazing by livestock; physical disturbance by machinery; and urban expansion (DEC (NSW), 2005k) are also considered major threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

This species has not been recorded from the Project Boundary, however potential habitat occurs, and the Project is expected to directly impact approximately 864 ha of potential woodland habitat for this species. The species has previously been recorded elsewhere in the Gunnedah LGA (approximately 20 km from the Project Boundary) and these populations will not be impacted by the Project. This will ensure the viability of known and potentially occurring regional populations. No viable local population is likely to be placed at risk of extinction by the Project. The Project is therefore unlikely to have a significant impact on Ooline.

1.3.5 Swainsona murrayana (Slender Darling Pea)

Swainsona murrayana (Slender Darling Pea) is listed as Vulnerable under both the TSC and EPBC Acts. 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 New South Wales 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) 2005n). 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) 2005n).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

Although potential habitat for the Slender Darling Pea will be removed, no known individuals will be impacted by the Project, therefore it is unlikely that the Project will place a viable local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*

- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of woodland and grassland is proposed to be removed as part of the Project, which provides potential habitat for this species.

The potential habitat for this species that remains outside of the Project Boundary will not be substantially fragmented by the Project. Large areas of similar habitat exist in the locality and the removal of this area of potential habitat will not disrupt connectivity between known populations.

As no individuals have been recorded within the Project Boundary, the potential habitat to be cleared is not considered to be important to this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for Slender Darling Pea has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan*

Recovery plans have not been prepared for this species. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to Slender Darling Pea:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion;

- Invasion of native plant communities (by various exotic species) that readily invade disturbed sites and communities as they can dominate and suppress native flora species by reducing the availability of shelter and nutrient resources; and
- Clearing and habitat fragmentation, roadwork, fire, trampling and grazing by livestock, physical disturbance by machinery, and urban expansion (DEC (NSW), 2005k) are also considered major threats to this species as these actions destroy and degrade suitable habitat.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of potential habitat for this species. However, no known populations of the species occur within the Gunnedah LGA, and Breeza State Forest will continue to provide an area of suitable habitat for the species. Accordingly, the Project is not considered likely to have a significant impact on the Slender Darling Pea.

I.4 Birds

I.4.1 *Brown Treecreeper (eastern subspecies) (Climacteris picumnus victoriae)*

The Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*) is a bird listed as Vulnerable under the TSC Act. There are 35 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. This species was observed within the Project Boundary as well as in Breeza State Forest and adjacent lands to the north-west of the Project during field surveys.

The Brown Treecreeper is an insectivorous woodland species endemic to eastern New South Wales. They are a sedentary species most commonly found in open woodlands and dry forest with an open grassy understorey for foraging, and in grasslands with scattered mature trees (Garnett and Crowley 2000, Birds Australia 2011). Suitable nesting and foraging habitat typically contains a high abundance of important habitat components such as fallen timber, hollows in stags and live trees (Garnett and Crowley 2000, NSW Scientific Committee 2004c). The species is dependent on the availability of small tree hollows for nesting, and as such, prefers patches of remnant vegetation which contain trees of hollow-bearing age of at least 150 years old.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known forage and breeding habitat for the Brown Treecreeper, which is likely to have an adverse effect on the life cycle of individuals known to occur within the Project Boundary. While the Project is likely to displace some individuals and impact on population dynamics within the area, this is not considered likely to place the local population

at risk of extinction. Remaining areas of Breeza State Forest and other lands adjacent to the Project will continue to provide good quality habitat for the Brown Treecreeper.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. This includes known forage, breeding and nesting habitat for the Brown Treecreeper.

The removal of patches of native vegetation and scattered trees will affect connectivity for this species and thus inhibit fauna movement and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

The species' sedentary nature and limited capacity for dispersal means they are generally unable to move across open country greater than 100m, making them susceptible to habitat fragmentation and genetic isolation (Cooper et al. 2002, Doerr et al. 2011). The species requires areas of habitat that are at least 300ha to maintain viable populations. The remaining habitat within Breeza State Forest and the wider locality will provide areas of suitable habitat, including important habitat features such as nesting hollows, debris and

foraging substrates. However, limiting resources such as hollows within the Project Boundary may affect the emigration and nesting success of some individuals.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Brown Treecreeper has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Brown Treecreeper:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral Honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and indirectly impact other areas of potential habitat. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Project will clear a large area of known habitat for this species within an otherwise cleared, agricultural landscape, resulting in the likely displacement and loss of individuals. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.2 Hooded Robin (*Melanodryas cucullata cucullata*)

The Hooded Robin (south-eastern form) (*Melanodryas cucullata cucullata*) is listed as Vulnerable under the TSC Act. There are 11 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during surveys of the Project Boundary or surrounding lands, however potential habitat exists and the species is considered to have potential to occur.

The Hooded Robin (south-eastern form) is a woodland species with a sparse distribution in south-eastern Australia. It is a mostly sedentary species that prefers open and lightly timbered acacia or eucalypt woodlands, particularly box-ironbark, that are structurally diverse and often at the edges of clearings and grassland (Birds Australia 2011).

The species forages on the ground, perching on fallen timber and low-lying branches to feed on insects. The species breeds between July and November, building nests in tree forks, hollows or crevices at heights between one – five metres (DEC (NSW) 2005g).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project is unlikely to have an adverse effect on the life cycle of this species or place a local population at risk of extinction. It has seldom been recorded in the Gunnedah LGA and has not been recorded from the Project Boundary.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential woodland habitat will be removed as part of the Project.

Other areas of similar habitat will remain in the locality and the Project is considered unlikely to fragment or isolate areas of known habitat for this species.

The species is particularly affected by understorey clearing which impacts on their foraging and nesting success. The species' sedentary nature and limited capacity for dispersal means they are susceptible to habitat fragmentation and genetic isolation; even in large remnant patches Hooded Robins are unable to sustain populations in the long term, which can lead to local extinctions (Birds Australia 2011). Once forced from a fragment they are unlikely to recolonise new habitat without assistance (Garnett and Crowley 2000).

As this species has not been recorded from the Project Boundary it is considered that the habitat to be removed is not important for the long term survival of this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Hooded Robin has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Hooded Robin:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species through the removal of potential forage and breeding habitat and indirectly impact other areas of potential habitat. No known habitat for this species will be removed. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.3 Speckled Warbler (Chthonicola saggitatus)

The Speckled Warbler (*Chthonicola saggitatus*) is listed as Vulnerable under the TSC Act. There are 30 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was recorded during recent surveys of the Project Boundary, as well as in Breeza State Forest and adjacent lands to the north-west of the Project.

The Speckled Warbler is a woodland species endemic to south-eastern Australia. The species is most commonly found in eucalypt-dominated dry sclerophyll forest and woodland with a grassy understorey (NSW Scientific Committee, 2010e) particularly on the western slopes and tablelands of the Great Dividing Range and along the drier sections of the coast (Garnett and Crowley 2000). It is a territorial, sedentary species with a typical home range of approximately 10 ha (NSW Scientific Committee 2001d). It forages on the ground for seeds and insects around tussocks and under shrubs and trees, and nests on the ground in undergrowth and thick litter.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known forage and breeding habitat for the Speckled Warbler. A large area of suitable habitat will remain in Breeza State Forest and in adjacent lands to the north-west of the Project. These areas will continue to provide habitat for this species. Accordingly, the Project is considered unlikely to result in the extinction of a viable local population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland habitat is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Speckled Warbler.

