

Appendix 4

Ecological Assessment

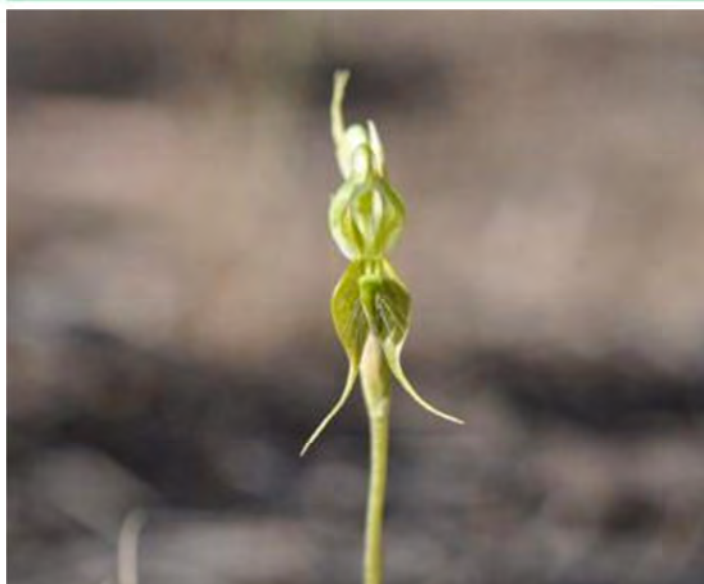


Dewhurst Gas Exploration Pilot Expansion

Ecological Assessment of the expansion of operations at Dewhurst 13 – 18H and Dewhurst 26 – 31 pilots

Prepared for
Santos NSW (Eastern) Pty Ltd

October 2013



DOCUMENT TRACKING

Item	Detail
Project Name	Dewhurst Gas Exploration Pilot Expansion. Ecological Assessment for the expansion of operations at Dewhurst 13 – 18H and Dewhurst 26 – 31 pilots
Project Number	13NEWECO-0046
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Status	FINAL
Version Number	4
Last saved on	28 October 2013
Cover photo	Clockwise from left: <i>Pterostylis mitchellii</i> (WI, 2012), Arboreal Elliott A trap with remote camera (AS, 2013), <i>Vespadelus vulturnus</i> (Little Forest Bat) (PK, 2013), Harp trap installed in flyway (PK 2013)

This report should be cited as ‘Eco Logical Australia 2013. *Dewhurst Gas Exploration Pilot Expansion. Ecological Assessment for the expansion of operations at Dewhurst 13 – 18H and Dewhurst 26 – 31 pilots.* Prepared for Santos NSW (Eastern) Pty Ltd.’

ACKNOWLEDGEMENTS

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Abbreviations

Abbreviation	Description
BBAM	BioBanking Assessment Methodology
CAP	Catchment Action Plan
CMA	Catchment Management Authority
CMA Act	Catchment Management Authorities Act 2003
DGRs	Director Generals Requirements
DoE	Australian Government Department of the Environment
DoP&I	NSW Department of Planning and Infrastructure
DPI	NSW Department of Primary Industries
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Services
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
ELA	Eco Logical Australia Pty Ltd
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FM Act	Fisheries Management Act 1994

Abbreviation	Description
GPS	Global Positioning System
HBT	Hollow Bearing Tree
Km	Kilometres
LEPs	Local Environmental Plans
LGA	Local Government Area
m	Metres
mm	Millimetres
MNES	Matters of National Environmental Significance
NGDP	Narrabri Gas Development Project
NPWS	NSW National Parks and Wildlife Service (part of OEH)
NW Act	Noxious Weeds Act 1993
OEH	NSW Office of Environment and Heritage (formerly NSW Department of Environment, Climate Change and Water)
PAL	Petroleum Assessment Lease
PDA	Personal Digital Assistant
PEL	Petroleum Exploration Lease
PPL	Petroleum Production Lease
REF	Review of Environmental Factors
SEPPs	State Environmental Planning Policies
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now Australian Government Department of the Environment)
SRD	State and Regional Development
SSD	State Significant Development
TEC	Threatened Ecological Community
TSC Act	Threatened Species Conservation Act 1995

Executive summary

Eco Logical Australia (ELA) was engaged by Santos NSW (Eastern) Pty Ltd (the proponent) to undertake an Ecological Assessment of the Dewhurst Gas Exploration Pilot Expansion which addresses the expansion of operations at Dewhurst 13 - 18H and Dewhurst 26 - 31 pilots (the proposed activity) within Petroleum Exploration Lease (PEL) 238. This Ecological Assessment will form part of the Environmental Impact Statement (EIS) for the proposed activity.

The study area is located approximately 25 to 44 kilometres (km) south of Narrabri NSW on freehold land and Crown Land (Dewhurst 13-18H) or within the Pilliga East State Forest (Dewhurst 30-31), which forms part of a large tract of remnant native vegetation referred to colloquially as the Pilliga Scrub.

This report details the ecological survey undertaken by RPS and ELA used to assess the potential impacts of the proposed activity on ecological values and the environment more broadly. Surveys were undertaken in 2012 by RPS with supplementary survey undertaken in 2013 by ELA.

The vegetation in the study area is consistent with the vegetation community *Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion*. This vegetation type provides habitat for a range of threatened flora, as well as foraging, breeding and roosting habitat for a range of threatened fauna species addressed in this impact assessment.

A total of four threatened flora and 33 threatened fauna including 21 birds and 12 mammals have been assessed as potentially, likely or known to occur in the study area and Assessments of Significance for these species under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) have been undertaken where applicable.

The removal of 2.44 hectares (ha) of vegetation for the proposed activity is not considered likely to have a significant impact on ecological values listed under the TSC Act or EPBC Act or on the environment more broadly, provided the measures described in **Section 6** are adhered to.

Avoidance, minimisation and mitigation measures have been addressed in order to reduce the impact of the proposed activity on ecological values and the environment.

1 Introduction

1.1 Project description

Eco Logical Australia (ELA) was engaged by Santos NSW (Eastern) Pty Ltd (the proponent) to undertake an Ecological Assessment of the Dewhurst Gas Exploration Pilot Expansion which addresses the expansion of operations at the Dewhurst 13 – 18H and Dewhurst 26 - 31 pilots (the proposed activity) within Petroleum Exploration Lease (PEL) 238 (hereafter referred to as the study region). This Ecological Assessment will form part of the Environmental Impact Statement (EIS) for the proposed activity.

The study area is located approximately 25 to 44 kilometres (km) south of Narrabri NSW on freehold land and Crown Land (Dewhurst 13-18H) or within the Pilliga East State Forest (Dewhurst 30-31), which forms part of a large tract of remnant native vegetation referred to colloquially as the Pilliga Scrub (**Figure 1**). The proposed location of works is shown in **Figure 2**.

The proposed activity involves the expansion of operations at the Dewhurst 13-18H and Dewhurst 26-31 pilots, and operation of both pilots for up to three years. Works at Dewhurst 13-18H involve re-entering three existing wells to convert single horizontal wells to triple-stacked horizontal wells. Works at Dewhurst 26-31 involve the construction of two additional wells on new lease areas to expand the proposed pilot from four to six wells.

The Dewhurst 13-18H Pilot is an existing pilot well set that comprises three vertical wells (Dewhurst 13, 14 and 15) and three single horizontal wells (16H, 17H and 18H). The NSW Department of Primary Industries (DPI) approved construction, drilling and operation of Dewhurst 13, 14, 15, 16H, 17H and 18H on 21 July 2009 following a Review of Environmental Factors (REF) assessment under Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The wells operated for a short period in 2011.

Dewhurst 26-29 is a proposed four well pilot which was approved by the NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) on 16 August 2013 following a REF assessment under Part 5 of the EP&A Act. Dewhurst 26-29 is scheduled to be drilled in Q3 2013.

More specifically, the proposed activity includes:

Site preparation

- Establishing two 10 metre wide service corridors between Beehive Road and the Dewhurst 30 and 31 lease areas (including clearing of approximately 0.2 hectares of vegetation).
- Constructing access roads within the two service corridors at Dewhurst 30 and 31.
- Establishing the Dewhurst 30 and Dewhurst 31 lease areas each up to approximately one hectare in size (including approximately two hectares of vegetation clearing).
- Removing the existing water gathering system and electrical cable connecting Dewhurst 13, 14 and Dewhurst 15 wells.
- Preparing the sites and establishing necessary equipment, temporary structures and facilities on the existing well leases Dewhurst 16H, 17H and 18H and on the new lease areas Dewhurst 30 and 31 to enable drilling.

Drilling

- Drilling an additional two horizontals from existing casing within Dewhurst 16H, 17H and 18H to convert each well from a single horizontal to a triple-stacked horizontal well targeting the Bohena, Namoi and Rutley coal seams.
- Drilling one vertical (Dewhurst 30) and one triple-stacked horizontal (Dewhurst 31) well to target coal seams within the Maules Creek Formation.

Surface and subsurface facility construction

- Preparing the site on the existing well lease Dewhurst 14 to enable installation of a gas flare and water balance tank.
- Constructing a new gas and water gathering system connecting all the wells within the Dewhurst 13-18H Pilot to the existing Dewhurst 14 well lease area (including clearing of approximately 0.24 hectares of disturbed vegetation).
- Extending the existing water and gas gathering system for Dewhurst 26-29 within the service corridors to Dewhurst 30 and 31.
- Installing surface and sub-surface infrastructure within the lease areas to connect the wells to the Dewhurst 13-18H and Dewhurst 26-31 gas and water gathering system.
- Installing a gas flare and water balance tank at the existing Dewhurst 14 lease area and a gas flare at the Dewhurst 28 lease area.

Operation

- Operating the Dewhurst 13-18H Pilot and Dewhurst 26-31 Pilot for up to three years from the commencement of operations at each pilot respectively.
- Managing the water and gas produced during operation.
- Undertaking occasional maintenance of the pilots.

Post operation

- On completion of operations, suspending the wells and ancillary infrastructure or decommissioning them and rehabilitating the well leases.

1.2 Area addressed in this assessment**1.2.1 Subject site**

The subject site is the area directly impacted by the proposed activity and is defined as the vegetation to be removed for the construction of the new Dewhurst 13 – 18H gathering system and the disturbance footprint for the construction of the Dewhurst 30 and 31 pilot wells and associated service corridors.

1.2.2 Study area

The study area includes all areas surveyed as part of this assessment, incorporating all areas of direct and indirect impacts including a 10 metre (m) buffer around the subject sites (**Figure 1** and **Figure 2**).

1.2.3 Study region

The study region is defined as the area within PEL 238 which includes Petroleum Assessment Lease (PAL) 2 and Petroleum Production Lease (PPL) 3 (**Figure 1**). This area is used to discuss the

proposed activity within the context of the broader north-east Pilliga Forest and assess the cumulative impacts of all projects undertaken by the proponent in the Pilliga region.

1.3 Report structure

The report is structured in the following chapters:

1. **Introduction** – outlines the proposed activity and provides detail on all project components and their likely impact areas. Also outlines the legislative framework under which the proposed activity is to be assessed including Commonwealth and NSW legislation and the Director General's Requirements (DGRs).
2. **Existing environment** – provides context for the landscape in which the study region is located.
3. **Methods** – outlines the methods used for database and literature review and field survey.
4. **Results** – outlines the findings of the database and literature review and field survey.
5. **Impact assessment** – assesses the likely direct, indirect and cumulative impacts from the proposed activity (residual impacts after avoidance).
6. **Mitigation measures** - outlines the proposed measures to mitigate impacts from the proposed activity.
7. **Conclusion** - summarises the key findings of this assessment and provides recommendations.

1.4 Objectives

The key objectives of the Ecological Assessment are to:

- Identify and describe any threatened flora and fauna species, populations, ecological communities, as well as migratory species and their habitats that may occur within the study area.
- Evaluate the conservation significance of the proposed subject sites.
- Assess the impact of the proposed activity on threatened flora and fauna species, populations and ecological communities, and migratory species, likely to occur in the study area through significance assessments in accordance with the EP&A Act and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Recommend measures to minimise and mitigate the impacts of the proposed activity on native flora and fauna and their habitats.

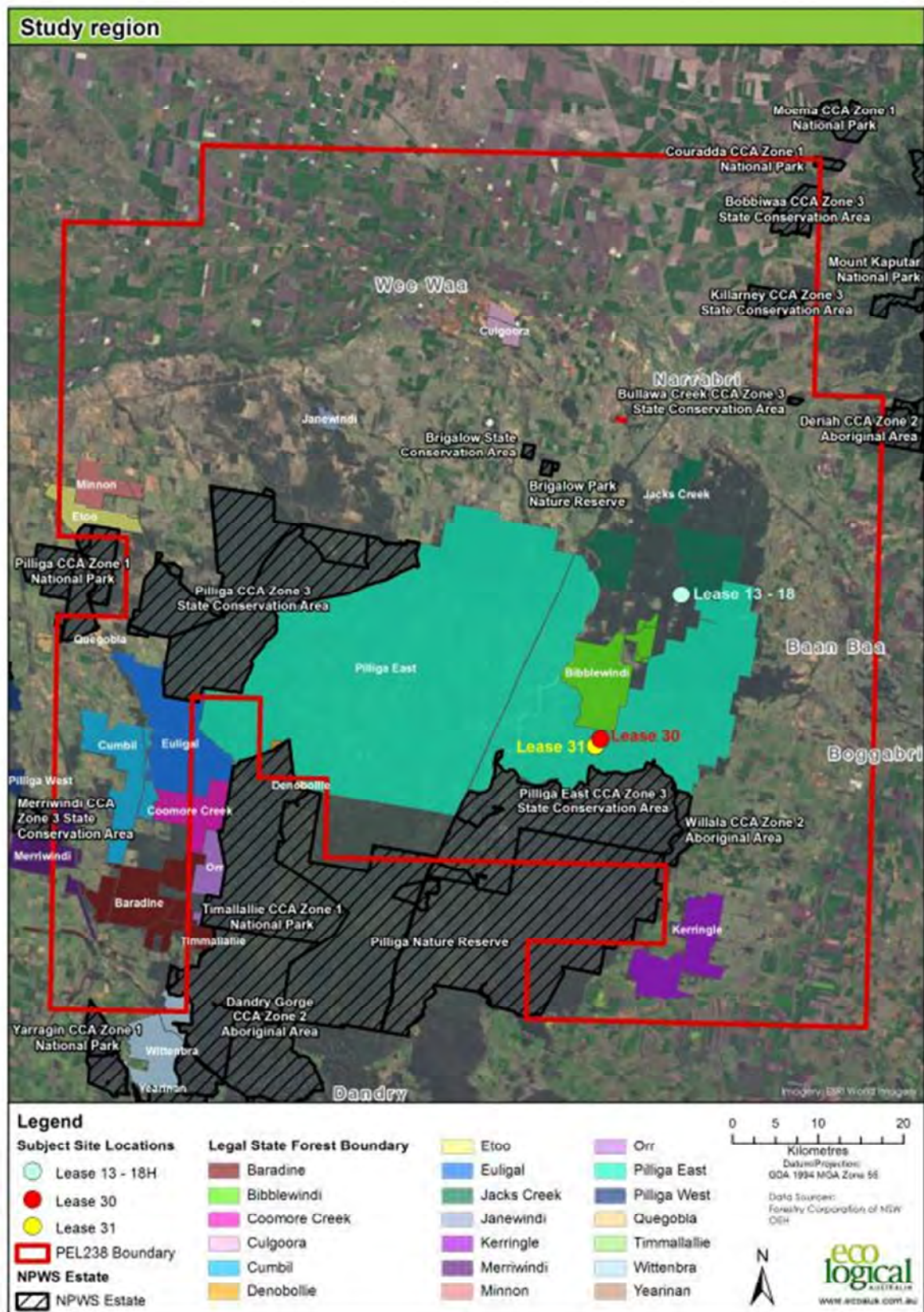


Figure 1: Study region

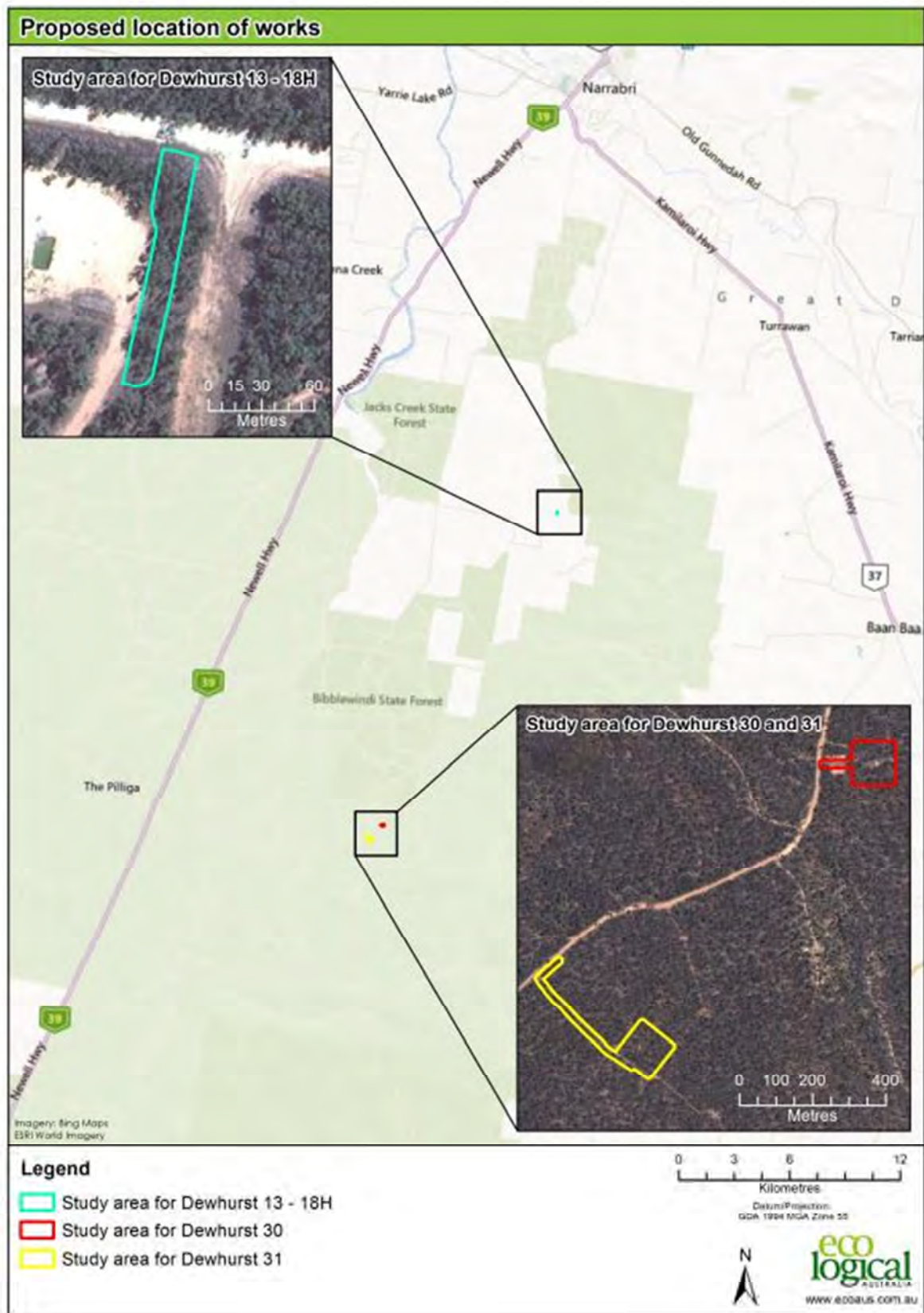


Figure 2: Proposed location of works

1.5 Statutory framework

1.5.1 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

The primary objective of the EPBC Act is to 'provide for the protection of the environment, especially those aspects of the environment that are Matters of National Environmental Significance.'

Environmental approvals under the EPBC Act are required for an 'action' that is likely to have a significant impact on Matters of National Environmental Significance (known as 'MNES') including:

- World Heritage Area.
- National Heritage Places.
- Ramsar wetlands of international importance.
- Nationally listed threatened species and ecological communities.
- Listed migratory species.
- Commonwealth marine areas.
- Nuclear actions.
- Great Barrier Reef Marine Park.
- A water source, in relation to coal seam gas development and large coal mining development.

In addition, the EPBC Act confers jurisdiction over actions that have a significant impact on the environment:

- where the actions affect, or are taken on, Commonwealth land
- are carried out by a Commonwealth agency (even if that significant impact is not on one of the nine matters of 'national environmental significance')

An 'action' is considered to include a project, development, undertaking, activity or series of activities.

Ecological MNES relevant to the study area are nationally listed threatened species and ecological communities and listed migratory species. Ecological MNES that were recorded or have the potential to be present or use the study area are listed in **Appendix A**. An assessment of the potential impacts of the proposed activity in accordance with the EPBC Act has been undertaken and provided in **Appendix G**.

Santos referred the Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program (the program) to the Australian Government Department of the Environment (DoE) (formerly Commonwealth Department of Sustainability, Environment, Water, Population and Communities, SEWPaC) as part of the Energy NSW Coal Seam Gas (CSG) Exploration and Appraisal Program (the Program) on 27 June 2013. A 'not controlled action if undertaken in a particular manner' decision was made on 1 October 2013 by the Minister for the Environment, meaning the program does not require Australian Government approval, provided it is undertaken in the particular manner set out in the decision notification.

1.5.2 New South Wales legislation

Environmental Planning and Assessment Act 1979

The EP&A Act is the principal planning legislation for NSW. It provides a framework for land use control and assessment, determination and management of development.

The proposed activity is designated State Significant Development (SSD) under Part 4.1 of the EP&A Act due to the proposed activity meeting the criteria listed in Schedule 1 of the State Environmental Planning Policy (State and Regional Development) (SRD SEPP) 2011.

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act is integrated with the NSW EP&A Act and requires consideration of whether SSD (Division 4.1 of Part 4 of the EP&A Act) or state significant infrastructure (Part 5.1 of the EP&A Act) is likely to significantly affect threatened species, populations and ecological communities or their habitats.

Threatened species, populations and ecological communities that were recorded or have the potential to be present on or use the study area are listed in **Appendix A**.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) aims to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. The FM Act defines 'fish' as any marine, estuarine or freshwater fish or other aquatic animal at any stage of their life history, excluding whales, mammals, reptiles, birds, amphibians or other species specifically excluded.