The removal of patches of native vegetation and scattered trees is likely to affect connectivity for this species and thus inhibit fauna movement and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

The habitat to be removed is not considered to be important for the survival of the local population as this species is expected to persist in the much larger area of intact woodland that is present in Breeza State Forest and lands adjacent to the Project.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Speckled Warbler has been identified by the Director-General of EPA under the TSC Act.

The area within the Project Boundary and surrounding habitat within the Breeza State Forest does not constitute critical habitat for this species. However, it does provide suitable nesting and forage habitat.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Speckled Warbler:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of potential forage and shelter habitat;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;

- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and indirectly impact other areas of potential habitat. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.4 Diamond Firetail (*Stagonopleura guttata*)

The Diamond Firetail (*Stagonopleura guttata*) is listed as Vulnerable under the TSC Act. There are six Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was observed during recent surveys of the Project Boundary.

The Diamond Firetail is a woodland species endemic to south-eastern Australia with scattered distribution in New South Wales (NSW Scientific Committee 2001b). This species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain of western Sydney and the Hunter, Clarence, Richmond and Snowy River valleys. They are a mainly sedentary, ground-foraging species most commonly found in or on the edge of lightly timbered open eucalypt forest and woodlands including box-ironbark and casuarina associations (NSW Scientific Committee 2001b). They also occur in farmland and grassland with remnant trees and a sparse understorey, and along watercourses (Birds Australia 2011).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known forage and breeding habitat for the Diamond Firetail. A large area of suitable habitat will remain in Breeza State Forest and adjacent lands to the north-west of the Project. These areas will continue to provide habitat for this species. Accordingly, the Project is considered unlikely to result in the extinction of a viable local population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland habitat is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Diamond Firetail.

The removal of patches of native vegetation and scattered trees is likely to affect connectivity for this species and thus inhibit fauna movement and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

The habitat to be removed is not considered to be important for the survival of the local population as this species is expected to persist in the much larger area of intact woodland that is present in Breeza State Forest and in adjacent lands.

The species is vulnerable to fragmentation and genetic isolation due to its sedentary nature and dispersal capacity is restricted to local movements. Populations appear unable to persist in areas which lack remnant native vegetation larger than 200ha (NSW Scientific Committee 2001b). The long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of forest will still provide suitable habitat, including important ground habitat features such as a grassy understorey for foraging, thus supporting and maintaining viable local populations of the species (Higgins and Peter 2002).

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Diamond Firetail has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Diamond Firetail:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and indirectly impact other areas of potential habitat. This includes the removal of known forage, roosting and breeding habitat for locally occurring populations of the species. The Project will clear a large area of known habitat for this species within an otherwise cleared, agricultural landscape, resulting in the likely displacement and loss of individuals.

Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.5 Grey-crowned Babbler (eastern subspecies) (Pomatostomus temporalis temporalis)

The Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*) is listed as Vulnerable under the TSC Act. There are 35 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was recorded during recent field surveys of the Project Boundary and in surrounding lands.

The Grey-crowned Babbler is a woodland insectivorous bird species endemic to eastern Australia. The species is abundant and widespread in northern Queensland, but is in considerable decline in the southern part of its range in Victoria and New South Wales. It is a ground-dwelling, sedentary species most commonly found in open forest and woodland dominated by acacias or eucalypt box-ironbark associations where they live in extended family groups (NSW Scientific Committee 2001c). The species forages for insects on trunks and branches of eucalypts and other woodland trees, and on the ground amongst litter and tussock grasses (Garnett and Crowley 2000).

The species is only found in habitat containing all of the following elements: woodland or open forest on fertile or heavy soils; abundant trees, with a high proportion of large, mature eucalypts with a trunk measuring >90 cm diameter at breast-height (dbh), an understorey of shrubs with dbh of 10–30 cm, for nesting and sheltering, and an open ground layer with much leaf litter and fallen timber debris, and sparse grass cover (Birds Australia 2011).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known forage and breeding habitat for the Grey-crowned Babbler. A large area of suitable habitat will remain in Breeza State Forest and this will continue to provide habitat for this species. Accordingly, the Project is considered unlikely to result in the extinction of a viable local population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland habitat is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Grey-crowned Babbler.

The species is highly susceptible to habitat fragmentation; laboured flight and their inability to cross large open areas greater than 900 m (Blackmore et al. 2011), combined with a lack of habitat connectivity and decrease in territory size can disrupt dispersal and increase the population's vulnerability to inbreeding depression and thus local extinction (Birds Australia 2011). Once lost from a fragment, natural recolonisation is unlikely (Garnett and Crowley 2000). However, the long term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of woodland will still provide extensive habitat greater than 100 ha. This is considered the minimum area of habitat required to support and maintain viable populations of the species (Higgins and Peter 2002). Also, the remaining woodland will provide critical habitat features for the species including structurally intact habitat and complexity, and important midstorey and ground habitat features such as nesting debris and foraging substrates (NSW Scientific Committee 2001c).

The removal of patches of native vegetation and scattered trees is likely to affect connectivity for this species and thus inhibit fauna movement and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

The habitat to be removed is not considered to be important for the survival of the local population as this species is expected to persist in the much larger area of intact woodland that is present in Breeza State Forest and surrounding lands.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Grey-crowned Babbler has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Grey-crowned Babbler:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and indirectly impact other areas of potential habitat. This includes removal of known forage, roosting and breeding habitat for this species. The Project will clear a large area of known habitat for this species within an otherwise cleared, agricultural landscape, resulting in the likely displacement and loss of individuals. Avoidance, mitigation and offset measures

detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.6 Varied Sittella (Daphoenositta chrysoptera)

The Varied Sittella (*Daphoenositta chrysoptera*) is listed as Vulnerable under the TSC Act. There are five Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was not recorded during surveys of the Project Boundary but suitable habitat exists. This species is considered to have potential to occur.

The Varied Sittella is an insectivorous woodland species endemic and widespread in across mainland Australia. They are a sedentary species most commonly found in eucalypt woodlands and dry forest, and acacia woodland containing mature trees and dead branches (Birds Australia 2011). The species feeds on arthropods and insects on stags, dead branches, in decorticating bark and in the canopy. The Varied Sittella often re-uses the same fork or living tree to build its nest in successive years (NSW Scientific Committee 2010).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and breeding habitat for the Varied Sittella. However low numbers have been recorded from the Gunnedah LGA, and it has not been recorded from the Project Boundary. Breeza State Forest and lands adjacent to the Project Boundary will continue to provide habitat for Varied Sittella, and the Project is considered unlikely to result in a viable local population being placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential woodland habitat is proposed to be removed as part of the Project. This includes potential forage, breeding and nesting habitat for the Varied Sittella.

The removal of patches of native vegetation and scattered trees may affect connectivity for this species and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape. However, as this species has not been recorded from the Project Boundary, no known habitat will be fragmented or isolated.

As this species was not recorded from the Project Boundary and as low numbers have been recorded in the Gunnedah LGA, it is considered that the habitat within the Project Boundary is not important for the long-term survival of a local population of this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Varied Sittella has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Varied Sittella:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;

- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species and indirectly impact other areas of potential habitat. This includes removal of potential forage, roosting and breeding habitat. No known habitat for this species will be removed. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.7 *Turquoise Parrot (Neophema pulchella)*

The Turquoise Parrot (*Neophema pulchella*) is listed as Vulnerable under the TSC Act. There are 26 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 as well as Breeza State Forest and adjacent lands to the north-west of the Project. The species is considered to have potential to occur.

The Turquoise Parrot is a woodland species endemic to south-eastern Australia with patchy distribution in New South Wales. It occurs on the western side of the tablelands and inland slopes, plains and some dry coastal valleys in eastern New South Wales (Pizzey and Knight 2003). The species is most commonly found in open, grassy woodland composed of mixed assemblages of eucalypt species, including box-ironbark, with abundant hollow-bearing trees and stags for nesting (NSW Scientific Committee 2009). The Turquoise Parrot occurs solitarily, in pairs, in family groups, or in small flocks. It breeds in solitary pairs, though pairs are possibly clumped in favoured nesting patches. Turquoise Parrots are generally resident in an area, but some local seasonal movement occurs. Foraging is typically ground-based among seeding grasses and weeds, and sometimes near cropland (Birds Australia 2011).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and breeding habitat for the Turquoise Parrot. Based on low Gunnedah LGA records and a lack of observations, the Project Boundary is considered unlikely to support a local resident population of Turquoise Parrots. Therefore the Project is unlikely to place a local population of the species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential habitat for the Turquoise Parrot is proposed to be removed as part of the Project. This includes potential forage, breeding and nesting. The removal of patches of native vegetation and scattered trees may affect connectivity for this species and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

As this species is not known to utilise this habitat, the potential habitat to be cleared is not considered to be important to the long term survival of this species in the locality.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Turquoise Parrot has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Turquoise Parrot:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources; and

- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance, particularly as they predate on nests and nesting females.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species and indirectly impact other areas of potential habitat. This includes the removal of potential forage, roosting and breeding habitat for individuals that may occur in the locality. This species has not been recorded from the Project Boundary. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.8 Superb Parrot (*Polytelis swainsonii*)

The Superb Parrot (*Polytelis swainsonii*) is listed as Vulnerable under both the TSC and EPBC Acts. 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 as well as Breeza State Forest and lands adjacent to the Project. 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) 2005q). 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 10 km 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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and breeding habitat for the Superb Parrot. However no records exist for this species within the locality and they have not been recorded from the Project Boundary. Accordingly the Project is considered unlikely to place a viable local population of the species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. This includes potential forage habitat for the Superb Parrot.

Atlas of NSW Wildlife searches did not indicate any records of the Superb Parrot within the Gunnedah LGA. The nearest recent Atlas of NSW Wildlife records for this species are approximately 70km to the west of the Project near Purlewaugh and Pilliga State Forest. This species is able to fly over disturbed land to access other resources and the Project will not fragment or isolate areas of habitat for this species.

The Project will result in the loss of potential foraging habitat for the Superb Parrot in the locality, however as the species does not breed in the locality and it has not been recorded from the locality, this potential habitat is not considered to be important to the long term survival of the local population of this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Superb Parrot has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Superb Parrot. The Project is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Superb Parrot:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources;
- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance, particularly as they predate on nests and nesting females; and
- Infection by Psittacine Circoviral (*beak and feather*) Disease affecting endangered psittacine species and populations as this can lead to a severe reduction in populations.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species and indirectly impact other areas of potential habitat. However, this species has not

been recorded from the Project Boundary or the locality and the habitat to be removed is not important to this species. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.9 Painted Honeyeater (Grantiella picta)

The Painted Honeyeater (*Grantiella picta*) is listed as Vulnerable under the TSC Act. There is one record of the species within the Gunnedah LGA. The species was not recorded during field surveys, however suitable habitat including feed trees exist in both the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Painted Honeyeater is endemic to eastern Australia. It is rare throughout its range and has sparse distribution in south-east New South Wales (DEC (NSW) 2006). The species often occurs singly or in pairs and is most commonly found in dry open woodland and forest, such as box-ironbark, which support parasitic mistletoe species, with which the species is closely associated (Pizzey and Knight 2003). The species has a general north-south seasonal movement linked to the fruiting of mistletoe species. It also feeds on nectar and insects in tree canopies. Breeding occurs south of Queensland on inland slopes of the Great Dividing Range.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and breeding habitat for the Painted Honeyeater. Based on low Gunnedah LGA records and a lack of observations, this species is considered unlikely to frequent the locality and the Project Boundary unlikely to support a local population. Accordingly the Project will not place a viable local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. This includes potential forage, breeding and nesting habitat for the Painted Honeyeater.

As the species is a seasonal migrant with distribution dictated by the presence of mistletoes, the removal of patches of native vegetation and scattered trees is considered unlikely to affect connectivity for this highly mobile species, and its capacity for dispersal within the locality is unlikely to be affected.

As this species does not rely on habitat resources present within the Project Boundary, the potential habitat present is not considered to be important to this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Painted Honeyeater has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Painted Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;

- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species and indirectly impact other areas of potential habitat. However, this species has not been recorded from the Project Boundary or the locality and the habitat to be removed is not important to this species. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.10 Black-chinned Honeyeater (eastern subspecies) (Melithreptus gularis gularis)

The Black-chinned Honeyeater (eastern subspecies) (*Melithreptus gularis gularis*) is listed as Vulnerable under the TSC Act. There is one 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 eastern subspecies of the Black-chinned Honeyeater is endemic to eastern Australia from inland slopes of the Great Dividing Range to the coast (Pizzey and Knight 2003). The species is declining in the wheat-belt region of western New South Wales where large areas would have once contained suitable habitat. The species is most commonly found in the upper levels of dry open eucalypt woodlands and forest containing box-ironbark associations where they build suspended nests and feed on insects, nectar and lerps (NSW Scientific Committee 2001a).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and breeding habitat for the Black-chinned Honeyeater. However, only one Gunnedah LGA record and no observations indicate the species does not frequent the locality and the Project is unlikely to place a viable local population of the species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential forage and nesting habitat for the Black-chinned Honeyeater is proposed to be removed as part of the Project.

The removal of patches of native vegetation and scattered trees may affect connectivity for this species and thus inhibit fauna movement and dispersal within the locality, particularly as the Project is located within a predominantly cleared, agricultural landscape.

The species has only been recorded once in the Gunnedah LGA, which indicates that habitat within the locality is not core habitat and does not form part of the territorial range of a local population. The species is an infrequent visitor, is mobile and has the capacity to disperse to remaining areas of forest such as Breeza State Forest. Accordingly the habitat to be removed is not considered to be important to the long term survival of this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Black-chinned Honeyeater has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Black-chinned Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;

- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential habitat for this species and indirectly impact other areas of potential habitat. However, this species has not been recorded from the Project Boundary or the locality and the habitat to be removed is not important to this species. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.11 Little Lorikeet (Glossopsitta pusilla)

The Little Lorikeet (*Glossopsitta pusilla*) is listed as Vulnerable under the TSC Act. There are 29 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has been recorded during surveys within the Project Boundary, as well as Breeza State Forest and lands adjacent to the Project.

The Little Lorikeet is a nectivorous species endemic to eastern mainland Australia. In New South Wales, the species is most commonly found in dry, open sclerophyll forests and woodlands dominated by eucalypts, from the coast to the western slopes of the Great Dividing Range and extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri (Pizzey and Knight 2003).