No threatened fish species or endangered populations are known or expected to occur within the study area.

Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act) defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The NW Act sets up categorisation and control actions for the various noxious weeds, according to their potential to cause harm to the local environment.

The objectives of the NW Act include:

- Identify noxious weeds in respect of which particular control measures need to be taken.
- Specify those control measures.
- Specify the duties of public and private landholders as to the control of those noxious weeds.
- Provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Under this Act, noxious weeds have been identified for Local Government Areas (LGAs) and assigned Control Classes. Part 3 provides that occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy.

1.5.3 State Environmental Planning Policies (SEPPs)

State Environmental Planning Policy 44 (Koala Habitat)

State Environmental Planning Policy 44 (Koala Habitat) (SEPP 44) aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline. As the proposed activity is over 1 ha in size and SEPP 44 applies to the Narrabri Shire Council LGA, an assessment under SEPP 44 is required. As Koala is listed as a threatened species, impacts to Koalas and their habitat have also been assessed.

1.5.4 Local Environment Plans (LEPs)

The Narrabri Local Environment Plan 1992 (Narrabri LEP 1992) applies to Narrabri Shire Council LGA not including Boggabri and Narrabri municipal areas. The objectives of the Narrabri LEP1992 that are relevant to the proposed activity include:

- To encourage the proper management, development and conservation of natural and man-made resources within the Shire of Narrabri by protecting, enhancing or conserving:
 - o timber, mineral, soil, water and other natural resources
 - o areas of ecological significance
 - o areas of high scenic or recreational value
 - o the environmental heritage of the Shire of Narrabri.

1.5.5 Director General's Requirements (DGRs)

The Director General of NSW Department of Planning and Infrastructure (DoP&I) issued DGRs, including ones specifically related to ecology, for the assessment of the Dewhurst Gas Exploration Pilot Expansion, on 22 July 2013. **Table 1** lists the key issues and requirements of the DGRs relevant to ecology, and the sections of this document that address these.

Table 1: DGRs and sections of the report where these have been addressed

Key issue	Requirement	Relevant section of this document
General	An assessment of the potential impacts of all stages of the development, including any cumulative impacts.	Section 5
	A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment.	Section 5 and Section 6
Biodiversity	Accurate estimates of any proposed vegetation clearing.	Section 5
	An 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 • regionally significant remnant vegetation, or vegetation/wildlife corridors	Appendix F & Appendix G
	Impacts on the Pilliga State Forest, including impacts on conservation and recreational values.	Appendix F & Appendix G
	Measures taken to avoid, reduce or mitigate impacts on biodiversity.	Section 5 and Section 6

2 Existing environment

2.1 Pilliga Forest

The Pilliga Forest represents the largest block of remnant vegetation in NSW, west of the Great Dividing Range. The Pilliga Forests are comprised primarily of State Forests managed for timber production, as well as conservation reserves and other landholdings. There are 24 State Forests within the study region, with the Dewhurst 26-31 pilot being located within the Pilliga East State Forest. There are four National Parks, two Aboriginal Areas, six State Conservation Areas and two Nature Reserves within the study region. The study area does not intersect any of these conservation reserves.

The Pilliga Forests have the following conservation values (NPWS 2000):

- Contain provisionally identified wilderness areas that are important recharge areas for the Great Artesian Basin and represent important areas for carbon recycling.
- Support areas of “old growth” not surviving in other locations.
- Represent significant and intact refugia within the region.
- Contain high levels of biodiversity, due to its location between the dry inland (Eyrean) and wetter coastal (Bassian) zones.
- Contain at least one endemic species, *Pseudomys pilligaensis* (Pilliga Mouse). However, it is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2011). It is important to note that this taxonomic change has not yet been formally recognised; hence this assessment considers the Pilliga Mouse as currently listed.
- Contain threatened ecological communities.
- Contain a high diversity of threatened flora and fauna species.
- Contain large populations of threatened species, such as *Ninox connivens* (Barking Owl), *Nyctophilus corbeni* (South-eastern Long-eared Bat), *Polygala linariifolia* (Native Milkwort), *Rulingia procumbens* and *Philothea ericifolia*.
- Provide habitat for species and populations that have become isolated due to the fragmentation of forest in the bioregion.

The Pilliga Forests have been variously disturbed by a long history of forestry, fire and small-scale agriculture. Existing forestry tracks and fire trails (both formal and informal) form a fragmented network across the study region. There are however still large patches (>1,000 ha) of contiguous vegetation that have not been dissected by forestry activities. Dewhurst 30 & 31 are located within the Pilliga East State Forest, while the Dewhurst 13 – 18H pilot is located on private and Crown land.

2.2 Landscape context

2.2.1 The Brigalow Belt South Bioregion

Location and bioregional provinces

The Pilliga Forests and the study region are located within the southern part of the Brigalow Belt South Bioregion. This bioregion extends over NSW and Queensland, with the majority occurring in Queensland. In NSW, the bioregion covers an area of 52,409 km², which represents 18.7% of the total bioregion (NPWS 2000).

The Brigalow Belt South Bioregion shares its borders with five other bioregions: the Nandewar and North Coast Bioregions to the east, the Sydney Basin and South Western Slopes Bioregions to the south, and the Darling Riverine Plains Bioregion to the west. Within the NSW section of the Brigalow Belt South Bioregion, major towns include Baradine, Binnaway, Coonabarabran, Dubbo, Gunnedah, Merriwa, Moree and Narrabri. Major rivers include the MacIntyre, Gwydir, Namoi, Castlereagh, Goulburn, Talbragar and Macquarie Rivers (NPWS 2000; 2010).

The Brigalow Belt South Bioregion is divided into seven provinces in NSW: Northern Outwash, Liverpool Plains, Pilliga Outwash, Liverpool Range, Northern Basalt, Pilliga, and Talbragar Valley. Of these, the proposed activity is situated in the Pilliga and Pilliga Outwash provinces (southern and northern portions of the proposed activity, respectively (**Figure 3**). These provinces are characterised by occurring on Mesozoic bedrock containing extensive sandstone hills and coarse sandy soils (Pilliga), and on the plains of deep sandy texture dominated by alluvial and colluvial sediments (Pilliga Outwash) (NPWS 2000).

The Pilliga sandstones over which the study area lies form the intake area and aquifer beds in NSW for the Great Artesian Basin. The alluvial soils of the Namoi River and its larger tributaries are an important source of groundwater (NPWS 2000).

2.3 Land use

Within the NSW section of the Brigalow Belt South Bioregion, the majority of land (approximately 85%) is freehold land. Much of the freehold land is used for agricultural purposes, where cropping (dryland and irrigation farming) and grazing/pastoral activities dominate (NPWS 2000).

Approximately 11% of the NSW sections of the bioregion are used by the forestry industry. Goonoo Forest and Pilliga Forests managed by Forests NSW are the two largest areas of forestry in the NSW sections of the bioregion. There are many small forest and flora reserves in addition to these forests.

Crown lands and conservation reserves form approximately 4% of the bioregion in NSW. Other land uses within the bioregion include mining and apiary industries (NPWS 2000). The mining industry is based mainly on coal, as the region lies mostly within the Gunnedah Basin, which is a major coal-bearing sedimentary basin. Current mining titles are held for coal and some industrial minerals while exploration titles are held for coal, petroleum, gold, base metals, zeolites and clay minerals (NPWS 2010).

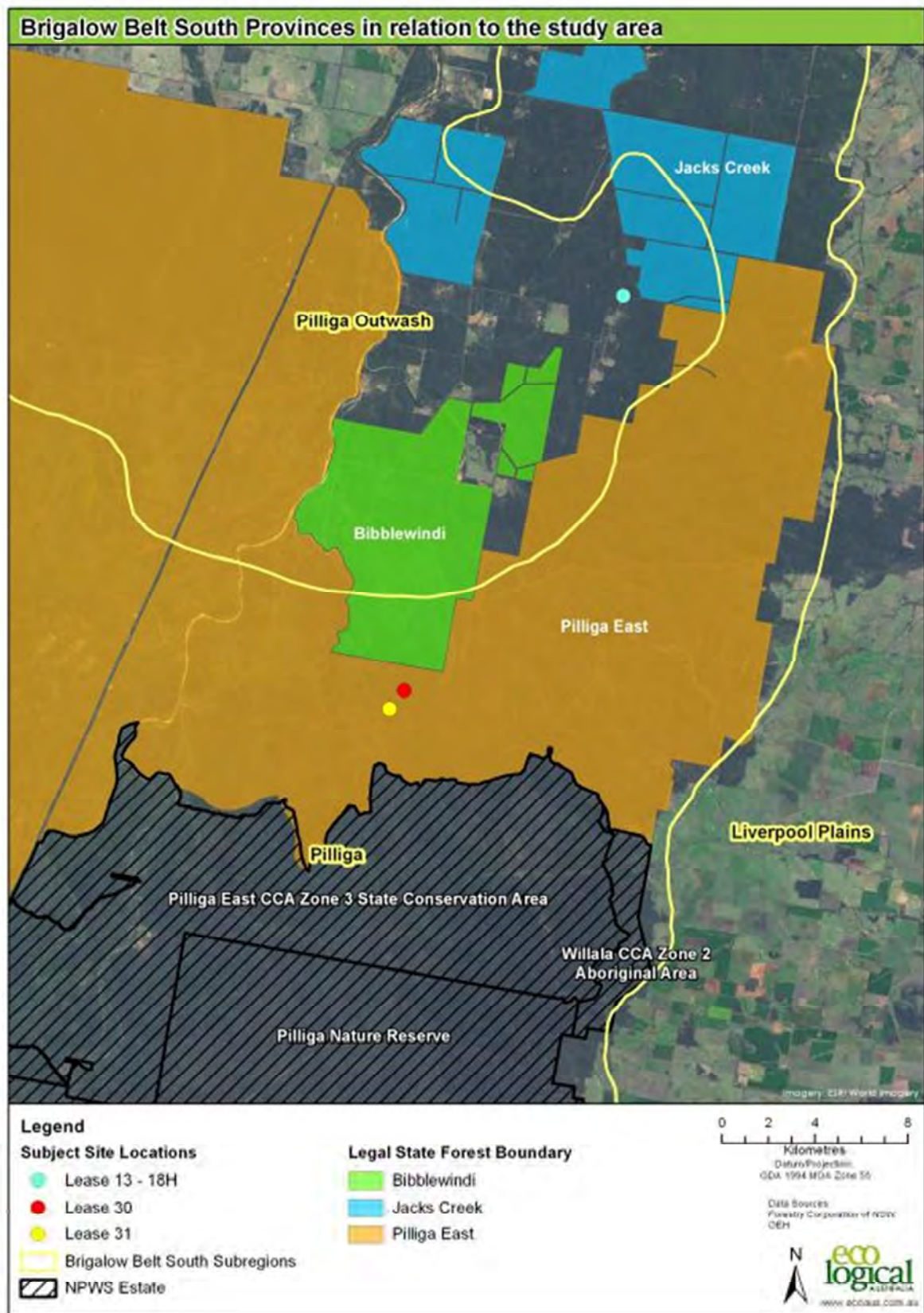


Figure 3: Brigalow Belt South Provinces in relation to the study area

2.4 Mitchell landscapes

Mitchell Landscapes are a system of ecosystem classification mapped at the 1:250,000 scale, based on a combination of soils, topography and vegetation (DECC 2008). Mitchell Landscapes are used in regional conservation planning in NSW and form a component of the BioBanking Assessment Methodology (BBAM). Two Mitchell Landscape have been mapped in the study area (**Table 2** and **Figure 4**).

Table 2: Mitchell Landscapes within the study area

Mitchell landscape	Landscape description (Mitchell 2002)	Location
Cubbo Uplands	Pilliga horizontal Jurassic quartz sandstones, limited shales, Tertiary basalt caps and plugs plus the sediments derived from these rocks. Stepped sandstone ridges with low cliff faces and high proportion of rock outcrop. Long gentle outwash slopes intersected by sandy streambeds and prior stream channels. A few patches of heavy clay. General elevation 400 to 550m, local relief 50m. On sandstone, the ridge tops have thin discontinuous soils with stony, sandy profiles and low nutrients. Down slope texture-contrast soils are more common typically with harsh clay subsoils and in the valley floors sediments tend to be sorted into deep sands with yellow earthy profiles, harsh grey clays, or more texture-contrast soils with a greater concentration of soluble salts. The sandstone outcrop areas support various forests and woodlands including; <i>E. nubila</i> (Blue-leaved Ironbark), <i>E. rossii</i> (Inland Scribbly Gum), <i>C. endlicheri</i> (Black Cypress Pine), <i>Atalaya hemiglauca</i> (Whitewood), and <i>Angophora floribunda</i> (Rough-Barked Apple). Stony hills in the north of the region carry mallee patches with; <i>E. melanophloia</i>, <i>Corymbia maculata</i> (Spotted Gum), and <i>A. leiocarpa</i> (Smooth-barked Apple). Gentler sandstone slopes over most of the region carry; <i>E. crebra</i> (Narrow-leaved Ironbark), <i>C. glaucophylla</i>, <i>E. macrorhyncha</i> (Red Stringybark), patches of <i>E. viridis</i> (Green Mallee) and <i>Melaleuca uncinata</i> (Broombush) heath. In western and northern sections on texture-contrast or more uniform harsh clay soils forests of <i>E. pilligaensis</i>, <i>E. microcarpa</i> (Grey Box), <i>E. populnea</i>, and <i>E. conica</i> (Fuzzy Box) are found with stands of <i>Allocasuarina luehmannii</i>, <i>Alectryon oleifolium</i> (Rosewood), <i>Atalaya hemiglauca</i>, <i>Geijera parviflora</i> (Wilga), <i>Casuarina cristata</i> (Belah), <i>Acacia homalophylla</i> (Yarran), and <i>Eremophila mitchellii</i> (Budda).	Extends over Dewhurst 30 & 31
Coghill Alluvial Plains	Distal parts of the Quaternary alluvial fans largely derived from Jurassic quartz sandstone on streams draining from the Pilliga Forests. Long gentle slopes broken by sandy abandoned stream channels (sand monkeys), patches of heavy grey clay, and contemporary incised stream channels. General elevation 200 to 280m, local relief 5 to 9m. Deep texture-contrast soils with harsh clay subsoils, grey clay with gilgai. Open forest of <i>C. glaucophylla</i>, <i>E. populnea</i>, <i>E. pilligaensis</i>, <i>E. blakelyi</i> and <i>E. sideroxylon</i>. <i>Corymbia trachyphloia</i> (Brown Bloodwood) and <i>Xanthorrhoea</i> sp. (Grass Trees) on sand monkeys (abandoned stream channels). Patches of <i>Allocasuarina luehmannii</i> (Bull Oak) or <i>Acacia harpophylla</i> (Brigalow) on gilgai in heavy clay. <i>E. chloroclada</i> (Dirty Gum) and <i>E. camaldulensis</i> in creek lines.	Extends over Dewhurst 13-18

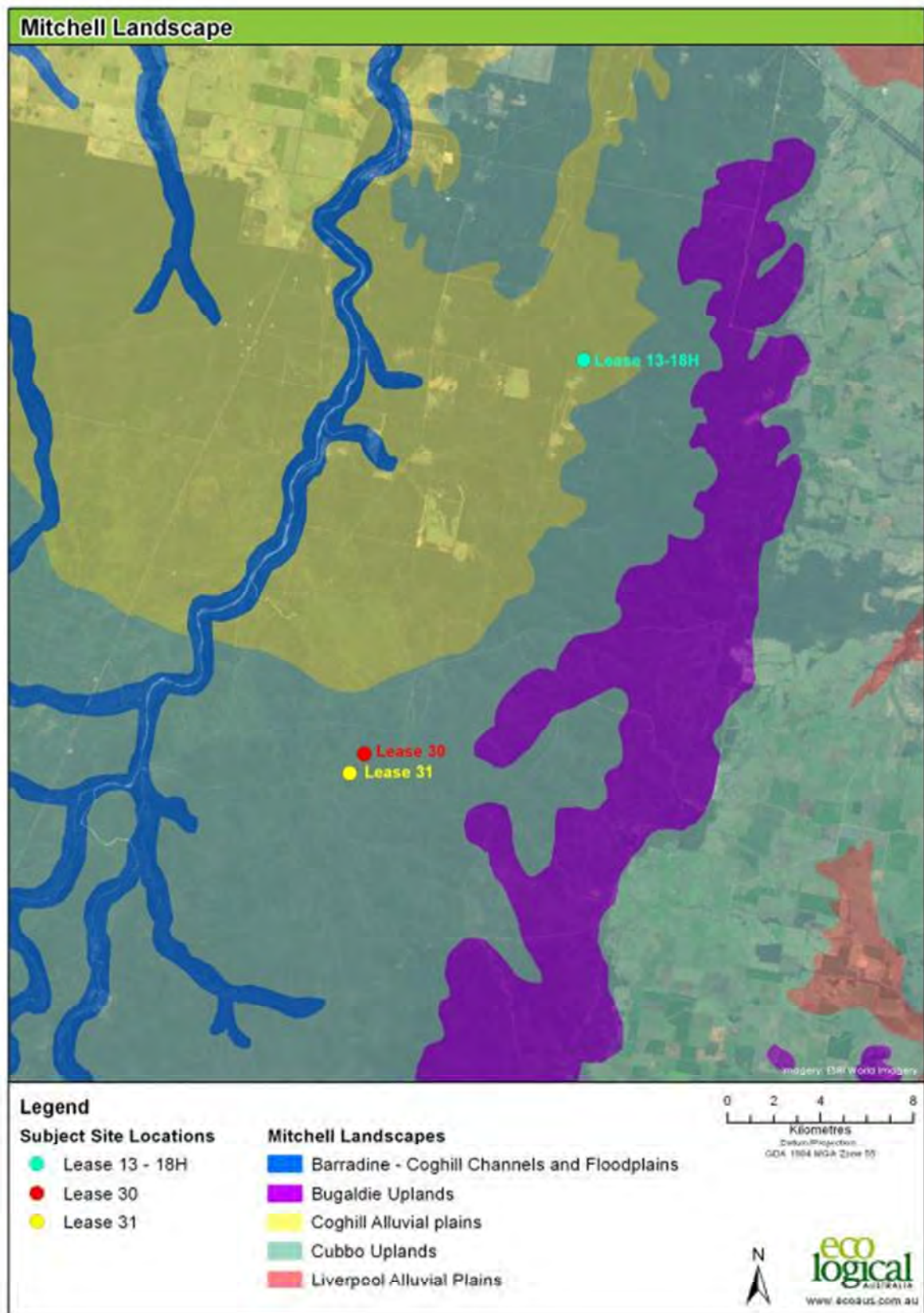


Figure 4: Mitchell Landscapes

2.5 Geology

The study area is underlain by a geological formation described as the Orallo Formation (often referred to as Keelindi Beds), consisting of Clastic sediment, Colluvial polymictic gravel, sand, silt and clay. The study area may include some alluvial *in situ* regolith deposits with fine to coarse grained quartzose sandstone, pebbly sandstone and conglomerate interbedded with minor shale (DMR 2002).

2.6 Climate

The Brigalow Belt South Bioregion is located within an ecological gradient, or ecotone, between the dry inland or Eyrean zone and the wetter coastal or Bassian zone. Within the south eastern section of the bioregion where the study area is located, the climate is classed as subhumid: there is no dry season and the area experiences hot summers (NPWS 2000).

Substantial rainfall can occur at any time of the year but there is a peak in summer and a smaller peak in winter. In summer, high intensity rain or thunderstorms can cause significant erosion. Evaporation rates are high in summer and often exceed precipitation rates, so the net penetration of rainfall is greater in winter than in summer (NPWS 2000). Mean annual rainfall in the NSW section of the Brigalow Belt South Bioregion varies from 550 mm in the west (in Gilgandra) to 823 mm on the east of the bioregion (at Murrurundi). On the north-south gradient, mean annual rainfall is 587 mm in Dubbo, 651 mm at Narrabri, and 659 mm on the Queensland border (at Texas).

Temperatures vary with altitude throughout the bioregion and have large daily variation (daily maximum can reach 45 °C in summer and stay above 40 °C for several days, and minimum temperatures can be as low as -9 °C). However, mean monthly temperatures (based on 6 weather stations in NSW) range from a maximum of 33 °C in January to a minimum of 3 °C in July (NPWS 2000).

3 Methods

3.1 Database review

A number of key datasets and mapping were available to determine ecological values and constraints within the study region. These included:

- NPWS BioNet Database (Atlas of NSW Wildlife) (OEH 2013a)
- EPBC Act Protected Matters Search Tool (DoE 2013a)
- NSW geology mapping (DMR 2003)
- ELA drainage mapping
- Namoi CMA vegetation mapping (ELA 2009)
- Namoi CMA wetland mapping (ELA 2008)

High resolution aerial photographs and high resolution surface contours (captured through LiDAR) of the study region were also used to investigate the extent of vegetation cover, landscape features and disturbance patterns in the area.

Databases and maps were searched for state and federally listed threatened species, populations and Threatened Ecological Communities (TECs). Searches were conducted for a 50 km area around the study area due to an initial paucity of records within a 10 km area surrounding the proposed activity. It is noted that this large search area included regions of different topography, geology and climate, and thus species that will not have suitable habitat in the study area.

3.2 Literature reviewed

A number of additional ecological impact assessments, and flora and fauna surveys conducted in the north-east Pilliga Forest, were also reviewed for records of threatened vegetation communities and flora and fauna species occurring in the study area. These flora and fauna assessments and surveys are listed below:

- Dewhurst 26 – 29, *Pseudomys pilligaensis* (Pilliga Mouse) Assessment of Significance, Prepared for Santos Limited (ELA 2013a)
- Dewhurst 26 – 29 Pilot Wells, PEL 238, Narrabri – Ecological Assessment, Prepared for Santos Limited (RPS 2013)

3.3 Field survey

The field survey was undertaken in a two part process with initial surveys undertaken by RPS and subsequent field surveys completed by ELA. RPS conducted ecological surveys for Dewhurst 26-29 in 2012 which are located directly adjacent to Dewhurst 30 and 31 (RPS 2013). Due to the location of these surveys and their relevance to the current study, the survey effort undertaken by RPS has been closely integrated into this study. The fauna survey effort and results obtained by RPS have been included in this assessment.