The species has been found in both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes, where it forages in the canopy. It is generally thought to be nomadic in response to food availability, though in some areas it is considered resident, particularly during breeding season from April to December (NSW Scientific Committee 2009).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known forage and breeding habitat for the Little Lorikeet. However this is a highly mobile species that is able to access resources from across a wide area. The local population is unlikely to be placed at risk of extinction due to the species' nomadic nature and dispersal capabilities.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of known and potential forage, breeding and nesting habitat for the Little Lorikeet is proposed to be removed as part of the Project.

The removal of patches of native vegetation and scattered trees is unlikely to fragment or isolate areas of habitat as these species are highly mobile and can fly over disturbance to access food resources.

For these reasons the habitat to be removed is not considered to be important to this species. Other areas of habitat occur in the locality, particularly in Breeza State Forest and adjacent lands to the north-west of the Project, and this species will be able to access other habitat resources.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Little Lorikeet has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

The “Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species” is relevant to the Little Lorikeet. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Little Lorikeet:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation by the Feral Cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources; and
- Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations as this can lead to a severe reduction in populations.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and indirectly impact other areas of potential habitat. This includes the removal of known

forage, roosting and breeding habitat for locally occurring populations of the species. The Project will clear a large area of known habitat for this species within an otherwise cleared, agricultural landscape, resulting in the likely displacement and loss of individuals. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.12 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 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 Critically Endangered under the TSC Act and Endangered under the EPBC Act. It is also listed as 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 New South Wales 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 creeklines and river valleys. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in New South Wales at Capertee Valley and the Bundarra-Barraba region (DEC (NSW) 2005r). Numbers fluctuate greatly between years and sites, and movement outside of breeding season is poorly understood. Only 1,500 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 under both the TSC and EPBC Acts. 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 New South Wales 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). The species has high site fidelity and returns to sites on a cyclic basis. However, this site fidelity depends on availability of foraging resources.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

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 864 ha of woodland that on occasion may be used by Regent Honeyeaters and Swift Parrots. Such clearance is not likely to place local populations at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of potential forage habitat for the Regent Honeyeater and Swift Parrot is proposed to be removed as part of the Project.

While the Project will fragment habitat in the locality, this is not likely to affect these species as they are highly mobile and have the capacity to disperse to areas of forest such as Breeza State Forest that will still provide good quality habitat.

The potential habitat to be removed is not considered to be important to these species as they have the ability to access higher quality foraging resources from a wide area during their long migrations.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Regent Honeyeater and Swift Parrot has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have been prepared for the Swift Parrot and the Regent Honeyeater. The general aims of these plans include the protection and enhancement of key breeding and foraging habitats for these species. The Project Boundary does not occur in any key breeding or foraging areas for these species and is therefore consistent with these plans.

The "Threat Abatement Plan for Beak and Feather Disease affecting endangered psittacine species" is relevant to the Swift Parrot. The Proposal is unlikely to increase the likelihood of extinction or escalate the threatened status of psittacine birds and is therefore consistent with the objectives of this plan.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Swift Parrot and Regent Honeyeater:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;

- Predation by the feral cat (*Felis catus*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals, reptiles and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pig (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources; and
- Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations as this can lead to a severe reduction in populations.

Conclusion

The Project is expected to directly impact approximately 864 ha of known forage habitat for these species and indirectly impact other areas of potential habitat. On current data Regent Honeyeaters and Swift Parrots are unlikely to make significant recurrent use of habitat available within the Project Boundary. These species are highly mobile however and are able to access resources from a wide area. The removal of a relatively degraded area of woodland is not expected to limit the ability of these species to find suitable forage. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to these species.

1.4.13 *Spotted Harrier (Circus assimilis)*

The Spotted Harrier (*Circus assimilis*) is listed as Vulnerable under the TSC Act. There are four Atlas of NSW Wildlife records of the species within the Gunnedah LGA, and it has been recorded during surveys within the Project Boundary.

The Spotted Harrier is a partly nomadic raptor with widespread but sparse distribution across mainland Australia (Pizzey and Knight 2003). The species is most commonly found in grassy open woodland including remnant vegetation, riparian woodland and native grassland. The species nests in live trees in open or remnant woodland, often close to food sources such as crops. The species is irruptive in response to local availability of key prey species such as terrestrial grassland birds, including quail, pipits and larks.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove forest, woodland and grassland that includes known forage habitat and may potentially include nesting habitat for the Spotted Harrier. The species prefers living close to open woodland on the edge of native grassland and cropland which support key prey species, a landscape that surrounds the Project Boundary.

Assuming that a viable local population could consist of just a single pair of birds, the Project has potential to make a viable local population become extinct by clearing and disturbing habitat.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of known and potential forage, breeding and nesting habitat for the Spotted Harrier is proposed to be removed as part of the Project.

The removal of patches of native vegetation and scattered trees is unlikely to affect connectivity for this species as it forages widely between patches, but may inhibit prey fauna movement, dispersal and thus availability within the locality.

Spotted Harriers prefer foraging in open woodland margins, grassland and agricultural land which provide suitable habitat for key prey species such as terrestrial grassland birds, including quail, pipits and larks. As Breeza State Forest is surrounded by agricultural land, suitable forage habitat will still exist for the species regardless of the Project, and therefore

the habitat to be removed is not considered to be important to the survival of this species in the locality.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Spotted Harrier has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Spotted Harrier:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of woodland and grassland that could include foraging and nesting habitat for this species and indirectly impact other areas of potential habitat. Large areas of similar habitats occur in the locality and the vegetation to be removed is not likely to be important to the survival of this species

in the locality. Accordingly, no significant impact is predicted to occur to this species as a result of the Project. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.14 Little Eagle (*Hieraaetus morphinoides*)

The Little Eagle (*Hieraaetus morphinoides*) is listed as Vulnerable under the TSC Act. There are seven Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has been recorded during surveys of the Project Boundary.

The Little Eagle is a small, territorial raptor, uncommon but with widespread distribution across mainland Australia (Pizzey and Knight 2003). The species is considered partly migratory, with adults generally resident and sedentary, while the juvenile birds tend to disperse. The species is most commonly found in open eucalypt forest and woodland with abundant prey availability, Sheoak or acacia woodlands and riparian woodlands (Debus 1984). The species is tolerant of agricultural landscapes provided woodland habitat is available for nesting (Marchant and Higgins 1993), where they require a tall living tree within a remnant patch.

For widely dispersed raptorial birds with large territories, a viable local population may be as little as a single nesting pair of birds and so on current data there is likely to be a viable local population within the vicinity of the Project Boundary.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove approximately 4,021 ha of woodland and grassland that includes foraging and nesting habitat for this species. The Little Eagle is considered likely to have territory sizes larger than those contained within the Project Boundary and are able to access resources from a very wide area. Accordingly a viable local population is not likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of known and potential forage, breeding and nesting habitat for the Little Eagle is proposed to be removed as part of the Project.

The Project may have short term impacts on the availability of habitat for the species but the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of forest such as Breeza State Forest that will still provide suitable habitat.