The RPS field surveys were conducted between 12 November and 16 November 2012. The subsequent ELA field surveys were undertaken between 25 and 30 August 2013 for a total of approximately 104 person hours.

The ELA survey was conducted by eight ELA ecologists in four teams of two. The field staff included senior ecologists Peter Knock, Martin Sullivan and Will Introna and ecologists Andrea Sabella, Kurtis Lindsay, Emily Southwell, Daniel McKenzie and Ben Martin. A summary of field survey effort is provided in **Table 3**.

ELA has conducted extensive fieldwork within the vicinity of the study area between 2010 and 2013 as part of ongoing investigations into the biodiversity values of the north-east Pilliga Forest. Results from these studies have been used in this report where applicable.

Table 3: ELA field survey effort

Survey method	ELA person hours
Flora survey	8
Habitat Assessment	6
Bat survey	30
Remaining fauna survey	60

During the RPS survey (2012), temperature ranged from 9.2 to 37.3 degrees Celsius (°C) and conditions were fine with moderate winds. During the ELA survey period (2013), temperature ranged from 1.8 to 29 °C and conditions were fine with little wind or cloud cover (**Table 4**).

Table 4: Weather conditions during field surveys

Date	Minimum daily temperature (°C)	Maximum daily temperature (°C)	Daily rainfall (mm)
12 November 2013	9.2	30.3	0
13 November 2013	17.5	33.6	0
14 November 2013	16.0	36.2	0
15 November 2013	17.0	37.3	0
16 November 2013	18.2	29.1	0
26 August 2013	1.8	24.4	0
27 August 2013	4.4	25.7	0
28 August 2013	5.5	25.9	0

Date	Minimum daily temperature (°C)	Maximum daily temperature (°C)	Daily rainfall (mm)
29 August 2013	6.8	27.6	0
30 August 2013	16.0	29.0	0

Source: Bureau of Meteorology (BoM): <http://www.bom.gov.au/climate/data/index.shtml> Narrabri Weather Station 054038

3.3.1 Vegetation

The vegetation survey involved validating the mapped vegetation communities, delineating the boundaries of mapped vegetation and assessment of community condition. Vegetation quadrats and transects were undertaken by ELA botanists at each pilot well following the BBAM.

Quadrats included 0.04 ha (20 m x 20 m) surveys to record the presence of visible vascular flora species, along with cover and abundance for each species using a modified Braun-Blanquet scale (measures of cover and abundance taken to determine species dominating each stratum). Vegetation structure and fauna habitat features were determined over 0.1 ha survey (50 m x 20 m quadrats); measures included number of hollow bearing trees and length of fallen dead timber greater than 10 cm diameter. Within the 0.1 ha quadrats, projected foliage cover of each strata level and exotic flora was assessed along a 50 m transect.

The physical characteristics (such as aspect, slope and disturbance) of each location were noted and photos were taken of the quadrats along the 50 m transect line as well at points along the random meander traverses for threatened flora species. Species were identified to the lowest taxonomic level possible, following the Flora of NSW (Harden 1992-2002) and NSW Flora online (www.plantnet.rbgsvd.nsw.gov.au). Quadrat locations are shown in **Figure 5**.

3.3.2 Targeted threatened flora survey

The survey involved two ELA botanists traversing the study area on foot walking approximately 10 m apart along transects. Transects were repeated until the entire study area was considered adequately traversed. The location of all threatened flora individuals located within the study area was recorded using a Personal Digital Assistant (PDA) with a Global Positioning System (GPS) accuracy of 3 m. Where records for threatened flora existed within or in proximity to the study area, these areas were visited to determine the flowering status of the species. Species predicted to occur in the study area are outlined in **Table 5**. Survey effort for the targeted threatened flora survey is shown in **Figure 5**.

Results from previous surveys have also been used in this assessment (ELA 2012).

Table 5: Threatened flora species targeted during field survey

Scientific name	Common name	Status	
		TSC Act	EPBC Act
<i>Bertya opponens</i>	Coolabah Bertya	V	V
<i>Cyperus conicus</i>		E	
<i>Diuris tricolor</i>	Pine Donkey Orchid / Painted Diuris	V	Delisted
<i>Homopholis belsonii</i>	Belson's Panic	E1	V
<i>Philothea ericifolia</i>		Delisted	V
<i>Polygala linariifolia</i>	Native Milkwort	E	~
<i>Pomaderris queenslandica</i>	Scant Pomaderris	E	~
<i>Pterostylis cobarensis</i>	A Greenhood Orchid	V	V

Scientific name	Common name	Status	
		TSC Act	EPBC Act
<i>Rulingia procumbens</i>		V	V
<i>Tylophora linearis</i>		V	E

3.3.3 Hollow bearing trees

Searches for hollow-bearing trees (HBTs) followed similar methodology undertaken for threatened flora species (**Section 3.3.2**) within the study area. All Hollow Bearing Trees (HBT's) observed were recorded with a PDA of 3 m accuracy and later mapped. Survey effort for HBT's is shown in **Figure 5**.

3.3.4 Fauna survey effort

The fauna survey was designed to target key threatened fauna species identified as having suitable habitat within the study area. Surveys followed recommended survey methods and habitat stratification procedures of the draft *Threatened Biodiversity Survey and Assessment Guidelines* (DEC 2004) and relevant EPBC survey guidelines (SEWPaC 2010a, SEWPaC 2010b, SEWPaC 2011). Survey effort for fauna stratified by habitat type as per the DEC (2004) guidelines is shown in **Appendix H**. This assessment includes survey effort undertaken by ELA and RPS (**Figure 6** and **Figure 7**).

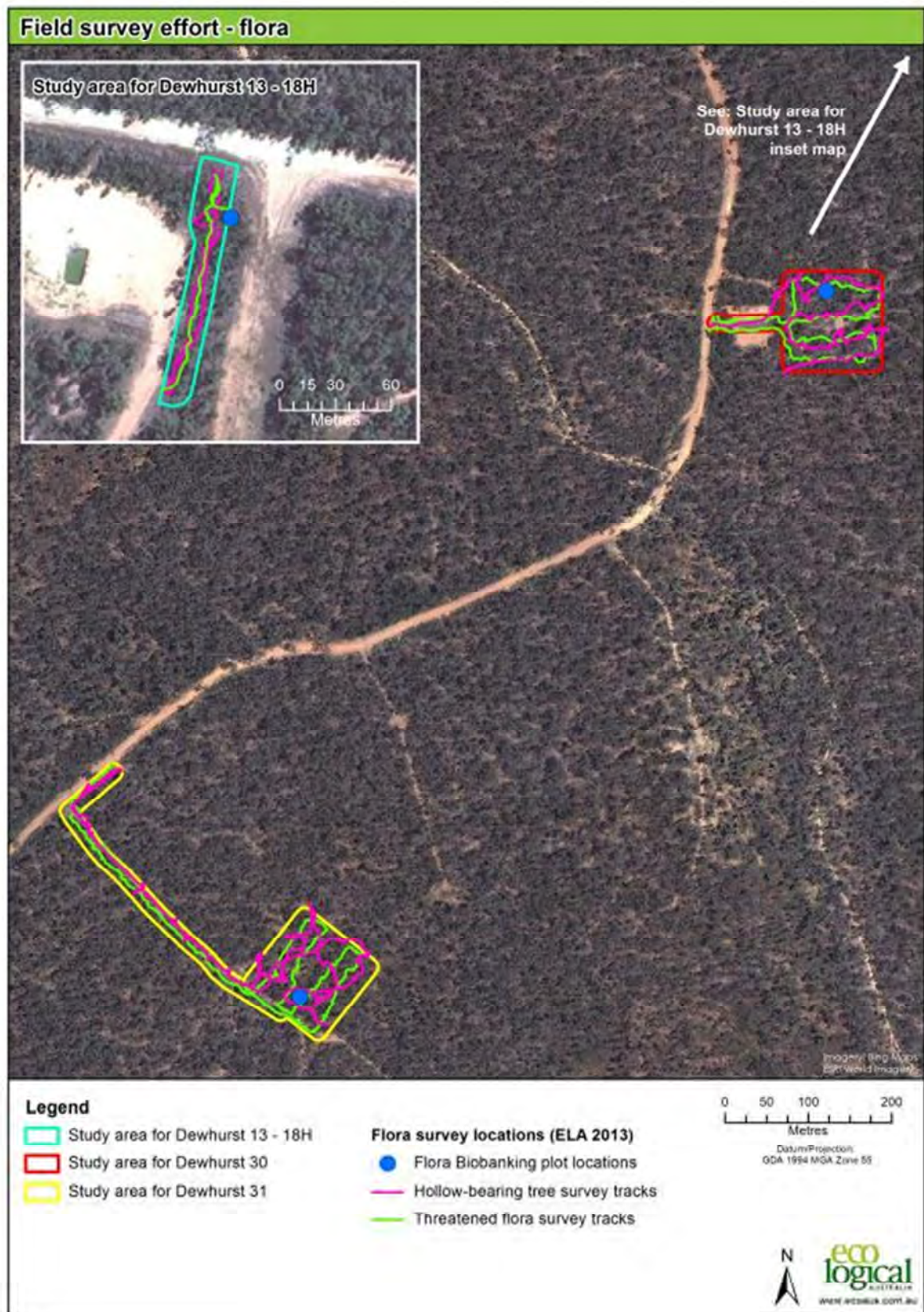


Figure 5: Field survey effort- flora

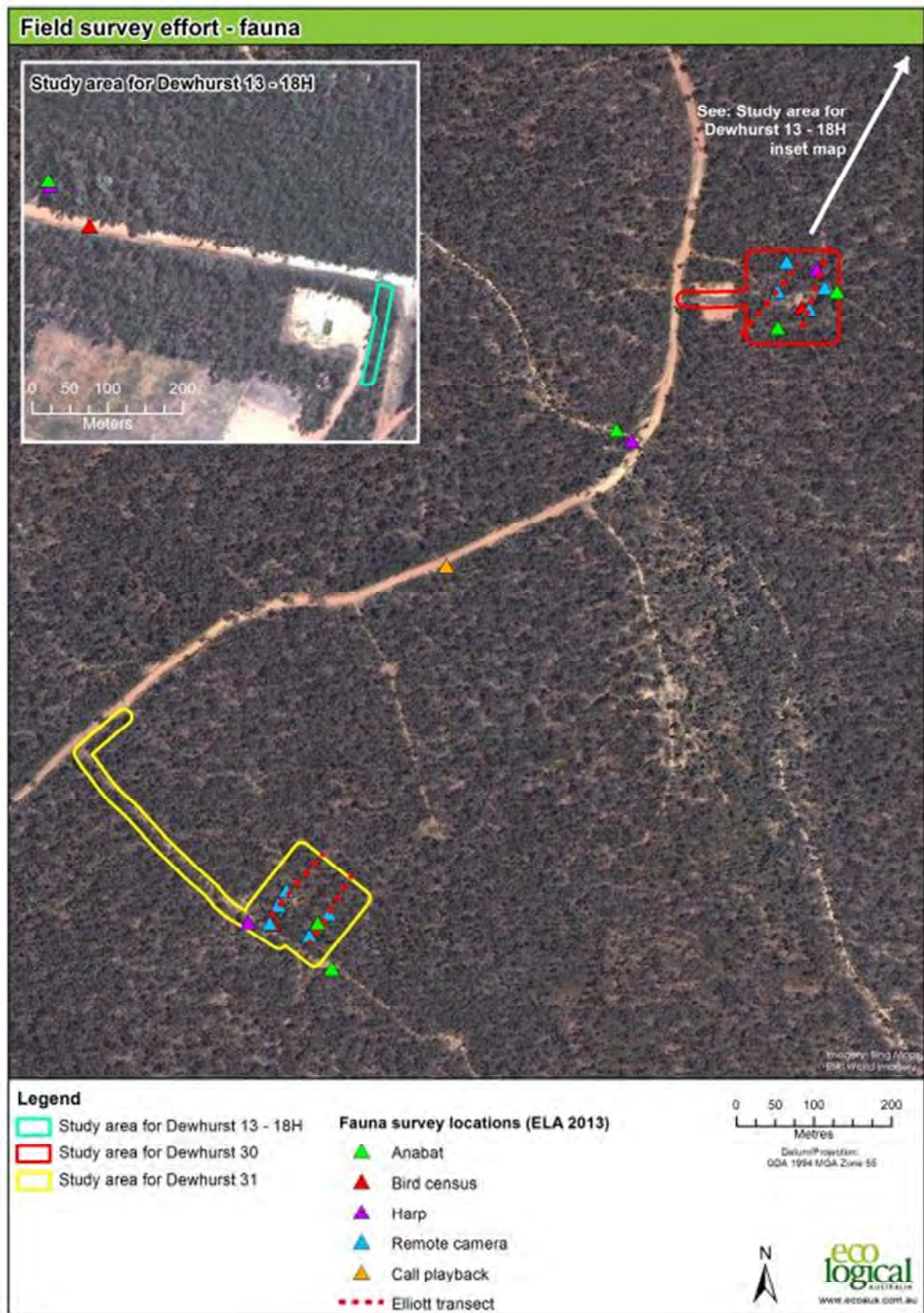


Figure 6: Field survey effort - fauna

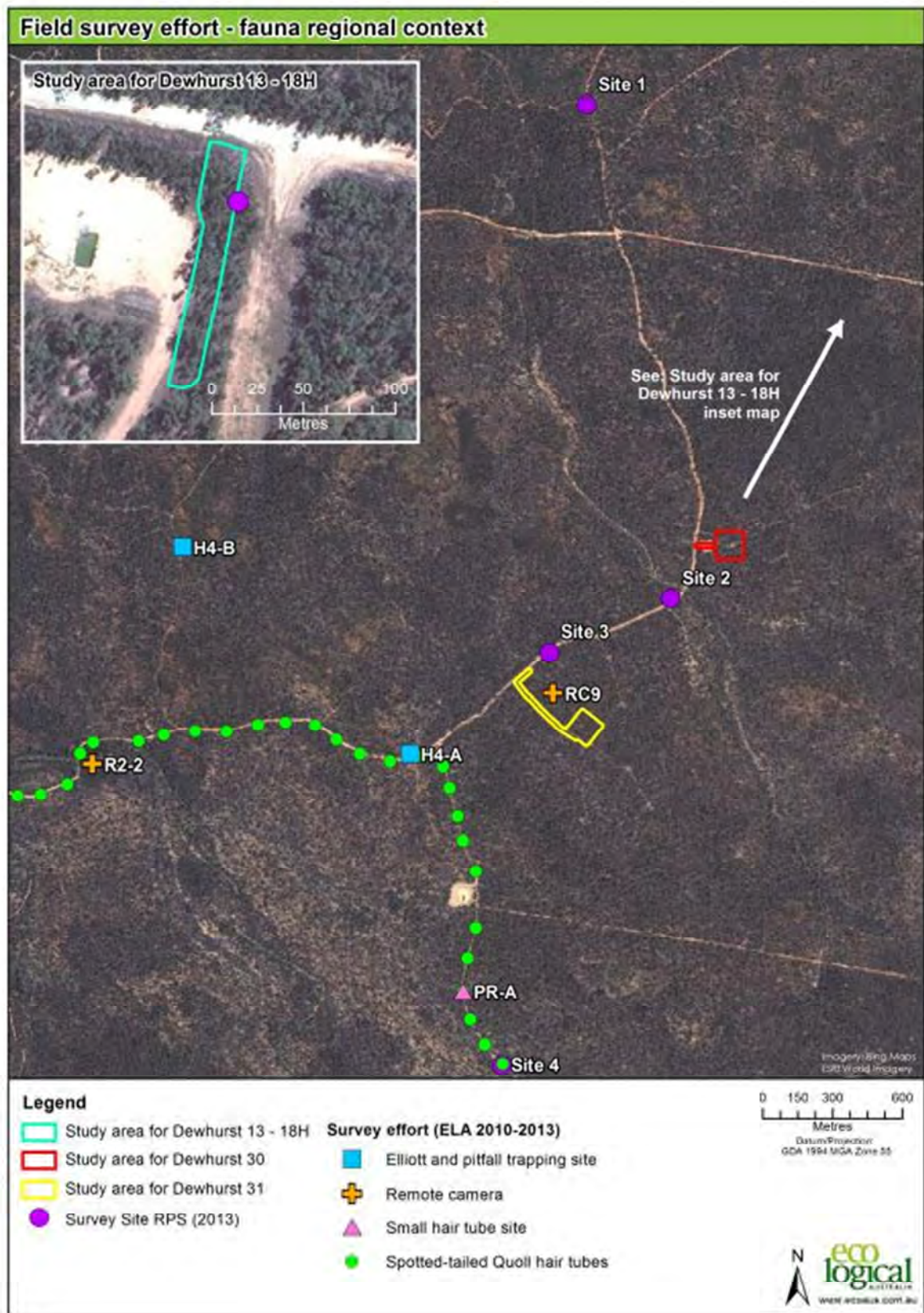


Figure 7: Regional survey locations - fauna

3.3.5 Habitat assessment

A habitat assessment was conducted for all survey sites by RPS. Data collected included the amount of foraging substrate (sap trees, blossoms, she-oaks, acacias) for fauna, the presence of sheltering resources (trees with hollows, shrub and ground layer, fallen logs, and rocks) and the level of disturbance from tracks, fire, grazing, logging, weeds, introduced fauna and rubbish.

3.3.6 Mammal survey (non-flying small and medium sized mammals)

The active and passive survey techniques used to detect small and medium sized mammal species are outlined in the sections below. Survey techniques employed were terrestrial and arboreal Elliott A and B traps, terrestrial Elliott E traps, pitfall traps and remote cameras.

Terrestrial trapping

Terrestrial trapping was undertaken by RPS using 73 Elliott A traps, seven Elliott B traps, nine Elliott E traps, 14 snake funnel traps, four camera traps, 40 hair funnels and 15 pitfall traps set over three, four or five nights.

Elliott traps were baited with a mixture of rolled oats and peanut butter, except for half the Elliott B traps which were baited with a mixture of sardines and flour. Traps were checked early each morning and any captures were identified and immediately released at the point of capture. All bait was collected each morning and traps were closed for the day and then re-baited each evening.

Elliott traps targeted small terrestrial mammals such as Dasyurids (e.g. antechinus and dunnarts) and rodents (e.g. rats and mice), while pitfalls targeted small mammals as well as reptiles and amphibians. Camera traps and hair funnels targeted larger mammals (e.g. bettongs).

Terrestrial trapping was undertaken by ELA using 50 Elliott B traps. Twenty five traps were set up at both Dewhurst 30 and Dewhurst 31 study areas. Traps were placed at the base of shrubs, trees or along fallen logs. All Elliott traps were baited with a mixture of rolled oats, peanut butter and honey.

The trap lines were set for four consecutive nights from 26 to 30 August 2013 at both Dewhurst 30 and 31. The numbers of trap nights per site are shown in **Table 6**. Survey and trap locations are shown in **Figure 6**. Traps were checked by two people from 0630 hrs, with checks completed by 0900 hrs. Any mammals caught were identified to species level.

Within 2 km of the study area, two previous terrestrial Elliott and pitfall trapping sites (H4-A and H4-B), one previous small hair tube site (PR-A) and one previous large hair tube transect (R2-2) were installed by ELA (**Figure 7**). These sites were part of a survey targeting Pilliga Mouse and were undertaken in between 5 May and 1 June 2013. At each Elliott and pitfall trapping site, 36 Elliott traps were placed in a grid of 6 x 6 traps, spaced approximately 10 metres apart. Grids included twenty-eight standard A-size Elliotts and eight smaller E-size Elliotts. Traps were baited with rolled oats, peanut butter and honey and set for four or five nights. Traps were checked over four or five mornings. Weight, head and rear pes of captured animals were measured and photos were taken. Any animals captured were released on the morning of capture.

Pitfalls traps were set at the same sites as the Elliotts. Three separate pitfalls were located adjacent to each Elliott trap grid. Pitfall traps were located approximately 10 – 20 m from each other and consisted of PVC tubing (30 – 50 cm depth) with 5 – 10 m of drift fences each. Traps were checked over four or five mornings. Any animals captured were released on the morning of capture. Weight, head and rear pes of captured animals were measured and photos were taken. Any animals captured were released on the morning of capture.

At the small hair tube site, 20 small (30 mm diameter) hair tubes were set in 4 transects of 5 hair tubes. Two transects were placed on opposite sides of and perpendicular to a road, approximately 10 – 20 metres apart. Hair tubes within each transect were set approximately 10 metres apart. All hair tubes were baited with rolled oats, peanut butter and honey and set for 19 nights.

A transect of 40 large (90 mm diameter) hair tubes were installed approximately 100 m apart. All hair tubes were baited with pilchards, tuna oil and flour and were set for 25 nights, with a total effort of 600 trap nights. The transect traversed habitat similar to study area.

Arboreal trapping

ELA surveys involved six A and six B-sized Elliott traps (tree mounted) and 25 B-sized Elliott traps (ground traps) set at both Dewhurst 30 and 31. At each site, traps were set in two line transects spaced approximately 50 m apart, with each trap approximately 10-15 m apart.

Tree-mounted Elliott traps were mounted on wooden platforms attached to tree trunks 2 to 2.5 m above ground level. All Elliott traps were baited with a mixture of rolled oats, peanut butter and honey. A honey and water mixture (approximately 1:5 ratio) was sprayed on tree trunks where tree-mounted Elliott traps were positioned as a lure.

The terrestrial and arboreal trap lines at Dewhurst 30 and the terrestrial Elliott B trap lines at Dewhurst 31 were set for four consecutive nights from 26 to 30 August 2013. The Elliott A arboreal traps at Dewhurst 31 were set for three consecutive nights due to time constraints setting up the site (**Figure 6**). This survey effort satisfies the draft *Threatened Biodiversity Survey and Assessment Guidelines* (DEC 2004). The numbers of trap nights per site are shown in **Table 6**.

Traps were checked by two ecologists from 0630 hrs, with checks completed by 0900 hrs. Any mammals caught were identified to species level.

Table 6: Details of Elliott trapping survey details

Site	No. of survey nights	Number of trap nights per trap type						Total no. of trap nights	
		Elliott A: tree-mounted	Elliott A: ground	Elliott B: tree-mounted	Elliott B: ground	Elliott E: ground	Hair funnels	Arboreal	Terrestrial
Dewhurst 30	3-4	18	0	24	100	0	0	42	100
Dewhurst 31	4	24	0	24	100	0	0	48	100
Site 1 (RPS 2012)	4	0	0	0	6	0	30	0	36
Site 2 (RPS 2012)	4	0	65	0	5	14	50	0	134
Site 3 (RPS 2012)	4	0	60	0	6	6	30	0	102
Site 4 (RPS 2012)	4	0	60	0	0	6	0	0	66
Site 5 (RPS 2012)	4	0	77	0	8	8	40	0	133

Site	No. of survey nights	Number of trap nights per trap type						Total no. of trap nights	
		Elliott A: tree-mounted	Elliot A: ground	Elliott B: tree-mounted	Elliott B: ground	Elliott E: ground	Hair funnels	Arboreal	Terrestrial
Total number of trap nights		42	262	48	225	34	150	90	671

Remote camera

The RPS survey installed four motion activated remote cameras over 60 trap nights, targeting terrestrial fauna. The ELA survey installed nine motion activated remote cameras that were attached to trees and placed facing tree mounted Elliott traps within the study area. Remote cameras, configured to take three photos on detecting movement were set on the 26 August 2013, and were left undisturbed for four nights. The photographs from the cameras were analysed by ELA ecologist Dr Rodney Armistead.

Two remote cameras were previously installed by ELA within 2 km of the study area (R2-2 and RC9). One was in riparian woodland and baited with fish and the second was in habitat similar to that in the study area and baited with oats, peanut butter and honey (**Figure 7**).

The total effort of remote camera surveys is presented in **Table 7**.

Table 7: Remote camera survey details

Site	No. of trap nights
Dewhurst 30	16
Dewhurst 31	20
Site 1 (RPS 2012)	12
Site 2 (RPS 2012)	20
Site 3 (RPS 2012)	12
Site 4 (RPS 2012)	0
Site 5 (RPS 2012)	16
Riparian 2-2 (ELA 2013 – not yet reported on)	20
RC9 (ELA 2011 – not yet reported on)	8
Total number of trap nights	96

3.3.7 Microbat survey

Microbat species were surveyed by using harp traps and through Anabat detection. Harp traps were installed by ELA and were placed in flyways that were likely to be used by bats. Harp traps were assembled just prior to dusk and checked each morning before 0930 hrs. The harp traps were set for two consecutive nights from 26 to 28 August 2013 at Dewhurst 30 and 31 and from 28 August to 30 August at Dewhurst 13 – 18H. Any bats caught were identified to the lowest taxonomic level possible, kept in canvas bags during the day (which were left hanging in the cool of an air-conditioned or ventilated vehicle out of direct sunlight followed by indoors in a cool, ventilated area), and released at the point of capture at dusk. **Table 8** details site locations and number of harp traps used. The locations of the harp traps are shown in **Figure 6**.

Microbats were also surveyed for using Anabat detectors equipped with ZCAIM recording devices by both RPS and ELA. RPS surveys involved placing an Anabat detector for one to two nights in suitable flyways located adjacent to two survey sites. Positioning was focused on natural flyways below the canopy which typically provide an abundance of microbat foraging resources (insects). The Anabats were set before dusk and retrieved in the morning after sunrise.

Anabat detectors were set by ELA for two consecutive nights from 26 to 28 August 2013 and placed in flyways that were likely to be used by bats (**Figure 6**). **Table 8** details site locations and number of Anabat detectors used. On each night of survey the Anabats were turned on time-delayed recording prior to dusk and then turned off the following morning by 0930 hrs.

Anabat call identification of RPS data was analysed by Greg Ford of Balance Environmental, who provided an analysis summary report. Due to the high level of variability and overlap in call characteristics, a conservative approach was taken when analysing calls. Species names used in the Anabat analysis summary follow Churchill (1998).

Call identification was based on published call descriptions for New South Wales (Pennay *et al.* 2004) and on reference calls collected from southern Queensland and northern New South Wales. Determination of species' identification was further refined by considering probability of occurrence based on distributional information presented in Churchill (1998) and Van Dyck & Strahan (2008).

Anabat call identification of ELA data was analysed by Alicia Scanlon (ELA bat call analysis specialist). Analysis assigned bat calls to four levels of confidence as per Mills *et al.* (1996): definite, probable, possible, and unknown. Definite calls were calls of bat species that were not in doubt, probable calls were those calls of bat species with a low probability of confusion with species of similar calls, possible calls were calls of bat species with a medium to high probability of confusion with species of similar calls, and unknown calls were calls of bat species which could not be identified to even a species group.

Table 8: Details of microbat survey site locations

Site	Number of Anabat detector trap nights	Number of harp trap nights
Dewhurst 30	4	2
Dewhurst 31	4	2
Midway 30 & 31	2	2
Dewhurst 13-18H	2	2
RPS sites	2 - 4	0
Total number of trap nights	14 – 16	8

3.3.8 Diurnal bird survey

Two sites were surveyed by RPS, with one AM (four hours after sunrise) and one PM (four hours before sunset) survey undertaken at each site. Each survey consisted of a 30 minute survey identifying birds by direct observation or by recognition of calls or distinctive features such as nests, feathers and owl pellets.

Three sites were surveyed for birds by two ELA ecologists, one AM and one PM survey at Dewhurst 30 and Dewhurst 13-18H and one AM survey at Dewhurst 31 between 25 and 30 August 2013 (**Figure 6**). Each survey consisted of an initial 20 minute census recording all bird calls and observations. If new species are added to the list in the last 5 minute period of the survey, an extra five minutes of survey is

undertaken. This method was repeated to make a species-time curve until no new species were identified. All bird calls and observations were recorded.

Opportunistic survey was also undertaken for the duration of the field assessments by both RPS and ELA.

The total amount of survey effort for diurnal bird surveys is presented in **Table 9**.

Table 9: Diurnal bird survey effort

Site *	Number of surveys	Person hours
Dewhurst 30	2	1.5
Dewhurst 31	1	0.67
Dewhurst 13-18H	2	1.67
RPS sites	4	2
Total	9	5.84

3.3.9 Spotlighting and call playback

Spotlighting and call playback was conducted to search for nocturnal fauna species. Species targeted during call playback are shown in **Table 10**. Spotlighting by foot or by vehicle and dedicated listening periods for fauna vocalisations were undertaken by RPS over two nights. Spotlighting was conducted by two ELA ecologists over five separate nights on foot for approximately 20 minutes each night.

Call playback and quiet listening was undertaken by two ELA ecologists for approximately 40 minutes (**Figure 6**). Call playback involved playing recorded calls of the targeted threatened fauna species (**Table 10**) over a loudspeaker in an attempt to illicit a response from each species in the study area. A five minute listening period and five minute spotlighting session preceded each call playback event. The call of each species was then broadcast for approximately five minutes with a listening period of five minutes in between each call; this was then followed by a further five to ten minutes of listening for a response and spotlighting.

Table 10: Threatened fauna species targeted during call playback

Scientific name	Common name	Status	
		TSC Act	EPBC Act
<i>Ninox connivens</i>	Barking Owl	V	-
<i>Phascolarctos cinereus</i>	Koala	V	V
<i>Burhinus grallarius</i>	Bush-stone Curlew	E	-
<i>Tyto novaehollandiae</i>	Masked Owl	V	-

3.3.10 Reptile trapping

Reptile trapping was undertaken by RPS and involved 14 snake funnel traps and 15 pitfall traps over three to five nights. The number of trap nights achieved is represented in **Table 11**.

Table 11: Details of reptile survey effort

Site	Number of trap nights per trap type		Total no. of trap nights
	Snake funnels	Pitfalls	
Site 1 (RPS 2012)	16	12	28
Site 2 (RPS 2012)	20	20	40
Site 3 (RPS 2012)	12	12	24
Site 4 (RPS 2012)	6	9	15
Site 5 (RPS 2012)	16	16	32
Total number of trap nights	70	69	139

3.3.11 Active searches

Active searches were undertaken by RPS at two sites. Broad fauna searches looked for evidence of ground-dwelling mammals (bandicoots, native rats etc.) and were focused around key habitat features, such as extensive grassy ground cover and fallen woody debris, hollow logs and burrows that offer potential suitable shelter.

Reptile searches involved active searches to identify potential habitat for reptile species. Survey techniques employed included:

- Diurnal searches for sheltering or basking reptiles as well as indirect evidence of fauna e.g. tracks scratches, burrows etc.
- Rock, log and debris rolling.
- Spotlight surveys for nocturnally active species.

4 Results

4.1 Database review

Twenty eight threatened flora species listed under either the TSC Act and/or EPBC Act have been identified through the database review as known or with the potential to occur within a 50 km radius of the study area. The likelihood of these species occurring on site is presented in **Appendix A**.

Eighty nine threatened or migratory fauna species listed under either the TSC Act and/or EPBC Act have been identified through the database review as known or with the potential to occur within a 50 km radius of the study area. An assessment of the likelihood of threatened and migratory species potentially occurring at the study area is presented in **Appendix A**.

4.2 SEPP 44 assessment

An assessment of Koala habitat is required under SEPP 44 for the study area as it is greater than 1 ha, is within an LGA that is listed under Schedule 1 and is being assessed under Part 4 of the EP&A Act. The assessment requires three steps to be addressed:

Step 1: Is the land potential Koala habitat?

The study area does not support any tree species which are listed in Schedule 2 as feed tree species. Therefore, the study area does not constitute potential Koala habitat. No further assessment is required.

4.3 Field survey

4.3.1 Vegetation

Vegetation over the entire study area is consistent with the vegetation community *Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion* (Benson et al. 2006) (**Figure 8**). This vegetation community is commensurate with the BioMetric Vegetation Type *White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion*.

Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest is not commensurate with any Threatened Ecological Communities (TECs) listed under the TSC Act or EPBC Act.

Dominant canopy species include *Eucalyptus crebra* (Narrow-leaved Ironbark), *Allocasuarina luehmannii* (Buloke) and *Callitris glaucophylla* (White Cypress Pine). The height of the canopy was variable between 8 m - 20 m with 15 % - 20 % projected foliage cover. The mid storey was sparse with scattered occurrences of *Acacia deanei* subsp. *deanei* (Deane's Wattle), *A. caroleae*, *Allocasuarina luehmannii* and *Callitris glaucophylla*. The height of the mid storey was between 1 m - 10 m with less than 5 % cover. The ground layer consists of *Panicum decompositum* (Native Millet), *Aristida jerichoensis* var. *jerichoensis* (Jericho Wiregrass), *Lomandra multiflora* (Many-flowered Mat-rush) and shrubs including *Pultenaea foliolosa* and *A. parviflora* (Coil-pod Wattle). The height of the ground layer was between 0.3 m - 1 m with less than 10 % cover.

Dewhurst 13-18 was observed to be dominated by *Allocasuarina luehmannii* regrowth, Dewhurst 30 is heavily disturbed by previous logging activities and Dewhurst 31 consists of a moderately dense shrub layer however the thin-leaved shrub species create an appearance of sparseness within the site. Weed

incidence is low across the study area. Occasionally recorded species include *Anagallis arvensis* (Pimpernel), *Opuntia stricta* (Prickly Pear), *Hypochaeris radicata* (Catsear) and *Sonchus oleraceus* (Common Sow-thistle). Prickly Pear is a Class 4 noxious weed under the NW Act and a Weed of National Significance. The legal requirements for Class 4 noxious weeds specifies that “*growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction and the plant must not be sold, propagated or knowingly distributed*”.

Results of vegetation surveys are provided in **Appendix B**.

A drainage line runs south-east to north-west between Dewhurst 30 and Dewhurst 31. The drainage line is predominantly of the same vegetation as the study area, however, *E. chloroclada* is scattered along the drainage line.

4.3.2 Targeted threatened flora survey

Three threatened flora species have been recorded within the study area during field investigations:

- *Tylophora linearis*, listed as vulnerable under the TSC Act and endangered under the EPBC Act (three individuals at the Dewhurst 30 subject site).
- *Polygala linariifolia* (Native Milkwort), listed as endangered under the TSC Act (one individual at the Dewhurst 31 subject site).
- *Pterostylis cobarensis* (Greenhood Orchid), listed as vulnerable under the TSC Act and EPBC Act (three individuals at the Dewhurst 30 subject site).

The location of threatened flora species recorded within the study area is shown in **Figure 9**.



Figure 8: Vegetation communities in the study area

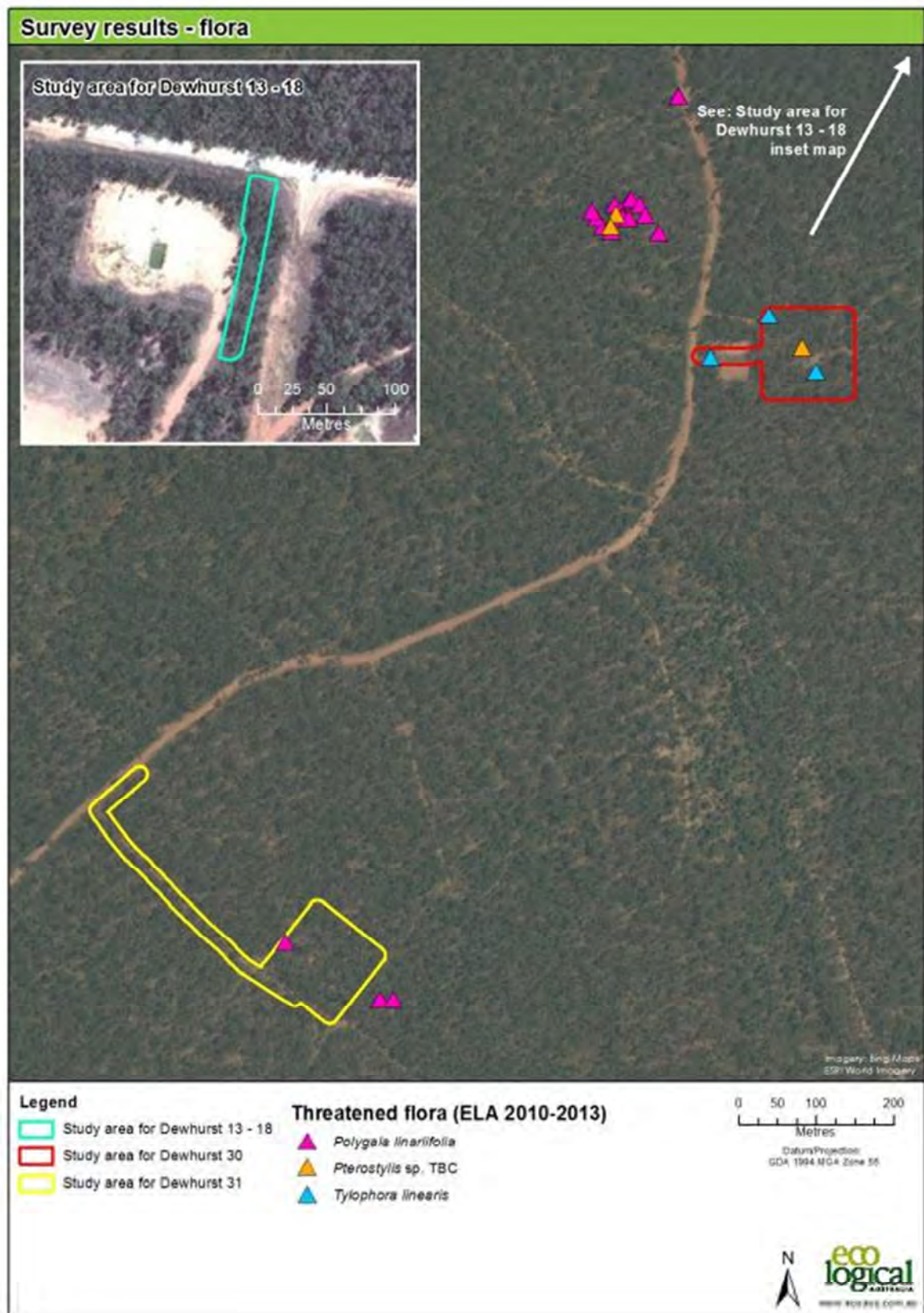


Figure 9: Survey results - flora

4.3.3 Fauna

Habitat assessment

Habitat within the study area provides potential foraging, roosting, breeding and nesting resources. A range of fauna habitat features are present throughout the study area and are identified in **Table 12** below.

Table 12: Key fauna habitat features present across the study area

Habitat features	Species
Vegetated areas of open forest	Arboreal mammals, microchiropteran bats and owls
HBT's and Stags	Birds, microchiropteran bats and arboreal mammals.
Fallen timber	Reptiles, molluscs and birds
Leaf litter (sparse to moderate)	Foraging resources for birds and mammals
Winter flowering eucalypts	Migratory birds, arboreal mammals
Foraging resources (nectar, fruits, seeds)	Mammals, birds

Hollow bearing trees

Twenty five HBT's were recorded within the study area during ELA field surveys. Hollows range in size from 5 cm to 30 cm width providing habitat for a variety of fauna species including microbats, birds, and arboreal mammals.

HBT's were identified at Dewhurst 30 and 31. No HBT's were recorded at Dewhurst 13-18. The location of HBT's within the study area is shown in **Figure 10**.

and details of tree species and hollow size for each HBT are provided in **Appendix C**.

Mammal survey (non-flying small and medium sized mammals)

Trapping

One species of small mammal; *Antechinus flavipes* (Yellow-footed Antechinus) was captured during the ELA field surveys within the Dewhurst 30 study area. It was recorded in an arboreal Elliott A trap.

Results from the RPS trapping survey have not been reported. However, a list of all fauna recorded during the RPS survey is provided in **Appendix E**.

Previous trapping by ELA in the study region recorded Yellow-footed Antechinus in terrestrial Elliott A traps, *Rattus* sp. and *Vulpes vulpes* (European Red Fox) in small hair tubes and possible records of *Macropus giganteus* (Eastern Grey Kangaroo) and *Trichosurus vulpecular* (Common Brushtail Possum) in large hair tubes.

Remote camera

Few vertebrate fauna species were detected via remote camera during the ELA survey. The tail of European Red Fox was photographed at Dewhurst 30 and several unidentified skink species can be seen in the background of several photographs at Dewhurst 31.

Results from the RPS remote camera survey have not been reported. However, a list of all fauna recorded during the RPS survey is provided in **Appendix E**.

No threatened mammal species (excluding bats) listed under the TSC Act and/or EPBC Act were recorded during the surveys.

Microbat survey

Harp Trapping

Three common species of microbat were captured via harp trap during the ELA survey. These included *Nyctophilus geoffroyi* (Lesser long-eared bat), *Nyctophilus gouldi* (Gould's long-eared bat) and *Vespadelus vulturnus* (Little forest bat). Locations of microbat species captured within the study area are shown in **Table 13**.

Table 13: Number of captures per species

Common Name	Species	Dewhurst 30	Dewhurst 31	Midway 30 & 31	Dewhurst 13-18
Lesser long-eared Bat	<i>Nyctophilus geoffroyi</i>	1	1	3	-
Gould's long-eared Bat	<i>Nyctophilus gouldi</i>	-	-	5	-
Little Forest Bat	<i>Vespadelus vulturnus</i>	2	4	4	1

Anabat- microbat call identification

A large number of species were recorded by Anabat detectors during field surveys.

Up to 14 species of microbat species were potentially recorded during the RPS survey. However, only 12 of these species were positively identified. Although its calls were not confirmed, *Mormopterus eleryi* (Bristle-faced Free-tailed bat), listed as Endangered under the TSC Act may also have been recorded, however due to uncertainty in the call identification and unconfirmed distribution of the species in the Pilliga Forest, the Bristle-faced Free-tailed bat has not been considered included in the impact assessment (**Appendix D**). Fourteen microbat species were recorded during the ELA survey including six (potentially seven) vulnerable species listed under the NSW TSC Act (**Table 14**). A full species list can be found in **Appendix D**.

The calls of two threatened species are difficult to distinguish from other more commonly recorded species and may have been recorded but not positively identified. It is also possible that the threatened *Nyctophilus corbeni* (South-eastern Long-eared Bat) was recorded. However the calls of *Nyctophilus* species cannot be differentiated based on call characteristics.

General bat activity was high at Dewhurst 31 and Midway 30 & 31 during the ELA survey with calls recorded more often than every two minutes throughout the evening. Most bat activity occurred between dusk and midnight across all sites and all nights. There were many long sequences recorded and feeding buzzes were regularly observed in the data set indicating that bats were actively foraging in the area rather than just passing through.

The most recorded species overall was *Chalinolobus gouldii* (Gould's Wattled Bat) which made up more than half of all definitely identified call sequences. The threatened *Miniopterus schreibersii oceanensis* (Eastern Bentwing Bat) was also represented by numerous call sequences, including feeding buzzes.

The calls recorded as *Falsistrellus tasmaniensis* (Eastern False Pipistrelle) and *Scoteanax rueppellii* (Greater Broad-nosed Bat) are only considered possible due to the species' unconfirmed distribution in the Pilliga Forest and the possibility of confusing call identification between these and other species. Further explanation can be found in **Appendix D**. These species have not been included in the impact assessment.