Accordingly the habitat to be removed is not considered to be important to the Little Eagle.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Little Eagle has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Little Eagle:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;

- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of woodland and grassland that includes foraging and nesting habitat for this species and indirectly impact other areas of potential habitat. The Little Eagle is considered likely to have territory sizes larger than those contained within the Project Boundary and are able to access resources from a very wide area. Large areas of similar habitats occur in the locality and the vegetation to be removed is not likely to be important to the survival of this species in the locality. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.15 Square-tailed Kite (Lophoictinia isura)

The Square-tailed Kite (*Lophoictinia isura*) is listed as Vulnerable under the TSC Act. There are five 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 both the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Square-tailed Kite is a raptor endemic to Australia, with widespread but sparse distribution in coastal and sub-coastal areas (Birds Australia 2011). The species is most commonly found in open forests and woodlands associated with ridge and gully forests, with particular preference for timbered watercourses; it is a regular resident along the major west-flowing river systems of New South Wales (Marchant and Higgins 1993, NSW NPWS 1999b). The Square-tailed Kite has a large home range of over 100 km². The species is specialist hunter of passerines (particularly honeyeaters) and foliage insects, with most prey taken from the outer foliage of the tree canopy (NSW NPWS 1999b).

Except when breeding, this species tends to be a solitary bird, usually seen hunting alone high in, or just above the tree canopy in coastal or sub-coastal rainforest, forest or woodland. Breeding occurs from July to February and nest sites are usually located near watercourses in a fork or large horizontal branches of eucalypts (Debus and Czechura 1989, Birds Australia 2011).

For widely dispersed raptorial birds with large territories of up to 100 km², a viable local population may be as little as a single nesting pair of birds and so on current data there is potential for a viable local population to include part of the Project Boundary within its territory.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove approximately 4,021 ha of woodland and grassland that includes foraging and nesting habitat for this species. The Square-tailed Kite is considered likely to have territory sizes larger than those contained within the Project Boundary and will be able to access alternative resources. Accordingly, a local population is not considered likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of woodland and grassland is proposed to be removed as part of the Project. This includes known and potential forage, breeding and nesting habitat for the Square-tailed Kite.

The viability of the species in the locality is unlikely to be impacted as the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of forest such as Breeza State Forest that will still provide suitable habitat.

Accordingly, the habitat to be removed is not considered to be important to the long term survival of a local population of this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Square-tailed Kite has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Square-tailed Kite:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;

- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of habitat for this species and indirectly impact other areas of potential habitat. Large areas of similar habitats occur in the locality. This species is highly mobile, has an extremely large home range and is an infrequent visitor to the locality. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.16 Black-breasted Buzzard (Hamirostra melanosternon)

The Black-breasted Buzzard (*Hamirostra melanosternon*) is listed as Vulnerable under the TSC Act. There is one record of the species within the Gunnedah LGA, although the species has not been recorded during surveys of the Project Boundary.

The Black-breasted Buzzard is one of the larger Australian birds of prey. It is found sparsely in areas of less than 500 mm rainfall, from north-western New South Wales and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, excepting only the Western Australian deserts. It lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. This species hunts over grasslands and sparsely timbered woodlands.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove approximately 4,021 ha of woodland and grassland that includes foraging and nesting habitat for this species. Black-breasted Buzzard is considered likely to have territory sizes larger than those contained within the Project Boundary and are able to access resources from a very wide area. Accordingly a viable local population is not likely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

(c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of known and potential forage, breeding and nesting habitat for the Black-breasted Buzzard is proposed to be removed as part of the Project.

The Project may have short term impacts on the availability of habitat for the species but the species is highly mobile, has a large home range and naturally sparse distribution, and will be able to disperse to remaining areas of forest such as Breeza State Forest that will still provide suitable habitat.

Accordingly the habitat to be removed is not considered to be important to the Black-breasted Buzzard.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Black-breasted Buzzard has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Black-breasted Buzzard:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this results in the loss of key food plants and habitat and encourages flock-foraging species;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females; and
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of woodland and grassland that includes potential foraging habitat for this species and indirectly impact other areas of potential habitat. The Black-breasted Buzzard is considered likely to have territory sizes larger than those contained within the Project Boundary and are able to access resources from a very wide area. Large areas of similar habitats occur in the locality and the vegetation to be removed is not likely to be important to the survival of this species in the locality, particularly as no suitable breeding habitat is present. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.4.17 Barking Owl (Ninox connivens) and Masked Owl (Tyto novaehollandiae)

This test assesses the Barking Owl and Masked Owl together. Both species are affected by the same threats and are likely to share the same potential impacts as a result of the Project.

They have similar habitat requirements including large hollow-bearing trees as nesting habitat and dense vegetation as roosting habitat.

The Barking Owl (*Ninox connivens*) is listed as Vulnerable under the TSC Act. There are six Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has been recorded during surveys of the Project Boundary. The Barking Owl is a sedentary, medium-sized owl widespread on the mainland. The species is most commonly found in dry open sclerophyll woodland and open forest dominated by eucalypts such red gums (Birds Australia 2011). It also inhabits fragmented remnant patches, partly cleared farmland and casuarinas along watercourses which contain large roost trees (NSW NPWS 2003). The species roosts in shaded portions of dense tree canopies, including tall mid-storey trees with dense foliage such as acacia and casuarina species. It nests in hollows of large, old Eucalypt trees and requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 ha, with 2000 ha being more typical in New South Wales habitats (DEC (NSW) 2005a).

The Masked Owl (*Tyto novaehollandiae*) is listed as Vulnerable under the TSC Act. There are three Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was not recorded during field surveys, however suitable habitat exists in both the Project Boundary and adjacent Breeza State Forest. The Masked Owl is restricted to the coast of New South Wales and Victoria (Pizzey and Knight 2003). The species is found within a diverse range of habitats that provide large hollow-bearing trees for roosting and nesting, typically in riparian vegetation, and adjacent open areas for foraging. The Masked Owl is also tolerant of disturbed areas and has a close association with drier, unlogged, or selectively logged forests (Newton et al. 2002). It is most commonly found within dry eucalypt forests and woodland from sea level to 1100 m. Pairs of Masked Owls have a large home range of 500-1000 ha (DEC (NSW) 2005i). The species is threatened by clearing which reduces habitat availability, particularly by limiting nesting resources, and because regrowth after logging makes the habitat less suitable for foraging on key prey such as terrestrial mammals.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove 4,021 ha of woodland and grassland that constitutes potential foraging and potential breeding habitat for the Masked Owl, and known habitat for the Barking Owl. These birds are known to have large territories and are able to access resources from across a wide area. Accordingly, the Project will not place a local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 4,021 ha of woodland and grassland is proposed to be removed as part of the Project. This includes known and potential habitat for both the Barking Owl and Masked Owl. Vegetation within the Project Boundary may support both potential breeding sites (tall remnant trees) and foraging resources (mammal and bird prey) for these species.

These species are highly mobile and have large home ranges, and will be able to disperse to remaining areas of forest that will still provide suitable habitat. Therefore areas of habitat are not expected to become fragmented.