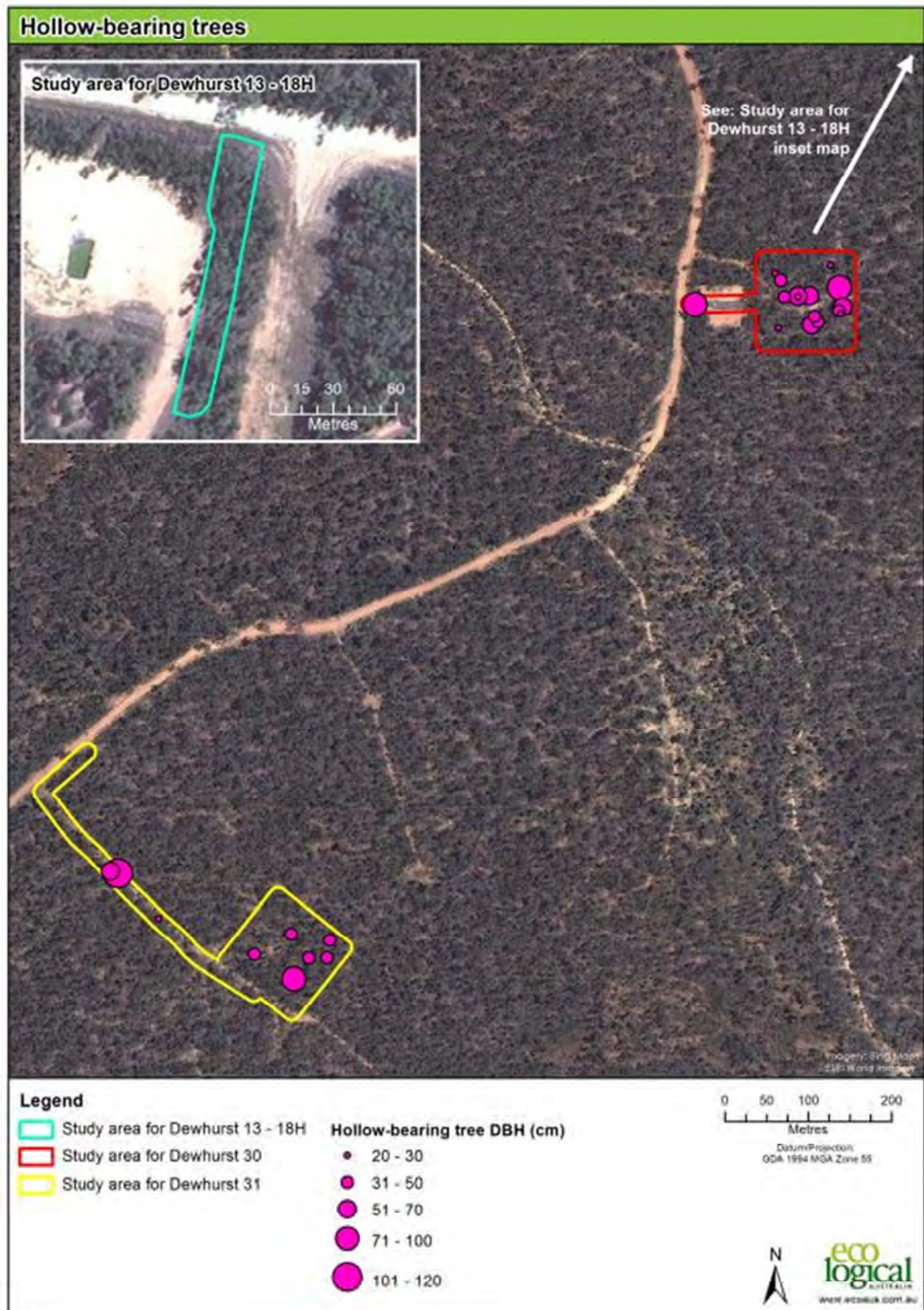


Figure 10: Hollowing-bearing trees

Table 14: The number of definite and probable identification calls for listed threatened microbat species at each site

Species		T S C	E P B C	ELA survey				RPS survey
Common name	Scientific name			Dewhurst 30	Dewhurst 31	Mid way 30 & 31	Dewhurst 13- 18	
Little Pied Bat	<i>Chalinolobus picatus</i>	V	-	0	2	0	0	Yes
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	V	-	(5)	(91)	(8)	0	No
Eastern Bentwing Bat	<i>Miniopterus schreibersii oceanensis</i>	V	-	7	66	7	7	Not positively identified
Yellow-bellied Sheath-tail Bat	<i>Saccolaimus flaviventris</i>	V	-	0	0	1	3	Yes
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V	-	(1)	0	(2)	0	No
Eastern Cave Bat	<i>Vespadelus troughtoni</i>	V	-	0	0	(1)	0	No

() = possible identification only – medium to high probability of confusion with species with similar calls

Diurnal bird survey

Sixty eight bird species were recorded during ELA and RPS field surveys. Five vulnerable species listed under the TSC Act and two migratory species listed under the EPBC Act were recorded (**Figure 11**). A full list of bird species recorded in the study area is provided as **Appendix E**. Threatened and migratory species recorded within the study area are shown in **Table 15**.

Table 15: Listed threatened and migratory species detected at or adjacent to the study area

Species		T S C	E P B C	ELA survey			RPS survey
Common name	Scientific name			Dewhurst 30	Dewhurst 31	Dewhurst 13-18	
Glossy Black-Cockatoo	<i>Calyptrorhynchus lathami</i>	V	-	W	-	-	-
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	V	-	W	E	-	Yes
Hooded Robin	<i>Melanodryas cucullata</i>	V	-	-	-	O	
Speckled Warbler	<i>Chthonicola sagittata</i>	V	-	-	W	-	Yes
Varied Sittella	<i>Daphoenositta</i>	V	-	-	O/W	-	-

	<i>chrysoptera</i>						
White-bellied Sea-eagle	<i>Haliaeetus leucogaster</i>	~	M	-	-	O	-
White-throated Needletail	<i>Hirundapus caudacutus</i>	~	M				

O = observed; W= heard; O/W= observed and heard; E= nest observed

V = Vulnerable; M = migratory

Reptiles

RPS and ELA surveys combined recorded 12 reptile species including two geckos, six skinks, two dragons and two monitor species.

No threatened reptile species listed under the TSC Act and/or EPBC Act were recorded during the surveys.

Amphibians

RPS recorded three amphibian species. The low number of amphibian captures can be attributed to dry conditions experienced throughout the survey.

No threatened amphibian species listed under the TSC Act and/or EPBC Act were recorded during the surveys.

Feral fauna

A number of feral fauna have been recorded by ELA and RPS in the study area and adjacent habitat, namely *Vulpes vulpes* (European Red Fox), *Sus scrofa* (Pig), *Felis catus* (Cat), *Capra aegagrus hircus* (Goat), *Oryctolagus cuniculus* (European rabbit) and *Lepus europaeus* (Brown Hare).

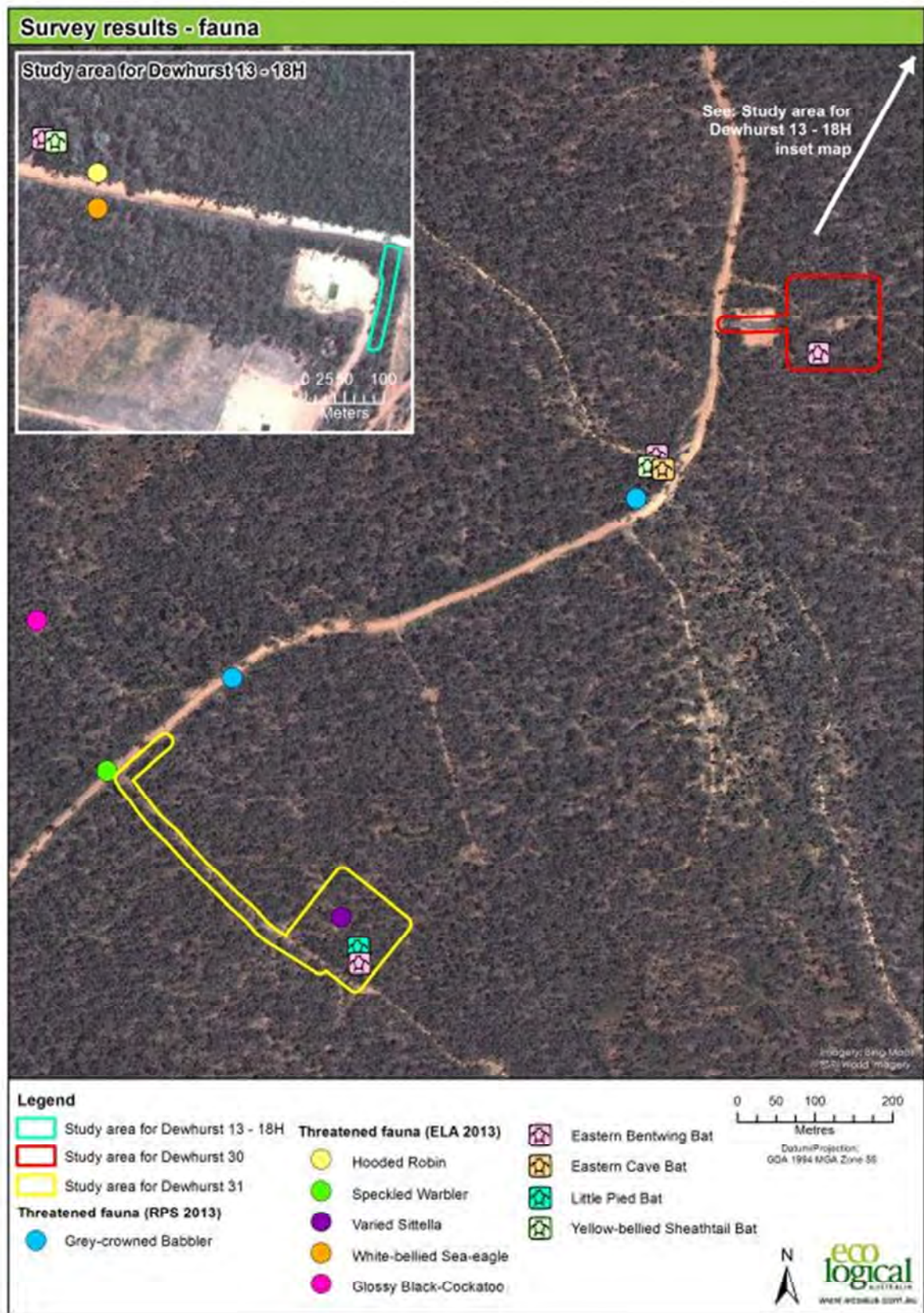


Figure 11: Survey results – fauna

5 Impact assessment

Based on searches of the Atlas of NSW Wildlife (OEH 2013a), review of relevant literature, vegetation mapping, results of flora and fauna surveys, presence of suitable habitat and professional judgement, a number of threatened species and ecological communities listed under the NSW TSC Act and/or Commonwealth EPBC Act have been identified as having the potential to be impacted by the proposed activity.

The likelihood of presence or absence of species and ecological communities has been assessed with full details provided in **Appendix A**.

Twenty-five bird species, twelve mammals and four plants which are listed under the TSC Act and/or EPBC Act are determined to have a likelihood of occurrence of 'known', 'likely', or 'potential' to occur within the study area (**Table 16**).

Impacts to these species have been considered in the various ecological reports and Review of Environmental Factors (REFs) for existing and planned exploration activities. A number of additional species have also been considered in relation to their likelihood of occurrence within the study area and determined to be unlikely to occur, as the area is outside of their distribution, and/or suitable habitat is not present. These species are not addressed in detail in this report, but have been considered in supporting ecological reports and are outlined in a full likelihood of occurrence table in **Appendix A**.

Assessments of Significance under the EP&A Act and/or EPBC Act have been carried out for the species listed below in **Table 16**. The Assessments of Significance for these species can be found in **Appendix F** (EP&A Act) and **Appendix G** (EPBC Act).

Table 16: Threatened flora, fauna and migratory species known, considered likely or have potential to be impacted by the proposed activity

Scientific name	Common name	TSC Act	EPBC Act	Conclusion
Flora				
<i>Diuris tricolor</i>	Painted Diuris	V	~	No significant impact proposed
<i>Polygala linariifolia</i>	Native Milkwort	E1	~	No significant impact proposed
<i>Pterostylis cobarensis</i>	Greenhood Orchid	V	V	No significant impact proposed
<i>Tylophora linearis</i>	-	V	E	No significant impact proposed
Birds				
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E, M	No significant impact proposed
<i>Apus pacificus</i>	Fork-tailed Swift	~	M, Mar	No significant impact proposed
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1	~	No significant impact proposed
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	~	No significant impact proposed

Scientific name	Common name	TSC Act	EPBC Act	Conclusion
<i>Chthonicola sagittata</i>	Speckled Warbler	V	~	No significant impact proposed
<i>Circus assimilis</i>	Spotted Harrier	V	~	No significant impact proposed
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	~	No significant impact proposed
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	~	No significant impact proposed
<i>Grantiella picta</i>	Painted Honeyeater	V	~	No significant impact proposed
<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle	~	M, Mar	No significant impact proposed
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V	~	No significant impact proposed
<i>Hieraaetus morphnoides</i>	Little Eagle	V	~	No significant impact proposed
<i>Hirundapus caudacutus</i>	White-throated Needletail	~	M, Mar	No significant impact proposed
<i>Lathamus discolor</i>	Swift Parrot	E1	E	No significant impact proposed
<i>Lophoictinia isura</i>	Square-tailed Kite	V	~	No significant impact proposed
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	~	No significant impact proposed
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	~	No significant impact proposed
<i>Merops ornatus</i>	Rainbow Bee-eater	~	M, Mar	No significant impact proposed
<i>Neophema pulchella</i>	Turquoise Parrot	V	~	No significant impact proposed
<i>Ninox connivens</i>	Barking Owl	V	~	No significant impact proposed
<i>Pachycephala inornata</i>	Gilbert's Whistler	V	~	No significant impact proposed
<i>Petroica boodang</i>	Scarlet Robin	V	~	No significant impact proposed
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	~	No significant impact proposed
<i>Stagonopleura guttata</i>	Diamond Firetail	V	~	No significant impact proposed
<i>Tyto novaehollandiae</i>	Masked Owl	V	~	No significant impact proposed
Mammals				
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	~	No significant impact proposed
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	No significant impact proposed
<i>Chalinolobus picatus</i>	Little Pied Bat	V	~	No significant impact proposed

Scientific name	Common name	TSC Act	EPBC Act	Conclusion
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	No significant impact proposed
<i>Macropus dorsalis</i>	Black-striped Wallaby	E1	~	No significant impact proposed
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V	~	No significant impact proposed
<i>Nyctophilus corbeni</i>	South-eastern Long eared Bat / Corben's Long-eared Bat	V	V	No significant impact proposed
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	~	No significant impact proposed
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	No significant impact proposed
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	No significant impact proposed
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V	~	No significant impact proposed
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	~	No significant impact proposed

V- vulnerable; E1- endangered under the TSC Act; E- endangered under the EPBC Act; M- migratory under the EPBC Act and Mar – Marine under the EPBC Act

5.1 Avoidance

The locations of Dewhurst 30 & 31 have been identified to avoid the following key ecological values:

1. Endangered Ecological Communities (EECs)
2. Riparian zone (at least 40 m from the top of bank of a drainage line)

5.2 Minimising impacts

The locations of the following ecological values have been recorded to reduce impact:

1. Hollow-bearing trees
2. Threatened flora locations

The location of HBTs has been mapped so that the clearing can be undertaken to minimise the removal of as many HBTs as possible. HBTs that are close to the edge of a lease area or access track will be retained where possible. A maximum of 25 HBTs would be removed by the proposed activity.

5.3 Impacts to vegetation communities

A total of 2.44 ha of *White Cypress Pine - Bulloak - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion* would be removed by the proposed activity. A 10 m buffer has been assessed surrounding the areas of vegetation removal as it is expected that any indirect impacts to vegetation communities would be contained within 10 m from the area to be cleared.

There is approximately 22,878 ha of this vegetation type mapped in the study region and therefore the removal of 2.44 ha constitutes <0.01% reduction of this vegetation community in the study region.

5.4 Impacts to threatened flora

Threatened flora species have been located within the study area and would be removed by the proposed activity. The numbers of threatened flora species within each subject site are:

- *Tylophora linearis* (three individuals at Dewhurst 30 subject site)
- *Polygala linariifolia* (one individual at Dewhurst 31 subject site)
- *Pterostylis cobarensis* (three individuals at Dewhurst 30 subject site)

Detailed targeted surveys within the broader north-east Pilliga Forest have identified significant populations of these threatened species. Modelled data predicts the existence of 122,713 *Polygala linariifolia*, 3,349,724 *Pterostylis cobarensis* and 183,908 *Tylophora linearis* individuals in the Pilliga and Pilliga Outwash CMA subregions (ELA 2012).

5.5 Impacts to fauna habitat

The total amount of potential foraging, breeding and roosting/sheltering habitat has been calculated for the disturbance areas within the study area to inform the significant impact assessments of the proposed activities (**Table 17**). The amount of loss of potential habitat in relation to the vegetation present within the study region has also been calculated.

Determination of the different types of habitat (foraging, breeding, roosting/sheltering) for individual threatened fauna species was made by first allocating vegetation types that would be used for foraging, breeding, and roosting/sheltering to individual species. The areas impacted were then summed for all vegetation types representing the type of habitat used by individual species within the study region.

The calculations include areas of clearing for all proposed impacts at Dewhurst 13-18H, Dewhurst 30 and Dewhurst 31.

Table 17: Direct impact areas to potential threatened fauna habitat

Species	Foraging (ha) loss within study area / loss in study region (%) ^{##}	Breeding (ha) loss within study area / loss in study region (%) ^{##}	Roosting (ha) loss within study area / loss in study region (%) ^{##}
Parrots			
Glossy Black-Cockatoo	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Little Lorikeet	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Swift Parrot	2.44 ha / <0.01%	N/A [#]	2.44 ha / <0.01%
Turquoise Parrot	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Owls			
Barking Owl	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Masked Owl	2.44 ha / <0.01%	N/A [#]	N/A [#]
Birds of prey			
Black-breasted Buzzard	2.44 ha / 0.03%	0.0	0.0
Little Eagle	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Spotted Harrier	2.44 ha / 0.03%	0.0	0.0
Square-tailed Kite	2.44 ha / <0.01%	0.0	0.0
Woodland birds – large ground foraging			
Bush Stone-curlew	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Woodland birds – ground and mid-storey foraging (passerines)			

Species	Foraging (ha) loss within study area / loss in study region (%) ^{##}	Breeding (ha) loss within study area / loss in study region (%) ^{##}	Roosting (ha) loss within study area / loss in study region (%) ^{##}
Diamond Firetail	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Gilbert's Whistler	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Grey-crowned Babbler (eastern subspecies)	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Hooded Robin	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Scarlet Robin	2.44 ha / <0.01%	N/A [#]	2.44 ha / <0.01%
Speckled Warbler	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Varied Sittella	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Woodland birds – canopy foraging (excluding parrots)			
Black-chinned Honeyeater (eastern subspecies)	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Painted Honeyeater	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Regent Honeyeater	2.44 ha / <0.01%	N/A [#]	2.44 ha / <0.01%
Arboreal mammals and megabats			
Grey-headed Flying-fox	2.44 ha / <0.01%	N/A [#]	N/A [#]
Squirrel Glider	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Ground and log dependent mammals			
Black-striped Wallaby	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Pilliga Mouse	0.0	0.0	0.0
Spotted-tailed Quoll	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Grassy woodland mammals			
Rufous Bettong	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Predominantly tree-roosting bats			
Yellow-bellied Sheath-tail-bat	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
South-eastern Long-eared Bat	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%
Predominantly cave-roosting bats			
Eastern Bentwing-bat	2.44 ha / <0.01%	N/A [#]	N/A [#]
Eastern Cave Bat	2.44 ha / <0.01%	N/A [#]	N/A [#]
Large-eared Pied Bat	2.44 ha / <0.01%	N/A [#]	N/A [#]
Little Pied Bat	2.44 ha / <0.01%	2.44 ha / <0.01%	2.44 ha / <0.01%

[#] Breeding and/or roosting habitat has not been impacted or is not present for these species within the study region

^{##} The regional vegetation class data utilised in this report is derived from a regional scale map that contains a proportion of modelling. Other datasets utilised are of varying scales and accuracies.

5.6 Impacts to aquatic habitat

No aquatic habitat occurs in the study area and it is unlikely that any aquatic habitat would be directly or indirectly impacted by the proposed activity.

5.7 Impacts to groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) may be defined as a community of plants, animals and other organisms which exist within a defined area with their species composition and natural ecological processes determined by groundwater (DLWC 2002, Commonwealth of Australia 1996). Groundwater filters down through the earth's surface to the point where the layer of loose rock and earth becomes fully saturated with the top of the saturated zone known as the watertable (DLWC 2002). GDEs are located across a broad range of environments. Eamus *et al.* (2006) have proposed three simple primary classes of GDEs:

1. **Aquifer and cave ecosystems:** These ecosystems are where stygofauna inhabit the groundwater resource. Examples include karstic, fractured rock and alluvial aquifers
2. **All ecosystems dependent on the surface expression of water:** This includes base-flow rivers and streams, wetlands, some floodplains and mound springs and estuarine seagrass beds
3. **All ecosystems dependent on the subsurface presence of groundwater:** These ecosystems typically access groundwater via the capillary fringe (non-saturated zone above the saturated zone of the water table) when roots penetrate this zone. This includes terrestrial ecosystems such as *Eucalyptus camaldulensis* (River Red Gum) forests on the Murray-Darling basin

Many native plant species utilise groundwater during their lifecycle including those plants utilising the groundwater resource at the surface (e.g. wetlands) and other plants where their roots penetrate into the watertable at some depth (DLWC 2002). GDEs can, therefore, include ecosystems with complete dependence on groundwater (i.e. stygofauna in aquifers) to those which may utilise groundwater on occasion, but are not necessarily dependant on the groundwater resource.

Within the study region groundwater is generally close to the surface (<5m) in the quaternary alluvium associated with the major creeks and floodplains (e.g. Bohena Creek), while generally being much deeper in those areas characterised by Jurassic quartz sandstone (20 – 50m) (SKM 2010). The majority of the vegetation within the study region on alluvial soils is likely to have a proportional association with groundwater. Vegetation along the major creeks and floodplains has the potential to be dependent on base-flow groundwater, whilst the vegetation on the alluvial plains is likely to utilise groundwater resources proportionally (depending on rainfall) whilst vegetation on Jurassic quartz sandstone is unlikely to be groundwater dependant. Further to this, there are minimal areas of permanent surface water within the study region over the course of a year. The exception being constructed dams and a number of relatively small groundwater fed springs. Following significant rainfall, the creeks within the study region were observed to flow for a period of days to weeks (depending on stream order) and then cease flowing.

The vegetation in the study area is considered a terrestrial ecosystem (EAMUS *et al.* 2006) and has potential to be proportionally dependent on groundwater (Hatton & Evans 1990). This dependency would be stronger during periods of drought. In periods of rainfall, the vegetation in the study area would draw its water source from rainfall and subsequent soil moisture.

A water resources assessment has been prepared by CH2MHILL for the Energy NSW Coal Seam Gas Exploration and Appraisal Program (the Program) (CH2MHILL 2013). The assessment included the proposed activity addressed in this ecological assessment. A risk assessment was used to predict the significance of potential impacts to water resources as a result of the Program which included identification of the following:

- The potential water resources which could be impacted by the Program activities, and the sensitivity of these water resources, were identified.
- The potential risks and significance of associated impacts to water resources as a result of the Program were identified.
- Mitigation and monitoring measures to be applied as a component of the Program were identified in order to reduce the risk of significant impacts occurring to water resources.

No significant impacts with very high or high likelihood of occurrence were identified.

5.8 Indirect impacts

The proposed activity has potential to indirectly impact on vegetation communities and flora and fauna species present in the study area through habitat fragmentation, sedimentation and erosion, introducing additional light, changing microclimates, increases in noise, traffic and dust and encouraging weed invasion and feral animal predators.

Due to the scale of the proposed activity, a 10 m buffer has been assessed around the subject sites in which it is predicted that the majority of potential indirect impacts would be contained. This would not hold true for short-term increases in noise.

Habitat fragmentation is considered to be minimal due to the nature of the subject sites and the use of existing roads where possible to reduce fragmentation. No patches of habitat would be isolated as a result of the proposed activity. Habitat fragmentation is known to encourage the movement of feral animal predators through the landscape. The proposed activity does not provide any new links between areas of habitat, although it is situated in an area that is already intersected by roads and is known to support a range of feral animal predators.

The removal of vegetation and transport of soil would increase the risk of sedimentation and erosion potentially leading to increased sediment load in aquatic systems and dust formation. This issue is addressed in the mitigation measures in **Section 6** to reduce the risk of this indirect impact.

Vegetation on the edge of the subject sites will be subject to increased light, changes to microclimate, increased dust and risk of weed invasion. The proposed activity has the potential to impact on the vegetation structure and health in the study area once the subject site has been cleared. Mitigation measures including avoiding activity outside of the study area, reducing speed limits on roads and rehabilitation measures have been presented in **Section 6** to address these indirect impacts.

Increases in noise during construction and operation of the proposed activity have potential to indirectly impact fauna both within the study area and in adjacent habitat. Mitigation measures addressing behaviour of construction teams have been presented in **Section 6** to address this indirect impact. Noise during operation would largely be kept to a minimum and constant, rather than intermittent which is considered to be less of an impact on fauna.

5.9 Cumulative impacts

Cumulative impacts for the Program have been assessed under the TSC Act (ELA 2013b) and the EPBC Act (ELA 2013c). These assessments address the removal of vegetation communities and habitat for threatened species at two different scales. The 'study area' as defined in the EPBC Act Impact Assessment (ELA 2013c) included an approximately 48,000 ha area within which detailed studies into the biodiversity values of the north-east Pilliga Forest were conducted. The 'study area' in the EPBC Act Impact Assessment contained all existing and proposed exploration and appraisal activities for the Program within the Pilliga Forest. The TSC Act assessment (ELA 2013b) had a

broader focus and addressed the cumulative impact associated with all existing and proposed exploration and production appraisal activities associated within PEL 238 (the study region as defined in this assessment). For the purposes of this assessment, the cumulative impacts have been reported against the same study region as included in the TSC Act assessment (ELA 2013b).

At the date of this report, a total of 78.08 ha of *White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion* has been removed for exploration activities from the study region since 2002. Of the vegetation that has been removed, 14.84 ha of this vegetation type is currently regenerating. A further 31.69 ha of this vegetation type is proposed to be removed from 2013 onwards which includes the 2.44 ha addressed in this ecological assessment. This equates to a cumulative total of 109.77 ha of removal of this vegetation type.

The study region has approximately 113,735 ha of this vegetation type and hence removal of 109.77 ha equates to less than 0.01 % removal of this vegetation type in the study region.

Cumulative impacts on threatened fauna addressed in this ecological assessment are presented in **Table 18**. These values include the 2.44 ha of vegetation removal for the proposed activity addressed in this ecological assessment.

Table 18: Cumulative direct impacts areas to potential threatened fauna habitat from 2002 to the Program

Species	Foraging (ha) loss within study region / loss in study region (%) [#]	Breeding (ha) loss within study region / loss in study region (%) [#]	Roosting (ha) loss within study region / loss in study region (%) [#]
Glossy Black-Cockatoo	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Little Lorikeet	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05
Superb Parrot	237.1 / 0.08	N/A [#]	159.9 / 0.05
Swift Parrot	237.1 / 0.08	N/A [#]	159.9 / 0.05
Turquoise Parrot	237.1 / 0.08	159.9 / 0.05	159.9 / 0.03
Barking Owl	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Masked Owl	237.1 / 0.08	N/A [#]	N/A [#]
Black-breasted Buzzard	113.5 / 0.63	N/A [#]	12.3 / 0.09
Little Eagle	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05
Spotted Harrier	110.9 / 0.36	36.0 / 0.20	36.0 / 0.20
Square-tailed Kite	237.1 / 0.05	12.3 / 0.09	12.3 / 0.09
Australian Bustard	220.7 / 0.17	N/A [#]	145.8 / 0.11
Bush Stone-curlew	220.7 / 0.17	145.8 / 0.11	145.8 / 0.11
Diamond Firetail	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Gilbert's Whistler	223.0 / 0.17	145.8 / 0.11	145.8 / 0.11
Grey-crowned Babbler (eastern subspecies)	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Hooded Robin	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Scarlet Robin	237.1 / 0.08	N/A [#]	159.9 / 0.05
Speckled Warbler	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05
Varied Sittella	237.1 / 0.08	159.9 / 0.05	159.9 / 0.05

Species	Foraging (ha) loss within study region / loss in study region (%) ^{##}	Breeding (ha) loss within study region / loss in study region (%) ^{##}	Roosting (ha) loss within study region / loss in study region (%) ^{##}
Black-chinned Honeyeater (eastern subspecies)	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Painted Honeyeater	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Regent Honeyeater	159.9 / 0.05	N/A [#]	159.9 / 0.05
Yellow-bellied Sheath-tail-bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
South-eastern Long-eared Bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Eastern Bentwing-bat	237.1 / 0.05	N/A [#]	N/A [#]
Eastern Cave Bat	237.1 / 0.05	N/A [#]	N/A [#]
Large-eared Pied Bat	237.1 / 0.05	N/A [#]	N/A [#]
Little Pied Bat	237.1 / 0.05	159.9 / 0.03	159.9 / 0.03
Grey-headed Flying-fox	159.9 / 0.05	N/A [#]	N/A [#]
Koala	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Squirrel Glider	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Black-striped Wallaby	224.9 / 0.05	147.6 / 0.03	147.6 / 0.03
Eastern Pygmy-possum	159.9 / 0.05	147.6 / 0.05	147.6 / 0.05
Pilliga Mouse	26.3 / 0.01	N/A [#]	N/A [#]
Spotted-tailed Quoll	159.9 / 0.05	159.9 / 0.05	159.9 / 0.05
Rufous Bettong	212.8 / 0.16	135.6 / 0.10	135.6 / 0.10
Pale-headed Snake	237.1 / 0.05	159.9 / 0.05	159.9 / 0.05

[#] Breeding and/or roosting habitat has not been impacted or is not present for these species within the study region

^{##} The regional vegetation class data utilised in this report is derived from a regional scale map that contains a proportion of modelling. Other datasets utilised are of varying scales and accuracies.

5.10 Assessment of significance under the EP&A Act

The following section provides an overview of the assessment process of the potential significance of the impacts from the proposed activity on ecological values listed under the TSC Act. The ecological values considered relevant to this assessment are identified in Section 4.2 of this report. The full assessments are found in **Appendix F** with results presented in **Table 16**.

The assessment of impact has been conducted where necessary with consideration to the 7-part test criteria (or assessment of significance). The flora and fauna species have been grouped for the assessment process with species that contain similar characteristics and are likely to be impacted in a similar manner.

The flora and fauna groupings for the assessment of significance for species listed under the TSC act include:

Flora

- *Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis* and *Tylophora linearis*

Birds

- Parrots:
 - o Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot and Turquoise Parrot
- Owls:
 - o Barking Owl & Masked Owl
- Birds of prey:
 - o Spotted Harrier, Black-breasted Buzzard, Little Eagle and Square-tailed Kite
- Woodland birds – large ground foraging:
 - o Bush Stone-curlew
- Woodland birds – ground and mid-storey foraging (passerines):
 - o Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin
- Woodland birds – canopy foraging (excluding parrots):
 - o Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater

Mammals

- Arboreal mammals and Flying Fox:
 - o Grey-headed Flying Fox and Squirrel Glider
- Ground and log dependent mammals:
 - o Black-striped Wallaby, Pilliga Mouse and Spotted-tailed Quoll
- Grassy woodland mammals:
 - o Rufous Bettong
- Predominantly tree-roosting bats:
 - o Yellow-bellied Sheath-tail-bat and South-eastern Long-eared Bat
- Predominantly cave-roosting bats:
 - o Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat and Little Pied Bat

The assessment of significance completed for each of these species (Appendix F) has shown the proposed activity is unlikely to constitute a significant impact.

5.11 Assessment of significance under the EPBC Act

This section provides an overview of the assessment process of potential significance of impacts from the proposed activity on Matters of National Environmental Significance (MNES). The EPBC Act Administrative Guidelines on Significance set out 'Significant Impact Criteria' that are to be used to assist in determining whether a proposed action is likely to have a significant impact on MNES.

Specific 'Significant Impact Criteria' are provided for each MNES, except for threatened species and ecological communities, in which case separate criteria are provided for species listed as endangered and vulnerable under the EPBC Act (**Table 19**).

Table 19: Significant impact criteria

Status	Significant impact criteria
Critically endangered and endangered species	An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • introduce disease that may cause the species to decline, or • interfere with the recovery of the species.
Vulnerable species	An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of an important population of a species • reduce the area of occupancy of an important population • fragment an existing important population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of an important population • modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.
Migratory species	An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or • seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

MNES considered relevant to this assessment include:

Flora

- *Pterostylis cobarensis* and *Tylophora linearis*.

Mammals

- South-eastern Long-eared Bat, Large-eared Pied Bat, Grey-headed Flying-fox, Spotted-tailed Quoll and Pilliga Mouse.

Birds

- Regent Honeyeater and Swift Parrot.

Migratory species

- Regent Honeyeater, White-bellied Sea Eagle, White-throated Needletail, Rainbow Bee-eater and Fork-tailed Swift.

The relevant Significant Impact Criteria have been applied to these threatened and migratory species to determine the significance of impact of the proposed activity, and are provided in **Appendix G** with results presented in **Table 16**.

The assessment of impact completed for each of these species (**Appendix G**) utilising the Significant Impact Criteria has shown the proposed activity is unlikely to constitute a significant impact.

6 Mitigation measures

6.1 Mitigation

Actions to mitigate the potential impacts of the proposed activity on ecological values have been provided below. These actions have been drawn from mitigation measures recommended for the associated proposed works where applicable.

- All personnel should be informed of their responsibilities whilst working on site in relation to ecological values and undertake a site specific induction.
- The site boundary should be clearly marked in the field to ensure all clearing and construction activities occur within the approved footprint.
- All access during the pre-construction, construction, operational and rehabilitation phases should be through existing roads and designated access tracks.
- Weed control measures should be in place during pre-construction, construction, operational and rehabilitation phases. These should include:
 - o The establishment of wash down points for vehicles to prevent the transportation of seeds and soil.
 - o Inspections of all equipment (machinery, tools, vehicles) brought on site to ensure that all equipment is free of materials where practicable (such as soils and seeds).
 - o Documentation and records that detail the use of wash down points and inspections.
 - o Measures to ensure that all weed growth is regularly and appropriately controlled in accordance with the NW Act.
- Removal of HBTs should be undertaken with the supervision of an ecologist and following the clearing procedure developed by ELA and Santos.
- Open trenches should be inspected twice daily by a suitably qualified fauna handler.
- Appropriate sediment and erosion control measures should be installed and maintained as specified in the EIS.
- Only 'fauna friendly' exclusion fencing (without barbed wire) in accordance with Santos policies should be installed around well infrastructure.
- 40 km/h speed limits will be implemented in the study area (i.e. lease areas and access tracks constructed for the activity). Otherwise the posted speed limit will apply.
- The subject sites should be progressively rehabilitated as soon as practicable following best practice guidelines.

6.2 Rehabilitation

Rehabilitation of existing exploration and appraisal activities is currently being undertaken. These activities provide a benchmark for understanding the potential reduction in impact as a result of rehabilitation works identified for the proposed activity.

Santos has commenced a program of rehabilitation works throughout PEL 238 and PAL 2. Rehabilitation works include:

- Reducing the size of existing well leases back to the minimum area required for operations.
- Plugging and abandoning, according to legislative requirements, wells that are no longer required for exploration and appraisal and rehabilitating associated well leases.
- Rehabilitating a number of water storage ponds that are no longer required for exploration and appraisal activities.

Actions undertaken during the clearing of vegetation include stockpiling 'waste' timber from felled trees not suitable for forestry activities, fallen logs and bush rock for later use in habitat restoration; slashing and mulching low vegetation onsite; and striping and stockpiling topsoil. Rehabilitation actions include; replacing topsoil; re-installing habitat features such as fallen timber and bush rock; natural re-establishment of slashed and cleared native vegetation; and direct seeding where required.

Monitoring of rehabilitation activities has shown an overall site value close to 45% of nearby reference sites after two years. This site value indicates that after two years, the community structure (measurement addressing native and exotic species richness and abundance, ground cover composition and habitat values) is at 45% of remnant condition. The replacement of topsoil is producing encouraging results, with sites showing a high number of native species when compared to reference sites. Rehabilitation measures undertaken have been considered using adaptive management principles with monitoring informing future modifications to works and methodology.

Rehabilitation works associated with the proposed activity should follow the methods developed for the existing exploration and appraisal activities.

6.3 Offsetting

Following consideration of the avoidance, minimisation and mitigation measures proposed, offsetting is not considered necessary due to the relatively small magnitude of impact, the short timeframe of the operation of the proposed activity and the recommended rehabilitation following completion of operations.

7 Conclusion

The vegetation in the study area is consistent with the vegetation community *Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion* which corresponds to the *White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion* vegetation type. This vegetation type provides habitat for a range of threatened flora and foraging, breeding and roosting habitat for a range of threatened fauna addressed this impact assessment.

A total of four threatened flora and 33 threatened fauna including 21 birds and 12 mammals have been assessed as potential, likely or known to occur in the study area.

The field surveys found three threatened flora within the study area; namely *Tylophora linearis*, listed as vulnerable under the TSC Act and endangered under the EPBC Act (three individuals at the Dewhurst 30 subject site), *Pterostylis cobarensis*, listed as vulnerable under the TSC Act and EPBC Act (three individuals at the Dewhurst 30 subject site) and *Polygala linariifolia* (Native Milkwort), listed as endangered under the TSC Act (one individual at the Dewhurst 31 subject site).

The field surveys recorded five birds listed as Vulnerable under the TSC Act (Grey-crowned Babbler, Hooded Robin, Speckled Warbler, Varied Sittella and Glossy Black-cockatoo) and White-bellied Sea-eagle and White-throated Needletail listed as Migratory under the EBPC Act in or adjacent to the study area.

The proposed activity involving the removal of 2.44 ha of vegetation is not considered likely to have a significant impact on ecological values listed under the TSC Act or EPBC Act or on the environment more broadly, provided the measures described in **Section 6** are adhered to.

Avoidance, minimisation and mitigation measures have been addressed in order to reduce the impact of the proposed activity on ecological values and the environment.

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Appendix A: Likelihood of occurrence

Provided below are the likelihood tables for threatened species listed under the NSW TSC Act and Commonwealth EPBC Act. Species, populations and communities considered to have the potential to occur are highlighted in yellow, those likely to occur are highlighted in brown, and those which are known occur are highlighted in green.

The analysis of the likelihood of occurrence table included previous reports conducted by Eco Logical Australia (ELA) and RPS.

Key to the table:

- TSC Status = Listing under the *Threatened Species Conservation Act 1995*
- EPBC Status = Listing under the *Environment Protection and Biodiversity Conservation Act 1999*
- CE = Critically Endangered
- E = Endangered (EPBC Act)
- E1 = Endangered (TSC Act)
- E2 = Endangered Population (TSC Act)
- E4 = Extinct (TSC Act)
- V = Vulnerable
- M = Migratory (EPBC Act)
- Mar = Marine (EPBC Act)

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
FAUNA										
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	~	The original range from Coen in north Queensland to central Victoria has been reduced to a patchy distribution from Cooktown, Queensland, to north-eastern NSW as far south as Mt Royal National Park. In NSW it has largely vanished from inland areas but there are sporadic, unconfirmed records from the Pilliga and Torrington districts. (OEH 2013b)	Prefer forests with a grassy to sparse understorey including coastal forest, tall wet sclerophyll forest and dry forests west of GDR (OEH 2013b). It is most commonly found on sites derived from sedimentary rock and in north eastern NSW in forests characterised by <i>Corymbia maculata</i> (Spotted Gum) and <i>C. henryi</i> (OEH 2013b). It has been known to feed on introduced pasture species (OEH 2013b).	Moderate	Potential	Moderate	Potential	The study area has moderate habitat of open woodland. There is potential for impact by the proposed activity and hence an AoS has been undertaken for this species.
<i>Alectura lathamii</i>	Australian Brush-turkey	E2	~	The Australian Brush-turkey has a largely coastal distribution from Cape York south as far as the Illawarra in NSW. A population of the Australian Brush-turkey is known from the Nandewar and Brigalow Belt South Bioregions. Recent records for the species show the population to range from north east of Warialda, to Narrabri, approximately 115 km to the south-west, and occur within the local government areas of Yallaroi, Bingara, Narrabri, Barraba and Moree Plains. (OEH 2013b)	It occurs in forested and wooded areas of tropical and warm-temperate districts, particularly above 300 m to at least 1200 m altitude. In NSW the inland vegetation type preferred by the Australian Brush-turkey is a dry rainforest community that is found within the Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions Endangered Ecological Community (OEH 2013b)	No habitat	No	No habitat	No	No potential
<i>Anomalopus mackayi</i>	Five-clawed Worm-skink	E1	V	Patchy distribution on the North West Slopes and Plains of north-east NSW and south-east Queensland, from the Ashford area west to Mungindi and Walgett in NSW and north to Dalby in Queensland (OEH 2013b)	Close to or on the lower slopes of slight rises in grassy White Box woodland on moist black soils, and River Red Gum-Coolibah-Bimble Box woodland on deep cracking loose clay soils. May also occur in grassland areas and open paddocks with scattered trees. Live in permanent deep tunnel-like burrows and deep soil cracks, coming close to the surface under fallen timber and litter, especially partially buried logs (OEH 2013b)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Anseranas semipalmata</i>	Magpie Goose	V	~	The Magpie Goose is still relatively common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s there have been an increasing number of records in central and northern NSW. Vagrants can follow food sources to south-eastern NSW (OEH 2013b)	Activities centred on terrestrial sedge-dominated wetlands; mainly those on floodplains of rivers (Marchant & Higgins 1993 Simpson & Day 1999).	Low	Unlikely	No habitat	No	No potential
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E, M	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Once recorded between Adelaide and the central coast of Queensland, its range has contracted	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of <i>Casuarina cunninghamiana</i> (River Oak) (Garnett 1993). Areas containing <i>Eucalyptus robusta</i> (Swamp	High	Potential	Moderate	Potential	Study area provides foraging habitat when <i>E. crebra</i> is in flower. Due to sporadic flowering of <i>E. crebra</i> , the study area is unlikely to provide a

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
				dramatically in the last 30 years to between north-eastern Victoria and south-eastern Queensland (OEH 2013b)	Mahogany) in coastal areas have been observed to be utilised. The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). As such it is reliant on locally abundant nectar sources with different flowering times to provide reliable supply of nectar (Environment Australia 2000).					reliable or abundant foraging habitat. However, it is possible that this species may use the study area sporadically as sub-optimal foraging habitat. There is a potential for impact by the proposed activity and an AoS has been undertaken for this species.
<i>Aprasia parapulchella</i>	Pink-tailed Legless Lizard	V	V	It is known only to occur in the Central and Southern Tablelands and South Western Slopes of NSW. Populations have been recorded in the Queanbeyan/Canberra district, Cooma, Yass, Bathurst, Albury and West Wyalong areas (DECC 2007)	It inhabits open woodland that has a predominately native grass understorey that is situated on sloping, well-drained soils with rocky outcrops or scattered partially buried rocks present. Burrows are formed beneath small, partially embedded rocks that are often inhabited by small black ants and termites. The Pink-tailed Worm-lizard feeds on the larvae and eggs of the ants with which it shares its burrows. In the summer months 2 eggs are laid inside the ant nests with the young first appearing in March. (DECC 2007)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Apus pacificus</i>	Fork-tailed Swift	-	M Mar	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia. In NSW, the Fork-tailed Swift is recorded in all regions. Many records occur east of the Great Divide, however, a few populations have been found west of the Great Divide. These are widespread but scattered further west of the line joining Bourke and Dareton. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs (DoE 2013b)	Sometimes travels with Needletails. Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas (Simpson & Day 1999).	High	Known	High	Likely	Potential. An AoS has been undertaken for this species.
<i>Ardea alba</i>	Great Egret, White Egret	~	M, Mar	Eastern Great Egrets are widespread in Australia. They occur in all states/territories of mainland Australia and in Tasmania. They have also been recorded as vagrants on Lord Howe, Norfolk and Macquarie Islands (DoE 2013b)	The Great Egret is common and widespread in Australia (McKilligan 2005). It forages in a wide range of wet and dry habitats including permanent and ephemeral freshwaters, wet pasture and estuarine mangroves and mudflats. (McKilligan 2005).	Moderate	Likely	Low	Unlikely	Unlikely
<i>Ardea ibis</i>	Cattle Egret	~	M, Mar	The Cattle Egret is widespread and common according to migration movements and breeding localities surveys. Two major distributions have been located; from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. In Western Australia and the Northern Territory, the Cattle Egret is	Cattle Egrets forage on pasture, marsh, grassy road verges, rain puddles and croplands, but not usually in the open water of streams or lakes and they avoid marine environments (McKilligan 2005). Some individuals stay close to the natal heronry from one nesting season to the next, but the majority	Moderate	Likely	Low	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
				located from Wyndham to Arnhem Land. In south-east Australia it is found from Bundaberg, inland to Roma, Thargominda, and then down through Inverell, Walgett, Nyngan, Cobar, Ivanhoe, Balranald to Swan Hill, and then west to Pinnaroo and Port Augusta (DoE 2013b)	leave the district in autumn and return the next spring. Cattle Egrets are likely to spend the winter dispersed along the coastal plain and only a small number have been recovered west of the Great Dividing Range (McKilligan 2005).					
<i>Ardeotis australis</i>	Australian Bustard	E1	~	The Australian Bustard mainly occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW (OEH 2013b)	Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams (OEH 2013b)	High	Potential	Low	Unlikely	Unlikely
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1	E	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west (OEH 2013b)	Terrestrial wetlands with tall dense vegetation, occasionally estuarine habitats (Marchant & Higgins 1993). Reedbeds, swamps, streams, estuaries (Simpson & Day 1999).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1	~	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range.	Associated with dry open woodland with grassy areas, dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000; Marchant & Higgins 1993). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins 1993). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed to lightly disturbed	High	Known	Moderate	Potential	The study area has areas of open woodland with fallen timber, leaf litter and little undergrowth. However, much of the study area is dense with regrowth from fire and logging disturbance and this high level of disturbance is not preferable for this species. There is a potential for impact by the proposed activity and an AoS has been undertaken for this species.
<i>Calyptorhynchus banksii</i> (inland subspecies)	Red-tailed Black-Cockatoo	V	~	The Red-tailed Black-Cockatoo is the most widespread of the Black-Cockatoos, ranging broadly across much of northern and western Australia as well as western Victoria. In NSW, one population occurs on the north-western slopes and plains but another small isolated population is found in the coastal north-east. (OEH 2013b).	Occurs in coastal forests and woodlands or inland open shrubland near water (Simpson & Day 1999). This species is noted to feed mainly on seeds, especially of eucalypts, casuarinas, acacia and banksias. May also take berries, nectar, flowers and occasionally insects and their larvae (Marchant & Higgins 1993).	Low	Unlikely	Low	Unlikely	The study area is situated outside of the regular range of this species. This species is unlikely to be reliant on the habitat in the study area and there is a low potential for impact by the proposed activity. As such, an AoS is