Due to their ability to access resources from other areas, the habitat within the Project Boundary is not considered to be important for the local population of these species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for either the Barking Owl or Masked Owl has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

The Project is consistent with the objectives and actions of the “Large Forest Owl Recovery Plan” (covering the Masked Owl) and the 2003 Draft “Recovery Plan for the Barking Owl”. No Threat Abatement Plans apply to these species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Barking Owl and Masked Owl:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and nesting habitat;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk. They also compete with owls for prey;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to directly impact approximately 4,021 ha of woodland and grassland that is known to provide foraging and breeding habitat for the Barking Owl, and has the potential to provide foraging and breeding habitat for the Masked Owl. The Project may also indirectly impact other areas of potential habitat. Large areas of similar habitats occur in the locality and the vegetation to be removed is not likely to be important to the survival of these species in the locality. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

I.5 Mammals

I.5.1 *Hollow-roosting Microbat Species*

Four hollow-roosting microbat species are known or have potential to occur within the Project Boundary; the Yellow-bellied Sheath-tail Bat, Eastern Free-tail Bat, South-eastern Long-eared Bat, and Little Pied bat.

- i. *Yellow-bellied Sheath-tail-bat (Saccolaimus flaviventris);*

The Yellow-bellied Sheath-tail-bat is listed as Vulnerable under the TSC Act. There are 20 Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species was recorded during field surveys of the Project Boundary.

The Yellow-bellied Sheath-tail Bat is a tree-hollow roosting species with wide-ranging distribution through tropical Australia, although it is considered rare in south-eastern Australia. It is an insectivorous species that primarily forages above the tree canopy in almost all habitats (DEC (NSW), 2005f). Most records in New South Wales have been obtained between January and May, leading to speculation that the species may be migratory in the southern portion of its range, although very little is currently known about seasonal movements. This species roosts in large tree-hollows in groups of between two and thirty (Churchill, 2008).

ii. *South-eastern Long-eared Bat (Nyctophilus corbeni)*

The South-eastern Long-eared Bat (*Nyctophilus corbeni*) is listed as Vulnerable under both the TSC and EPBC Acts. There are two Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded within the Project Boundary during field surveys, but suitable forage and roosting habitat is available within the Project Boundary and the adjacent Breeza State Forest. This species was recorded from adjacent lands in recent surveys, and is therefore considered to have potential to occur.

The South-eastern Long-eared Bat is an insectivorous, hollow-dependent species with rare distribution around south-eastern Australia (DEC (NSW) 2005f, Churchill 2008). The species is most commonly found in inland woodland vegetation types including box-ironbark dominated communities and mallee. Little is known about the species, but it is expected to roost solitarily in tree crevices and shedding bark, and forage in flight, on the ground or around patches of trees (Lunney et al. 2000).

iii. *Little Pied Bat (Chalinolobus picatus)*

The Little Pied Bat is listed as Vulnerable under the TSC Act. There are three Atlas of NSW Wildlife records of the species within the Gunnedah LGA. The species has not been recorded during surveys, however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Little Pied Bat is an insectivorous, hollow and cave-roosting species generally found in the semi-arid interior regions of eastern Australia to west of the Great Dividing Range (Van Dyck and Strahan 2008). The species is most commonly found in mallee and mixed species woodland, riverine open forest and dry open woodland. Colonies typically roost in large mature trees with dead limbs, hollowed stumps, caves and artificial construction such as mines and buildings (Churchill 2008). The species often roost alone and move roost location regularly, although that is generally within a 200 m area.

iv. *Eastern Freetail-bat (Mormopterus norfolkensis)*

The Eastern Freetail-bat is listed as Vulnerable under the TSC Act. There is one record of the species within the Gunnedah LGA. The species was not recorded during surveys,

however suitable habitat exists within the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur.

The Eastern Freetail-bat is an insectivorous species that occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. This species roosts mainly in tree hollows but will also roost under bark or in man-made structures. They are usually solitary but have also been recorded roosting communally.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential forage and roosting habitat for the Yellow-bellied Sheath-tail-bat, South-eastern Long-eared Bat and Little Pied Bat. These species have high capacities for dispersal, and are likely to be able to seek suitable habitat elsewhere outside the Project Boundary. The Project is therefore unlikely to place a viable local population of these species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of these species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland habitat is proposed to be removed as part of the Project. This includes known habitat for the Yellow-bellied Sheath-tail-bat and potential forage and roosting habitat for the South-eastern Long-eared Bat, Eastern Freetail-bat and Little Pied Bat.

The Project is not considered likely to fragment or isolate habitat for these species as they typically fly great distances to feed and extensive forage habitat will still be available in the remaining forest and in the adjacent Breeza State Forest.

As a result of this, the habitat to be removed is not considered to be important habitat for these species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Yellow-bellied Sheath-tail-bat, South-eastern Long-eared Bat, Eastern Freetail-bat or Little Pied Bat has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for these species. No threat abatement plans are relevant to these species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Yellow-bellied Sheath-tail-bat, South-eastern Long-eared Bat, Eastern Freetail-bat and Little Pied Bat:

- Clearing of native vegetation as this reduces the area of forage and roosting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of roosting habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important roosting habitat;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Competition from feral honey bees (*Apis mellifera*) as they compete with native fauna for tree hollows and floral resources.

Conclusion

The Project is expected to directly impact approximately 864 ha of woodland that provides known and potential foraging and breeding habitat for the Yellow-bellied Sheathtail-bat, South-eastern Long-eared Bat, Eastern Freetail-bat and Little Pied Bat. The Project may also indirectly impact other areas of potential habitat. These species typically fly great distances to feed and extensive forage habitat will still be available in the remaining forest and in the adjacent Breeza State Forest. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.5.2 Cave-roosting Microbat Species

Two cave-roosting microbat species have potential to occur within the Project Boundary; the Eastern Cave Bat (*Vespadelus troughtoni*) and The Large-eared Pied Bat (*Chalinolobus dwyeri*).

The Eastern Cave Bat (*Vespadelus troughtoni*) is listed as Vulnerable under the TSC Act. There are five 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 both the Project Boundary and adjacent Breeza State Forest.

The Eastern Cave Bat is a cave-roosting species typically found in dry open forest and woodland (Churchill 2008, Van Dyck and Strahan 2008). It generally roosts near cave entrances in moderately well-lit areas or in crevices of cliffs and overhangs. It has been recorded roosting in disused mine workings, occasionally in colonies of up to 500 individuals (DEC (NSW) 2005e).

The Large-eared Pied Bat (*Chalinolobus dwyeri*) is listed as Vulnerable under both the EPBC and TSC Acts. There are six 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 both the Project Boundary and adjacent Breeza State Forest. The species is considered to have potential to occur. 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 New South Wales (DEC (NSW) 2005h). 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.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

There are few records of these species in the locality and they were not detected within the current survey. Although the Project will remove potential forage habitat for the Eastern Cave Bat and Large-eared Pied Bat, these species have high capacities for dispersal, and have the ability to seek resources from a wide area. It is therefore considered unlikely that the Project would place a local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland habitat is proposed to be removed as part of the Project. This includes potential forage habitat for these species, although it is likely that they only frequent the area while foraging at night, and would return to roost sites outside of the Project Boundary each morning. The Eastern Cave Bat and Large-eared Pied Bat are predominantly cave-roosting species, and it is unlikely that the Project Boundary would provide suitable roosting habitat for these species.

Though the species typically fly great distances to feed and forage, and therefore no areas of habitat will become fragmented or isolated for these species that are able to fly over intervening areas of non-suitable habitat in order to access resources.

As no roosting habitat is available, and the foraging habitat within the Project Boundary is likely only part of a much larger territory, the habitat to be cleared is not considered to be important to these species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Eastern Cave Bat or Large-eared Pied Bat has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for these species. No other threat abatement plans are relevant to these species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Process is relevant to the Eastern Cave Bat and Large-eared Pied Bat:

- Clearing of native vegetation as this reduces the area of forage habitat available for this species.