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
										not required.
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo	V	~	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia (OEH 2013b)	Associated with a variety of forest types containing <i>Allocasuarina</i> species, usually reflecting the poor nutrient status of underlying soils (Environment Australia 2000; OEH 2013b). Intact drier forest types with less rugged landscapes are preferred (OEH 2013b). Nests in large trees with large hollows (Environment Australia 2000).	High	Known	Moderate	Likely	This species is commonly found in the study region. It feeds predominantly on comes from <i>Casuarina diminuta</i> subsp. <i>diminuta</i> which is found in the vegetation type that occurs in the study area. Large hollows in the study area provide suitable nesting habitat. An AoS has been undertaken for this species.
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	~	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. (OEH 2013b). It occupies small home ranges, rarely greater than 1 ha.	Found in wet and dry eucalypt forest, subalpine woodland, coastal banksia woodland and wet heath (Menkhorst & Knight 2004). Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will also eat insects, seeds and fruit (Turner & Ward 1995). The presence of <i>Banksia</i> sp. and <i>Leptospermum</i> sp. are an important habitat feature (OEH 2013b). Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds nests and in the branch forks of tea-trees (Turner & Ward 1995).	High	Known	Low	Unlikely	Unlikely, whilst the broader north-east Pilliga Forest contains known habitat for the Eastern Pygmy-possum, the study area does not support suitable habitat for this species (i.e. the study area does not have a heathy understorey suitable for foraging). As such, an AoS is not required.
<i>Certhionyx variegatus</i>	Pied Honeyeater	V	~	Widespread throughout acacia, mallee and Spinifex scrubs of arid and semi-arid Australia. Occasionally occurs further east, on the slopes and plains and the Hunter Valley, typically during periods of drought (OEH 2013b).	Inhabits wattle shrub (primarily Mulga, <i>Acacia aneura</i>), mallee, Spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (<i>Eremophila</i> spp.); also from mistletoes and various other shrubs (e.g. <i>Brachystema</i> spp. and <i>Grevillea</i> spp.); also eats saltbush fruit, berries, seed, flowers and insects. Highly nomadic, following the erratic flowering of shrubs; can be locally common at times (OEH 2013b)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes.	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests (Churchill 1998; DECC 2007). This species roosts in caves, rock overhangs and disused	High	Potential	High	Potential	No breeding habitat for this species is present in the study area. The woodland in the study area is suitable for foraging. An AoS

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
				(OEH 2013b)	mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill 1998).					has been undertaken for this species.
<i>Chalinolobus picatus</i>	Little Pied Bat	V	~	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria.	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. Feeds on moths and possibly other flying invertebrates.	High	Known	High	Known	This species has been recorded within Dewhurst 31 and is likely to use habitat within the study areas for roosting and foraging. An AoS has been undertaken for this species.
<i>Chthonicola sagittata</i>	Speckled Warbler	V	~	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive. (OEH 2013b)	Occupies a wide range of eucalypt dominated communities with a grassy understorey, often on rocky ridges or in gullies (OEH 2013b). Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy (OEH 2013b). Large, relatively undisturbed remnants are required for the species to persist in an area (OEH 2013b). Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding (OEH 2013b)	High	Known	High	Known	This species is known to forage in the study area and is likely to breed in habitat in the study area. An AoS has been undertaken for this species.
<i>Circus assimilis</i>	Spotted Harrier	V	~	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. (OEH 2013b)	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals (e.g. bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	Moderate	Potential	Moderate	Potential	Breeding and foraging habitat for this species is present in the study area. An AoS has been undertaken for this species.

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subspecies)	V	~	The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. The western boundary of the range of <i>Climacteris picumnus victoriae</i> runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper <i>Climacteris picumnus picumnus</i> which then occupies the remaining parts of the state (OEH 2013b)	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. It mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and <i>Eucalyptus camaldulensis</i> (River Red Gum) Forest. Generally not found in woodlands with a dense shrub layer. Fallen timber is an important habitat component for foraging. It is sedentary and nests in tree hollows within permanent territories (OEH 2013b).	High	Unlikely The north-east Pilliga Forest lies outside of the geographically defined area for the eastern subspecies	High	Unlikely The north-east Pilliga Forest lies outside of the geographically defined area for the eastern subspecies	Unlikely
<i>Crinia sloanei</i>	Sloane's Froglet	V	~	Sloane's Froglet has been recorded from widely scattered sites in the floodplains of the Murray-Darling Basin, with the majority of records in the Darling Riverine Plains, NSW South Western Slopes and Riverina bioregions in New South Wales. It has not been recorded recently in the northern part of its range and has only been recorded infrequently in the southern part of its range in NSW (OEH 2013b)	It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	~	Varied Sittellas are endemic and widespread in mainland Australia. (OEH 2013b)	Varied Sittellas are found in eucalypt woodlands and forests throughout their range. They prefer rough-barked trees like stringybarks and ironbarks or mature trees with hollows or dead branches (OEH 2013b)	High	Known	High	Known	This species is likely to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Only in Tasmania is it still considered common. (OEH 2013b)	It inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are found in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, which are usually traversed along densely vegetated creek lines. (OEH 2013b).	Moderate	Potential	Low	Potential	This species has potential to forage and breed in the study area. An AoS has been undertaken for this species.

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<i>Delma torquata</i>	Collared Delma	~	V	The main concentrations of records are from the western suburbs of Brisbane. Urban development in these suburbs has resulted in a contraction of previously recorded populations in this area (Ryan 2006a). The species is also known from the following sites: the Bunya Mountains; Blackdown Tableland National Park (NP); Bullyard Conservation Park (CP); D'Aquilar Range NP, Expedition NP; Naumgna and Lockyer Forest Reserves (inside Bunya Mountains NP; Western Creek, near Millmerran; and the Toowoomba Range (Davidson 1993; Ryan 2006a).	The Collared Delma normally inhabits eucalypt or acacia dominated woodland and open forest where it is associated with suitable microhabitats (exposed rocky outcrops, or a sparse understorey of tussock grass, shrubs or semi-evergreen vine thickets). <i>Corymbia citriodora</i> (Lemon-scented Gum) is typically the dominant canopy species. Other dominant canopy species include <i>Eucalyptus crebra</i> , <i>E. melanophloia</i> , <i>E. tessellaris</i> , <i>E. moluccana</i> , <i>E. microcorys</i> , <i>E. tereticornis</i> , <i>Angophora</i> sp. and <i>Acacia harpophylla</i> (Brigalow) (Peck 2003, cited in Peck & Hobson 2007; Ryan 2006a). Leaf Litter appears to be an essential part of the microhabitat and is always present. (DoE 2013b)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Drymodes brunneopygia</i>	Southern Scrub-robin	V	~	This species is restricted to mallees and shrublands across southern Australia and in NSW is confined to two main areas. The first is in central NSW and is centred on Round Hill and Nombinnie Nature Reserves, though suitable habitat probably exists on adjoining leasehold lands. The other population occurs in the far south west of NSW, mainly within the Scotia mallee centred on Tarawi NR and Scotia Sanctuary	Inhabits mallee and acacia scrub, particularly with dense sub-shrubs in the understorey, including Broombush and other dry shrubs	Moderate	Unlikely	Moderate	Unlikely	The study area is situated outside of the regular range of this species. This species is unlikely to be reliant on the habitat in the study area and there is a low potential for impact by the proposed activity. As such, an AoS is not required.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E1	~	In Australia, Black-necked Storks are widespread in coastal and subcoastal northern and eastern Australia, south to central-eastern NSW and with vagrants recorded at scattered sites well away from the coast (for example, near Moree, north-east of Hay and in Victoria). In NSW, the species becomes	Associated with tropical and warm temperate terrestrial wetlands, estuarine and littoral habitats, and occasionally woodlands and grasslands floodplains (Marchant & Higgins 1993). Forages in fresh or saline waters up to 0.5m deep, mainly in open fresh waters,	Low	Unlikely	Low	Unlikely	Unlikely

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				more uncommon south of the Northern Rivers region, and rarely occurs south of Sydney (OEH 2013b)	extensive sheets of shallow water over grasslands or sedgeland, mangroves, mudflats, shallow swamps with short emergent vegetation and permanent billabongs and pools on floodplains (Marchant & Higgins 1993; OEH 2013b).					
<i>Epthianura albifrons</i>	White-fronted Chat	V	~	The White-fronted Chat is found across the southern half of Australia. It is found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000 m above sea level. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the west. Along the coast, it is found mostly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. (OEH 2013b)	Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 m above the ground). (OEH 2013b)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Erythrotriorchis radiatus</i>	Red Goshawk	CE	V	Red Goshawks are found from across northern Australia, down the east coast of Qld and into the northern coast of NSW. In NSW records are rare. Listed as having occurred south to Port Stephens.	Its habitat consists of wooded and forested areas. Prefers forest and woodland with a mosaic of vegetation types, large populations of birds for prey and permanent water. Riverine vegetation is highly utilised by this species. Its habits are not well known, but it is considered to be a solitary, sedentary bird. They nest in tree forks of <i>Eucalypt</i> sp. and <i>Melaleuca</i> sp. or those nests of other large birds such as Magpies or Crows. The nests are generally built of sticks, which are lined with soft twigs and leaves	Moderate	Unlikely	Moderate	Unlikely	Unlikely
<i>Falco hypoleucos</i>	Grey Falcon	E1	~	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500 mm rainfall in NSW (OEH 2013b)	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey (OEH 2013b)	Moderate	Potential	Low	Unlikely	Unlikely
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	~	M, Mar	The species has been recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (DoE 2013b).	This species occurs in permanent and ephemeral wetlands up to 2000 m above sea-level, usually inhabiting open, freshwater wetlands with low, dense vegetation such as swamps, flooded grasslands or heathlands, around bogs and other water bodies. This species can also occur in habitats with saline or brackish water and in modified or artificial habitats.	Low	Potential	Low	Unlikely	Unlikely

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					It feeds in mud, either exposed or in very shallow water with low, dense vegetation. Roosting occurs on the ground near or in foraging areas beside or under clumps of vegetation, among dense tea-tree, in forests, in drainage ditches or plough marks, among boulders, or in shallow water if cover is unavailable. They feed on a variety of seeds, plant material, and insects.					
<i>Geophaps scripta scripta</i>	Squatter Pigeon	E	V	The Squatter Pigeon (southern) occurs on the inland slopes of the Great Dividing Range. Its distribution extends from the Burdekin-Lynd divide in central Queensland, west to Charleville and Longreach, east to the coastline between Proserpine and Port Curtis (near Gladstone), and south to scattered sites though out south-eastern Queensland. It's distribution historically extended into NSW, however, there have been no confirmed records of the species in NSW since the 1970s.	The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts . It has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements, in scrub and acacia growth, and remains common in heavily-grazed country north of the Tropic of Capricorn (EPA 2006). The species is commonly observed in habitats that are located close to bodies of water.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	~	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are common, influenced by season and food availability, although some areas retain residents for much of the year and 'locally nomadic' movements are suspected of breeding pairs (OEH 2013b).	Little Lorikeets mostly occur in dry, open eucalypt forests and woodlands. They have been recorded from 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. They feed primarily on nectar and pollen in the tree canopy, particularly on profusely-flowering eucalypts, but also on a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands <i>Eucalyptus albens</i> and <i>E. melliodora</i> are important food sources for pollen and nectar respectively.	High	Known	High	Likely	This species has been observed numerous in the study region and is likely to use the study area for foraging (especially for <i>E. crebra</i>) and nesting in hollows. An AoS has been undertaken for this species.
<i>Grantiella picta</i>	Painted Honeyeater	V	~	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird (and almost all breeding), occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern QLD. During the winter it is more likely to be found in the north of its distribution (OEH 2013b)	The Painted Honeyeater inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. It feeds on mistletoes growing on woodland eucalypts and acacias. It nests from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	High	Likely	High	Likely	This species is likely to use the study area for foraging (especially for <i>E. crebra</i>) and breeding. An AoS has been undertaken for this species.
<i>Grus rubicunda</i>	Brolga	V	~	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It still abundant in the northern tropics, but very sparse across the southern part of its range	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It still abundant in the northern tropics, but very sparse across the southern	Low	Unlikely	Low	Unlikely	Unlikely

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				(OEH 2013b).	part of its range (OEH 2013b).					
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	~	M, Mar	The White-bellied sea-eagle is distributed along the coastline of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The inland limits of the species are most restricted in south-central and south-western Australia, where it is confined to a narrow band along the coast (DoE 2013b).	Forages over large open fresh or saline waterbodies, coastal seas and open terrestrial areas (Marchant & Higgins 1993, Simpson & Day 1999). Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant & Higgins 1993)	Moderate	Known	Low	Potential	This species may potentially forage in the study area. An AoS has been undertaken for this species.
<i>Hamirostra melanosternon</i>	Black-breasted Buzzard	V	~	The Black-breasted Buzzard is found sparsely in areas of less than 500 mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts (OEH 2013b)	This species lives in a range of inland habitats including open forests, riverine woodlands, scrubs and heathlands. It is often found along timbered watercourses, which is preferred breeding habitat. It can also hunt over grasslands and includes reptiles, small mammals, birds and large eggs in its prey.	Low	Potential	Low	Potential	There is potential for this species to forage although unlikely to breed in the study area. An AoS has been undertaken for this species.
<i>Hieraaetus morphnoides</i>	Little Eagle	V	~	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW.	The Little Eagle is seen over woodland and forested lands and open country, extending into the arid zone. It tends to avoid rainforest and heavy forest (OEH 2013b)	High	Likely	Moderate	Potential	This species has potential to fly over the study area or forage in the study area. It is unlikely to breed in the study area. An AoS has been undertaken for this species.
<i>Hirundapus caudacutus</i>	White-throated Needletail	-	M, Mar	The White-throated Needletail is found throughout eastern and south-eastern Australia. In eastern NSW, it is found to extend inland to the western slopes of the Great Divide and occasionally to the adjacent inland plains (DoE 2013b).	In Australia, this species is almost exclusively aerial and found over most types of habitat (DoE 2013b).	High	Known	High	Likely	This species was recorded by RPS adjacent to the study area. An AoS has been undertaken for this species.
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	V	~	A patchy distribution from north-east Queensland to north-east NSW. In NSW it occurs from the coast to the western side of the Great Divide as far south as Tuggerah (OEH 2013b).	Wide range of habitats from rain or wet sclerophyll forest to drier eucalypt forests and favours streamside habitat in drier areas (OEH 2013b).	High	Likely	Low	Unlikely	Unlikely
<i>Jalmenus eubulus</i>	Pale Imperial Hairstreak	CE	~	It is found in Queensland and NSW. In Queensland it is restricted to the seasonally sub-humid central and southern areas of the state. In NSW it is found only in Brigalow -dominated open forests and woodlands in northern areas of the state.	Suitable habitat is dominated by <i>Acacia harpophylla</i> (Brigalow) and <i>Casuarina cristata</i> (Buloke) on clay soils on flat to gently undulating plants, usually with scattered emergent eucalypts. It is only known to breed in old-growth forest or woodland and does not appear to colonise regrowth habitats after clearing	Low	Unlikely	Low	Unlikely	Unlikely
<i>Lagorchestes leporides</i>	Eastern Hare-wallaby	E4	Ex	The Eastern Hare-wallaby was common in open plains country around the Murray River and in the grasslands and woodlands of western Victoria and	This species generally spent the day sheltering and foraged at night, it sheltered under large tussocks which it excavated itself.	Low	No	Low	No	No

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				southeastern South Australia, but it has not been seen alive this century. Last South Australian record: Lucindale, 1892 (South Australia Museum n.d)						
<i>Lathamus discolor</i>	Swift Parrot	E1	E, Mar	Breeds in Tasmania between September and January. Migrates to mainland in autumn, where it forages on profuse flowering Eucalypts (Blakers et al. 1984; Schodde and Tidemann 1986; Forshaw and Cooper 1981).	On mainland, autumn and winter flowering eucalypts are important for this species. Favoured feed trees include winter flowering species such as <i>Eucalyptus robusta</i> , <i>Corymbia maculata</i> , <i>C. gummifera</i> (Red Bloodwood), <i>E. sideroxylon</i> (Mugga Ironbark) and <i>E. albens</i> (OEH 2013b).	High	Potential	Moderate	Potential	Study area provides foraging habitat when <i>E. crebra</i> is in flower. Due to sporadic flowering of <i>E. crebra</i> , the study area is unlikely to provide a reliable or abundant foraging habitat. However, it is possible that this species may use the study area sporadically as sub-optimal foraging habitat. There is a potential for impact by the proposed activity and an AoS has been undertaken for this species.
<i>Leipoa ocellata</i>	Malleefowl	E1	V, M	The stronghold for this species in NSW is the mallee in the south west centred on Mallee Cliffs NP and extending east to near Balranald and as far north as Mungo NP. In central NSW it has been significantly reduced through land clearance and fox predation and now occurs chiefly in Yathong, Nombinnie and Round Hill NRs and surrounding areas, though birds continue to survive in Loughnan NR (OEH 2013b).	Dry inland scrub, mallee. Males tend large sand nest-mound (Simpson & Day 1999).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Leporillus apicalis</i>	Lesser Stick-nest Rat	E4	Ex	The last specimen of the Lesser Stick-nest Rat was captured near Mt Crombie, south-west of the present Amata settlement, South Australia in 1933. However, in the nineteenth century it occupied a broad area stretching from the Riverina in New South Wales, through most of inland South Australia and into the Gibson Desert, reaching the Western Australian coast in the Gascoyne region (Burbidge et al. 1988; Cole & Woinarski 2000; Finlayson 1961).	The Lesser Stick-nest Rat occupied arid and semi-arid lands (Burbidge et al. 1988; Cole & Woinarski 2000).	Low	No	Low	No	Unlikely
<i>Limosa limosa</i>	Black-tailed Godwit	V	~	In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary). Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It has been recorded within the Murray-Darling	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia (Palearctic) and flies to Australia for the southern summer, arriving in August and leaving in March. Primarily a coastal species, it is usually found in sheltered bays, estuaries and lagoons with large	Low	Unlikely	Low	Unlikely	Unlikely

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				Basin, on the western slopes of the Northern Tablelands and in far north-western NSW.	intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps.					
<i>Litoria booroolongensis</i>	Booroolong Frog	E1	E	It is restricted to the tablelands and slopes from 200 to 1300 m above sea level in NSW and north eastern Victoria. The species is mostly found along the western-flowing streams and their headwaters of the Great Dividing Range. Catchments drain from the Northern Tablelands to the Tumut River in the Southern Highlands, and other tributaries of the Murrumbidgee River. The only records of the species in northern NSW outside the Northern Tablelands are from two streams near Tamworth, NSW.	Typically inhabits rocky western-flowing creeks and their headwaters, although a small number of animals have also been recorded in eastern-flowing streams. along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses (DoE 2013b)	No habitat	No	No habitat	No	No
<i>Lophochroa leadbeateri</i> (<i>Cacatua leadbeateri</i>)	Major Mitchell's Cockatoo / Pink Cockatoo	V	~	Found across the arid and semi-arid inland, from south-western Queensland south to north-west Victoria, through most of South Australia, north into the south-west Northern Territory and across to the west coast between Shark Bay and about Jurien. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east than that. (OEH 2013b)	Inhabits a wide range of tree and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. (OEH 2013b)	Moderate	Unlikely	Moderate	Unlikely	The study area is situated outside of the regular range of this species. This species is unlikely to be reliant on the habitat in the study area and there is a low potential for impact by the proposed activity. As such, an AoS is not required.
<i>Lophoictinia isura</i>	Square-tailed Kite	V	~	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that it is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, from September to March	In coastal areas, this species is associated with tropical and temperate forests and woodlands on fertile soils with an abundance of passerine birds (Marchant & Higgins 1993, OEH 2013b). May be recorded inland along timbered watercourses (OEH 2013b). In NSW it is commonly associated with ridge or gully forests dominated by <i>Eucalyptus longiflora</i> (Woollybutt), <i>C. maculata</i> , or <i>E. elata</i> and <i>E. smithii</i> (OEH 2013b).	High	Likely	Moderate	Potential	This species has potential to breed and forage in the study area. An AoS has been undertaken for this species.
<i>Maccullochella peelii</i>	Murray Cod	-	V	The Murray Cod remains patchily distributed throughout the Murray-Darling Basin, but has undergone an extensive decline in abundance (Koehn and Clunie 2010). Commercial fisheries data indicate that natural populations declined in the 1920s and then again dramatically in the 1950s (Lintermans 2007). More recent survey data from the Basin states indicates some NSW populations may be recovering (Koehn and Clunie 2010). Murray Cod	The Murray Cod is the largest Australian freshwater fish, and is endemic to the Murray-Darling River system (Lintermans 2007). It is a top order 'sit and wait' aquatic predator, which prefers deep holes in rivers with instream cover such as rocks, stumps, fallen trees or undercut banks (Lintermans 2007).	No habitat	No	No habitat	No	No

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				populations in the Border Rivers, Gwydir, Namoi, mid-Murrumbidgee, lower Darling and lower Murray rivers appear to be in good condition (defined as widespread, abundant and recruiting) (Koehn and Clunie 2010).						
<i>Macropus dorsalis</i>	Black-striped Wallaby	E1	~	From the Townsville area in Queensland to northern NSW where it occurs on both sides of the Great Divide. On the North West Slopes of NSW it occurs in Brigalow remnants to south of Narrabri. On the north coast it is confined to the upper catchments of the Clarence and Richmond Rivers	Preferred habitat is characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. On the North West Slopes, it is associated with dense vegetation, including brigalow, ooline and semi-evergreen vine thicket. On the north coast, it is closely associated with dry rainforest but also occur in moist eucalypt forest with a rainforest understorey or a dense shrub layer.	High	Known	High	Likely	This species has been recorded in similar habitat adjacent to the study area and is likely to use the study area. An AoS has been undertaken for this species.
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V	~	The Hooded Robin is, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. However, it is common in few places, and rarely found on the coast. The south-eastern form (subspecies <i>cucullata</i> is found from Brisbane to Adelaide and throughout much of inland NSW, with the exception of the extreme north-west, where it is replaced by subsp. <i>picata</i>	Associated with a wide range of Eucalypt woodlands, Acacia shrubland and open forests. In temperate woodlands, the species favours open areas adjoining large woodland blocks, with areas of dead timber and sparse shrub cover. Hooded Robin home ranges are relatively large, averaging 18ha for birds from the New England Tableland. It is considered a sedentary species, but local seasonal movements are possible.	High	Known	High	Likely	This species was recorded at Dewhurst 13-18 just outside of the study area and has potential to breed and forage in the study area. An AoS has been undertaken for this species.
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	~	This subspecies extends south from central Queensland, through NSW, Victoria into south eastern SA. In NSW it is widespread, with records from the tablelands and western slopes of the Great Dividing Range to the north-west and central-west plains and the Riverina. It is rarely recorded east of the Great Dividing Range, although regularly observed from the Richmond and Clarence River areas. It has also been recorded at a few scattered sites in the Hunter, Central Coast and Illawarra regions	Predominantly associated with box-ironbark association woodlands, especially <i>Eucalyptus sideroxylon</i> , <i>E. albens</i> , <i>E. microcarpa</i> and <i>E. tereticornis</i> . Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees, and River Red Gum (OEH 2013b).	High	Likely	High	Likely	This species has potential to breed and forage in the study area. An AoS has been undertaken for this species.