Conclusion

The Project is expected to directly impact approximately 864 ha of foraging habitat for these species although no roosting habitat will be affected. The Project may also indirectly impact other areas of potential habitat. These species typically fly great distances to feed and forage, and habitat will still be available in the remaining Breeza State Forest and in other areas of woodland in the locality. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.5.3 Koala (*Phascolarctos cinereus*)

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under both the EPBC Act and the TSC 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 2008a). 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 2008a).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove known and potential forage and breeding habitat for the Koala. However, known habitat will remain in Breeza State Forest, and a detailed KPOM has been prepared to mitigate impacts on this species. A viable local population is unlikely to be placed at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 847 ha of preferred eucalypt-dominated habitat for the Koala is proposed to be removed as part of the Project.

The Project is likely to fragment adjoining habitat and affect local habitat connectivity.

The Project is expected to have some adverse effects on the relocation of individuals of the local population as the species has limited capacity to disperse due to its sedentary nature, and because it is dependent on the availability of suitable feed trees. The species is highly susceptible to habitat fragmentation; a lack of habitat connectivity and decrease in territory size can disrupt dispersal and increase the population's vulnerability to inbreeding depression, predation and disease. However, the long-term genetic viability of the species in the locality is unlikely to be impacted as remaining areas of Breeza State Forest and other lands adjacent to the Project will still provide suitable habitat.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Koala has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

A Recovery Plan has been prepared for the Koala. The general aims of this plan are to identify actions to be taken to ensure the long-term viability of the koala in nature and the parties who are responsible for undertaking these actions.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Koala:

- Clearing of native vegetation as this reduces the area of forage and breeding habitat available for this species;
- Predation and hybridisation of Feral Dogs (*Canis lupus familiaris*) as they pose a major threat to Koalas, particularly as they move between trees;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

The Koala is also likely to be susceptible to disease in areas of fragmented vegetation.

Conclusion

The Project is expected to impact approximately 847 ha of preferred eucalypt-dominated habitat for this species through the removal of forage and breeding habitat. The Project may also indirectly impact other areas of potential habitat. Substantial areas of suitable habitat are present in Breeza State Forest and other lands adjacent to the Project, and a detailed KPOM has been prepared to manage impacts to this species.

1.5.4 Spotted-tailed Quoll (*Dasyurus maculatus*)

The Spotted-tailed Quoll (*Dasyurus maculatus*) is listed as Vulnerable under the TSC Act and 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, Breeza State Forest and lands adjacent to the Project. 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 1999a). 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) 2005o). The species hunts medium-sized reptiles and mammals including possums and rabbits, and carrion.

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Spotted-tailed Quoll has not been recorded from the Project Boundary although it has potential to occur due to the presence of suitable habitat. They occupy extremely large home ranges and may utilise habitat within the Project Boundary as part of a much larger range. Similar habitat occurs in the locality and in nearby Breeza State Forest that this species is able to utilise. The Project is not considered likely to place a local population of this species at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

There are currently no endangered populations of this species listed under Part 2 of Schedule 1 of the TSC Act.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. This includes potential forage and shelter habitat for the Spotted-tailed Quoll.

This is a highly mobile species that is able to traverse cleared land. As such the Project is considered unlikely to fragment or isolate areas of habitat for this species.

The Project Boundary may provide some periodic foraging resources for this species as part of a much larger territory. Accordingly, the habitat present is not expected to be important to the survival of a local population of this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Spotted-tailed Quoll has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

A draft national recovery plan for the Spotted-tailed Quoll is currently being prepared. The Action Plan for Australian Marsupial and Monotremes, prepared by Wildlife Australia in 1996, is applicable to the Spotted-tailed Quoll.

Thirty-three priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Spotted-tailed Quoll:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species and its prey;
- Loss of hollow-bearing trees as this reduces the abundance of den habitat;
- Removal of dead wood and dead trees as this reduces the abundance of important ground foraging and den habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation and competition by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to directly impact approximately 864 ha of habitat for this species and may also indirectly impact other areas of potential habitat. . This includes the removal of potential forage and shelter habitat. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.5.5 *Squirrel Glider (Petaurus norfolcensis)*

The Squirrel Glider (*Petaurus norfolcensis*) is listed as Vulnerable under the TSC Act. There are four records Atlas of NSW Wildlife 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 Squirrel Glider is widely, but sparsely distributed in eastern Australia from northern Queensland to western Victoria. It commonly inhabits mature or old growth Box-Gum, Box-Ironbark woodlands and River Red Gum forest as the species requires abundant tree hollows for refuge during the day, and nest sites (DEC (NSW) 2005p). They live in family

groups and nest in tree hollows and prefer Eucalypt stands with a shrubby or an Acacia midstorey where they can forage at night. Diet varies seasonally but consists of Acacia gum, eucalypt sap, nectar, pollen and insect material. They prefer stands of mixed forests with at least one species of winter-flowering eucalypt or banksia to provide a reliable food source year round (DEC (NSW) 2005p, Van Dyck and Strahan 2008).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential nesting and forage habitat for the Squirrel Glider, however this species has not been recorded from the Project Boundary and large areas of suitable habitat will remain nearby in Breeza State Forest. Therefore the Project will not place a viable local population at risk of extinction.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. This includes potential nesting and forage habitat for the Squirrel Glider.

As no known individuals utilise the Project Boundary it is considered that no known habitat will become fragmented or isolated from other areas of known habitat. As better quality habitat occurs in Breeza State Forest, it is not considered that habitat within the Project Boundary is important for this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Squirrel Glider has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

The Action Plan for Australian Marsupial and Monotremes, prepared by Wildlife Australia in 1996, is applicable to the Squirrel Glider.

Six priority actions have been identified to promote the recovery of this species and the abatement of key threatening processes affecting its occurrence.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Squirrel Glider:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and

- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to directly impact approximately 864 ha of potential forage and nesting habitat for this species and may also indirectly impact other areas of potential habitat. No known individuals will be removed from the Project Boundary and larger areas of high quality habitat will remain in Breeza State Forest. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

I.6 Reptiles

I.6.1 *Pale-headed Snake (Hoplocephalus bitorquatus)*

The Pale-headed Snake (*Hoplocephalus bitorquatus*) is listed as Vulnerable under the TSC Act. There is one 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 potential to occur.

The Pale-headed Snake is a largely arboreal, snake with patchy distribution from north-east Queensland to north-east New South Wales. It occurs from the western side of the Great Divide to the coast in New South Wales. The nocturnal species is found in a range of habitats but prefers streamside dry eucalypt forest and woodlands and occasionally rainforest and wet sclerophyll forest (DEC (NSW) 2005k). The species shelters during the day between loose bark and tree trunks, or in the hollow trunks or limbs of stags. The snake actively hunts in the open at night and feeds largely on tree frogs and lizards, however can also prey on small mammals (Cogger 2000).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove 864 ha of woodland providing potential habitat for the Pale-headed Snake. Only one record of the species exists in the Gunnedah LGA however and the species was not recorded from the Project Boundary. It is therefore considered unlikely that the Project will result in the extinction of a viable local population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
 - (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland providing potential habitat for the Pale-headed Snake will be removed by the Project.

As no known individuals utilise the Project Boundary it is considered that no known habitat will become fragmented or isolated from other areas of known habitat.

As no known individuals utilise the Project Boundary and better quality habitat occurs in Breeza State Forest, it is not considered that habitat within the Project Boundary is important for this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Pale-headed Snake has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to these species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Pale-headed Snake:

- Clearing of native vegetation as this reduces the area of habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation and competition by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion;
- Predation by feral cats (*Felis Catus*), as this can cause direct mortality of individuals, particularly juveniles; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to impact on habitat for the Pale-headed Snake by removing potential forage and shelter habitat in the form of tree hollows and stags and may also indirectly impact other areas of potential habitat. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species. No known individuals occur within the Project Boundary and only one record is known from the Gunnedah LGA.

1.6.2 Border Thick-tailed Gecko (Underwoodisaurus sphyrurus);

The Border Thick-tailed Gecko (*Underwoodisaurus sphyrurus*) is listed as Vulnerable under both the TSC and EPBC Acts. There are two 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 lands. 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 New South Wales 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) 2005c).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential habitat for the Border Thick-tailed Gecko. Only two records of the species exist in the Gunnedah LGA however and the species was not recorded from the Project Boundary. The Project will not remove significant rocky outcrops that potentially provide suitable habitat for this species (e.g. Mt Watermark), and it is therefore considered unlikely that the Project will result in the extinction of a viable local population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

No endangered population of this species has been listed.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
 - (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland is proposed to be removed as part of the Project. Though the majority of this vegetation is not associated with the higher rocky outcrops, there is potential for the species to occur in other areas within the Project Boundary.

The rocky outcrops that form the main areas of suitable habitat for this species will not be cleared or isolated by the Project.

The main areas of suitable habitat will not be affected by the Project. Areas of marginal habitat (woodland lower on the slopes) will be cleared, however this is not considered to be important for this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Border Thick-tailed Gecko has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

(g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Border Thick-tailed Gecko:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Bushrock removal as this removes important habitat for the species;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna, with non-flying mammals and ground-nesting birds at greatest risk, particularly as they predate on nests and nesting females;
- Predation by the feral cat (*Felis catus*) as this directly reduces species abundance, particularly as they predate on nests and nesting females;

- Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*), as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to impact on some areas of marginal habitat for the Border Thick-tailed Gecko within woodland and grassland. This includes the removal of potential forage and shelter habitat in the form of tree hollows and bush-rock. The Project may also indirectly impact other areas of potential habitat. The highest quality habitat for this species will remain undisturbed on the higher rocky slopes. No known individuals occur within the Project Boundary and only two records are known from the Gunnedah LGA. Avoidance, mitigation and offset measures detailed within Chapter 7 and Chapter 8 have been proposed to minimise the impact to this species.

1.6.3 Five-clawed Worm-skink (*Anomalopus mackayi*)

The Five-clawed Worm-skink (*Anomalopus mackayi*) is listed as Endangered under the TSC Act and 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 New South Wales 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).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential habitat for the Five-clawed Worm-skink. However no records of the species exist in the Gunnedah LGA, and it has not been recorded from the Project Boundary. It is considered unlikely that the Project will result in the extinction of a local viable population of this species.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

No endangered population of this species has been listed.

(c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
- (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

(d) *in relation to the habitat of a threatened species, population or ecological community:*

- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
- (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*
- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland and 3,157 ha of grassland providing potential habitat is proposed to be removed as part of the Project. This includes potential shelter and forage habitat for the Five-clawed Worm-skink.

The species has not been recorded from the Project Boundary. No known habitat will be isolated from other areas of habitat by the Project.

As this species has not been recorded and there is only one record in the Gunnedah LGA, the habitat to be removed is not considered to be important to this species.

(e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Five-clawed Worm-skink has been identified by the Director-General of EPA under the TSC Act.

(f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to this species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Five-clawed Worm-skink:

- Clearing of native vegetation as this reduces the area of forage and nesting habitat available for this species;
- Loss of hollow-bearing trees as this reduces the abundance of nesting habitat;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and nesting habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key food plants and habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by the European Red Fox (*Vulpes vulpes*) as they pose a major threat to the survival of native Australian fauna;
- Predation by the feral cat (*Felis catus*) as this can cause direct mortality of individuals;
- Predation, habitat degradation, competition and disease transmission by Feral Pigs, (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to directly impact approximately 864 ha of woodland and 3,157 ha of grassland providing potential 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 Project may also indirectly impact other areas of potential habitat. The species has not been recorded from the Gunnedah LGA, and it has not been recorded from the Project Boundary. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.

1.6.4 Pink-tailed Legless Lizard (*Aprasia parapulchella*)

The Pink-tailed Legless Lizard (*Aprasia parapulchella*) is listed as Vulnerable under the TSC Act and Vulnerable under the EPBC Act. There is one 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 New South Wales, and near Bendigo in Victoria. 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).

- (a) *in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction*

The Project will remove potential habitat for the Pink-tailed Legless Lizard. Only one record of the species exists in the Gunnedah LGA, and it has not been recorded from the Project Boundary. Therefore no viable local population is likely to be placed at risk of extinction by the Project.

- (b) *in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction*

No endangered population of this species has been listed.

- (c) *in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*
- (i) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*
 - (ii) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction*

Not applicable to threatened species.

- (d) *in relation to the habitat of a threatened species, population or ecological community:*
- (i) *the extent to which habitat is likely to be removed or modified as a result of the action proposed, and*
 - (ii) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

- (iii) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality*

Approximately 864 ha of woodland and 3,157 ha of grassland providing potential habitat is proposed to be removed as part of the Project. This includes potential shelter and forage habitat for the Pink-tailed Legless Lizard.

The species has not been recorded from the Project Boundary. No known habitat will be isolated from other areas of habitat by the Project.

As this species has not been recorded and there is only one record in the Gunnedah LGA, the habitat to be removed is not considered to be important to this species.

- (e) *whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)*

No critical habitat for the Pink-tailed Legless Lizard has been identified by the Director-General of EPA under the TSC Act.

- (f) *whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*

Recovery plans have not been prepared for this species. No other threat abatement plans are relevant to these species.

- (g) *whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process*

The following Key Threatening Processes are relevant to the Pink-tailed Legless Lizard:

- Clearing of native vegetation as this reduces the area of forage and shelter habitat available for this species;
- Removal of dead wood and dead trees as this reduces structural complexity and the abundance of important ground foraging and shelter habitat;
- Invasion of native plant communities by exotic perennial grasses as this structural complexity and results in the loss of key habitat;
- Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) as they compete with native fauna for resources, alter the structure and composition of vegetation, and degrade the land;
- Predation by feral cats (*Felis catus*), as this can cause mortality of individuals;
- Predation by the European Red Fox (*Vulpes vulpes*), as this can cause mortality of individuals;

- Predation, habitat degradation, competition and disease transmission by Feral Pigs, (*Sus scrofa*) as wallowing and rooting causes direct disturbance to habitats and may increase erosion; and
- Anthropogenic climate change as this can reduce the geographic range of species and alter the structure and composition of communities.

Conclusion

The Project is expected to directly impact 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 Project may also indirectly impact other areas of potential habitat. The species is only known from one record in the Gunnedah LGA, and it has not been recorded within the Project Boundary. Accordingly no significant impacts are predicted to occur to this species as a result of the Project.