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Merops ornatus</i>	Rainbow Bee-eater	~	M, Mar	The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands. It is not found in Tasmania, and is thinly distributed in the most arid regions of central and Western Australia (DoE 2013b).	Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs (ibid). Nest is a chamber at the end of a burrow, up to 1.6 m long, tunnelled in flat or sloping ground, sandy back or cutting (ibid).	High	Known	High	Likely	Potential. This species is likely to forage or roost in the study area and there is potential for burrowing in the sandy soil. An AoS has been undertaken for this species.
<i>Miniopterus australis</i>	Little Bentwing-bat	V	~	This species occurs along the East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW.	Prefers well-timbered areas including rainforest, wet and dry sclerophyll forests, Melaleuca swamps and coastal forests (Churchill 1998). This species shelters in a range of structures including culverts, drains, mines and caves (Environment Australia 2000). Relatively large areas of dense vegetation of either wet sclerophyll forest, rainforest or dense coastal banksia scrub are usually found adjacent to caves in which this species is found (OEH 2013b). Breeding occurs in caves, usually in association with <i>M. schreibersii</i> (OEH 2013b).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V	~	Eastern Bentwing-bats occur along the east and north-west coasts of Australia	Associated with a range of habitats such as rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, paperbark forests and open grassland (Churchill 1998). It forages above and below the tree canopy on small insects (Dwyer 1995, Dwyer 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1995).	High	Known	High	Known	This species is known in the study area and is likely to forage in the study area. An AoS has been undertaken for this species.
<i>Monarcha melanopsis</i>	Black-faced Monarch	~	M, Mar	Widespread in eastern Australia. In NSW, the species occurs around the slopes and tablelands inland to Armidale. It is rarely recorded further inland (DoE 2013b).	The Black-faced Monarch mainly occurs in rainforest ecosystems, including semi-deciduous vine-thickets, complex notophyll vine-forest, tropical (mesophyll) rainforest, subtropical (notophyll) rainforest, mesophyll (broadleaf) thicket/shrubland, warm temperate rainforest, dry (monsoon) rainforest and (occasionally) cool temperate rainforest (DoE 2013b)	Low	Unlikley	Low	Unlikely	Unlikely
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V	~	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.	Most records of this species are from dry eucalypt forest and woodland east of the Great Dividing Range (Churchill 1998). Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000; Allison & Hoyer 1998). Primarily roosts in	Low	Unlikely	Low	Unlikely	Unlikely

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					hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000; Allison & Hoyer 1998).					
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	~	M, Mar	In NSW, they are widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains (DoE 2013b)	Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DoE 2013b)	High	Known	High	Unlikely	Unlikely
<i>Myotis macropus</i>	Large-footed / Southern Myotis	V	~	The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface	Low	Unlikely	Low	Unlikely	Unlikely
<i>Neophema pulchella</i>	Turquoise Parrot	V	~	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range (OEH 2013b)	Steep rocky ridges and gullies, rolling hills, valleys and river flats and the plains of the Great Dividing Range compromise the topography inhabited by this species (Marchant & Higgins 1993). Spends much of the time on the ground foraging on seed and grasses (OEH 2013b). It is associated with coastal scrubland, open forest and timbered grassland, especially low shrub ecotones between dry hardwood forests and grasslands with high proportion of native grasses and forbs (Environment Australia 2000).	High	Known	High	Likely	This species is known in the study region and is likely to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Ninox connivens</i>	Barking Owl	V	~	The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests (OEH 2013b)	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and Riverine forest. Habitat is typically dominated by Eucalypts (often Redgum species), but can also be dominated by <i>Melaleuca</i> species in the tropics (OEH 2013b). It usually roosts in dense foliage in large trees such as <i>Casuarina cunninghamiana</i> , other <i>Casuarina</i> and <i>Allocasuarina</i> , eucalypts, <i>Angophora</i> , <i>Acacia</i> and rainforest species from streamside gallery forests (NPWS 2003). It usually nests near watercourses or wetlands (NPWS 2003) in large tree hollows with entrances averaging 2-29 metres above ground.	High	Known	High	Potential	This species is known in the study region and is likely to forage and roost and potentially to breed in the study area. An AoS has been undertaken for this species.
<i>Ninox strenua</i>	Powerful Owl	V	~	It is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland	It inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The species breeds and hunts in open or closed sclerophyll forest or woodlands and	Low	Unlikely	Low	Unlikely	Unlikely

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				to tablelands, with scattered, mostly historical records on the western slopes and plains. Now uncommon throughout its range where it occurs at low densities	occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine, Black She-oak, Blackwood, Rough-barked Apple, Cherry Ballart and a number of eucalypt species					
<i>Nyctophilus corbeni</i> (syn. <i>Nyctophilus timoriensis</i> (South-eastern form))	South-eastern Long eared Bat / Corben's Long-eared Bat	V	V	The distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species (OEH 2013b)	It inhabits a variety of vegetation types including mallee, bullock and box eucalypt dominated communities. However, it is more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices and under loose bark.	High	Known	High	Likely	This species is known in the study region and is likely to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Oxyura australis</i>	Blue-billed Duck	V	~	The Blue-billed Duck is endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 km away. It is generally only during summer or in drier years that they are seen in coastal areas. (OEH 2013b)	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation (OEH 2013b). The species is completely aquatic, swimming low in the water along the edge of dense cover (OEH 2013b). They are partly migratory, with short-distance movements between breeding swamps and over-wintering lakes with some long-distance dispersal to breed during spring and early summer (OEH 2013b).	Low	Unlikely	No habitat	Unlikely	Unlikely
<i>Pachycephala inornata</i>	Gilbert's Whistler	V	~	This species occurs across most of NSW's semi-arid and arid regions. The eastern population extends from the central NSW mallee (Yathong, Nombinnie and Round Hill NRs), south and east through the Cocoparra Range to Pomingalama Reserve (near Wagga Wagga) then north through the South West Slopes east as far as Cowra and Burrendong Dam, to the Goonoo reserves (with scattered records as far north as Pilliga (OEH 2013b).	This species occurs in arid and semi-arid timbered habitats in mallee shrubland, and occasionally in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. Within mallee the species often occurs in association with an understorey of Spinifex and low shrubs of acacias, hakeas, sennas and grevilleas. In woodland habitats, the understorey contains areas of dense shrubbery (OEH 2013b).	Moderate	Potential	Moderate	Potential	This species has potential to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Petaurus australis</i>	Yellow-bellied Glider	V	~	This species is found along the eastern coast to the western slopes of the Great Dividing Range, from southern Queensland, through NSW to Victoria	This species occurs in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary, with mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Their den sites are in hollows of large trees. They can occupy large home ranges between 20 to 85 ha to encompass dispersed and seasonally variable food resources	Low	Unlikely	Low	Unlikely	Unlikely
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	~	The species is widely though sparsely distributed in eastern Australia, from	Associated with dry hardwood forest and woodlands (Menkhorst et al.	High	Likely	Moderate	Potential	This species has potential to forage

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				northern Queensland to western Victoria. (OEH 2013b)	1988; Quin 1995). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).					and breed in the study area. An AoS has been undertaken for this species.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1	V	The range of this species extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. However the distribution across its original range has declined significantly in the west and south and has become more fragmented. In NSW they occur from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit (OEH 2013b).	This species occupies rocky areas (escarpments and outcrops) in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995). They generally browse on vegetation in and adjacent to rocky areas, eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Moderate	Unlikely	Low	Unlikely	Unlikely
<i>Petroica boodang</i>	Scarlet Robin	V	~	The Scarlet Robin is found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter.	The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. It lives in dry eucalypt forests and woodlands with an understorey that is usually open and grassy with few scattered shrubs. It can live in both mature and regrowth vegetation with an abundance of logs and fallen timber an important component of its habitat.	High	Potential	High	Potential	This species has potential to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Petroica phoenicea</i>	Flame Robin	V	~	The Flame Robin is endemic to SE Australia, and ranges from near the Queensland border to SE South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands (OEH 2013b).	It breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. The species prefers clearings or areas with open understoreys. The ground layer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. It occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgeland at high altitudes (OEH 2013b).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Phaethon rubricauda</i>	Red-tailed Tropicbird	V	Mar	This species of Marine bird occurs throughout tropical and subtropical zones of the Indian and West Pacific Oceans. Breeding occurs on oceanic islands, with the largest breeding site occurring on Lord Howe Island. Vagrant birds occur in coastal water of NSW, and occasionally inland, particularly after storm events (OEH 2013b)	It is a Marine species that breeds in coastal cliffs and under bushes in tropical Australia. It nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island (OEH 2013b)	Low	Unlikely	No habitat	Unlikely	Unlikely

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<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	~	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are some records west of the divide (OEH 2013b).	It prefers dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter, but can also inhabit heath, swamps, rainforest and wet sclerophyll forest. It nests and shelters in tree hollows, with entrances 2.5 - 4 cm wide and can use many hollows over a short time span (OEH 2013b).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Phascolarctos cinereus</i>	Koala	V	V	The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. It was briefly historically abundant in the 1890s in the Bega District on the south coast of NSW, although not elsewhere, but it now occurs in sparse and possibly disjunct populations. Koalas are also known from several sites on the southern tablelands (OEH 2013b).	Associated with both wet and dry Eucalypt forest and woodland that contains a canopy cover of approximately 10 to 70% (Reed et al. 1990), with acceptable Eucalypt food trees. Some preferred <i>Eucalyptus</i> species are: <i>Eucalyptus tereticornis</i> , <i>E. punctata</i> , <i>E. cypellocarpa</i> and <i>E. viminalis</i> .	High	Likely	Low	Unlikely	Unlikely
<i>Polytelis anthopeplus monarchoides</i>	Regent Parrot (Eastern Subspecies)	E1	V	The Regent Parrot (eastern) is confined to the semi-arid interior of southeastern mainland Australia. In NSW, the Regent Parrot (eastern) is confined to the southern Lower Western Region, mainly along the Murray River, from Kyalite, north west to Mallee Cliffs State Forest, and is also recorded near Wentworth and the Rufous River. Away from the Murray River, the subspecies is recorded at isolated localities including west of Moonlight Lake, Arumpo Station, and near Pooncarie	The Regent Parrot (eastern) primarily inhabits riparian or littoral <i>Eucalyptus camaldulensis</i> (River Red Gum) forests or woodlands and adjacent <i>E. largiflorens</i> (Black Box) woodlands. Nearby open mallee woodland or shrubland, usually with a ground cover of <i>Triodia</i> spp. (spinifex) or other grasses, supporting various eucalypts, especially <i>E. socialis</i> (Christmas Mallee) and <i>E. costata</i> (Yellow Mallee), as well as <i>Allocasuarina cristata</i> (Belah), <i>A. leuhmannii</i> (Buloke) or <i>Callitris preissii</i> (Slender Cypress Pine) also provide important habitat for this subspecies. They often occur in farmland, especially if the farmland supports remnant patches of woodland along roadsides or in paddocks. The subspecies seldom occurs in more extensively cleared areas	Moderate	Unlikely	Moderate	Unlikely	Unlikely
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	The Superb Parrot is found throughout eastern inland NSW. On the South-western Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. 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.	The Superb Parrot inhabits box-gum woodland, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. It forages at or near the ground and nest in hollows in small colonies (OEH 2013b).	Moderate	Potential	Low	Unlikely	Unlikely

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<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V	~	This species has two distinctive subspecies that intergrade to the south of the Gulf of Carpentaria. West of here the subspecies <i>rubeculus</i> , formerly considered a separate species (Red-breasted Babbler) is still widespread and common. The eastern subspecies (<i>temporalis</i>) occurs from Cape York south through QLD, NSW and Vic and formerly to the south east of SA. This subspecies also occurs in the Trans-Fly Region in southern New Guinea. In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in some locations on the north coast.	This species is found in open woodlands dominated by mature eucalypts with regenerating trees, tall shrubs, and an intact ground cover of grass and forbs (OEH 2013b). This species avoids very wet areas (Blakers et al. 1984).	High	Known	High	Likely	This species was observed just outside of the study area and is likely to breed and forage in the study area. An AoS has been undertaken for this species.
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	Distribution restricted to the Pilliga region of New South Wales. Fox and Briscoe first described this species in 1980 (Fox and Briscoe 1980).	This species of small rodent occurs in Pilliga Scrub on an isolated area of low-nutrient deep sand predominantly in recently burnt moist gullies, areas dominated by Broombush and areas containing an understorey of Kurricabah (<i>Acacia burrowii</i>) with a <i>Corymbia trachyphloia</i> overstorey in the Pilliga region of NSW. They seem to prefer areas with a high species diversity and dense low shrub layer. The species is thought to live in burrows and is nocturnal. (OEH 2013b).	High	Known	Low	Potential	The study area doesn't support core habitat for this species. However, during a population boom, it is possible the study area could be used as dispersal habitat. An AoS has been undertaken for this species.
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. They show a regular pattern of seasonal movement with much of the population moving to northern NSW and QLD during May and June where they exploit the winter flowering trees such as <i>Eucalyptus robusta</i> , <i>E. tereticornis</i> and Paperbark (OEH 2013b).	This species roosts in camps generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. This species is known to forage in areas supporting subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps on the nectar and pollen of native trees, in particular eucalypts, melaleucas and banksias.	Moderate	Potential	Moderate	Potential	A camp is not known within 20 km of the study area. Due to sporadic flowering of dominant canopy species in the Pilliga Forest, the study area is unlikely to provide a reliable or abundant foraging habitat, however, this species has potential to forage in the study area on occasion. An AoS has been undertaken for this species.

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<i>Rhipidura rufifrons</i>	Rufous Fantail	~	M, Mar	The Rufous Fantail occurs in coastal and near coastal districts of northern and eastern Australia (DoE 2013b)	the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies (DoE 2013b)	Low	Unlikely	Low	Unlikely	Unlikely
<i>Rostratula australis</i> (syn. <i>Rostratula benghalensis australis</i>)	Australian Painted Snipe	E1	E, Mar	The Australian Painted Snipe has been recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It has been recorded less frequently at a smaller number of more scattered locations farther west in South Australia, the Northern Territory and Western Australia.	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber (OEH 2013b). Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds (<i>ibid.</i>). Breeding is often in response to local conditions; generally occurs from September to December (OEH 2013b). Roosts during the day in dense vegetation (OEH 2013b). Forages nocturnally on mud-flats and in shallow water (OEH 2013b). Feeds on worms, molluscs, insects and some plant-matter (<i>ibid.</i>).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail-bat	V	~	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes.	Found in almost all habitats, from wet and dry sclerophyll forest, open woodland (Churchill 1998), open country, mallee, rainforests, heathland and waterbodies (SFNSW 1995). It roosts in tree hollows and may also use caves. The species has also been recorded in a tree hollow in a paddock (Environment Australia 2000) and in abandoned sugar glider nests (Churchill 1998). It is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats (Environment Australia 2000).	High	Known	High	Known	This species has been recorded in the study area and has potential to forage, roost and breed in the study area. An AoS has been undertaken for this species.
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart	V	~	Throughout much of inland central and northern Australia, extending into central and northern NSW, western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Wyalda and Ashford. (OEH 2013b)	Native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather they shelter in cracks in the soil, in grass tussocks or under rocks and logs (OEH 2013b)	Low	Unlikely	Low	Unlikely	Unlikely

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<i>Stagonopleura guttata</i>	Diamond Firetail	V	~	The Diamond Firetail is endemic to south-eastern Australia, extending from central QLD to the Eyre Peninsula in SA. It is widely distributed in NSW, with a number of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW, and is rare west of the Darling River	Typically found in grassy eucalypt woodlands, but also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities (OEH 2013b). It is often found in riparian areas and sometimes in lightly wooded farmland (OEH 2013b). Appears to be sedentary, though some populations move locally, especially those in the south (OEH 2013b).	High	Known	High	Likely	This species is known in the study region and is likely to forage and breed in the study area. An AoS has been undertaken for this species.
<i>Stictonetta naevosa</i>	Freckled Duck	V	~	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina (OEH 2013b)	This species prefers permanent freshwater swamps and creeks with heavy growth of Typha, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. They generally rest in dense cover during the day in deep water. They feed at dawn and dusk and at night on algae, seeds and aquatic grasses and sedges and small invertebrates. Nesting usually occurs between October and December but can take place at other times when conditions are favourable (OEH 2013b).	Low	Unlikely	No habitat	Unlikely	Unlikely
<i>Tyto longimembris</i>	Eastern Grass Owl	V	~	Eastern Grass Owls have been recorded occasionally in all mainland states of Australia but are most common in northern and north-eastern Australia. In NSW they are more likely to be resident in the north-east. Eastern Grass Owl numbers can fluctuate greatly, increasing especially during rodent plagues (OEH 2013b).	This species is found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. They rest by day in a 'form' - a trampled platform in a large tussock or other heavy vegetative growth. They breeds on the ground and nests are found in trodden grass, and often accessed by tunnels through vegetation OEH 2013b.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Tyto novaehollandiae</i>	Masked Owl	V	~	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within approximately 90% of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. (OEH 2013b)	The species is associated with forest with sparse, open, understorey, typically dry sclerophyll forest and woodland (OEH 2013b) and especially the ecotone between wet and dry forest, and non forest habitat (Environment Australia 2000). The species is known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh & Peake 1993).	High	Known	High	Likely	This species has the potential to forage in the study area. An AoS has been undertaken for this species.
<i>Uvidicolus sphyrurus</i> (syn.	Border Thick-tailed	V	V	The Border Thick-tailed Gecko is found only on the tablelands and slopes of	The Border Thick-tailed Gecko is found in rocky hills with dry open	Low	Unlikely	Low	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Underwoodisaurus sphyrurus</i>	Gecko			northern NSW and southern Queensland, reaching south to Tamworth and west to Moree (OEH 2013b). Most common in the granite country of the New England Tablelands (OEH 2013b).	eucalypt forest or woodland (OEH 2013b). Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter (OEH 2013b).					
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V	~	The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT.	The species inhabits tropical mixed woodland and wet sclerophyll forest on the coast and the dividing range but extend into the drier forest of the western slopes and inland areas (Churchill 1998). It has been found roosting in sandstone overhand caves, boulder piles, mine tunnels and occasionally in buildings (Churchill 1998).	High	Known	High	Likely	This species was possibly recorded in the study area and is likely to forage in the study area. An AoS has been undertaken for this species.

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
FLORA										
<i>Acacia jucunda</i>	Yetman Wattle	E1	~	The Yetman Wattle is found in the Yetman district near the Queensland border on the North West Slopes of NSW. It also occurs in Queensland where it is reasonably common (OEH 2013b).	The Yetman Wattle is mainly restricted to the dry eucalypt forests or woodlands on sandy to sandy-loam soils. It is associated with other species in NSW including, <i>Acacia polybotrya</i> (Western Silver Wattle) and <i>Callitris endlicheri</i> (Black Cypress Pine). The species is known to occur within the Border Rivers – Gwydir CMA area but mostly restricted to the Yetman area.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Bertya opposens</i>	Coolabah Bertya	V	V	Known from scattered sites in NSW including Coolabah, south of Narrabri on the North West Slopes (including Jacks Creek State Forest), Cobar and the North Coast.	Ranges from stony mallee ridges and cypress pine forest on red soils.	Moderate	Known	Low	Unlikely	Unlikely
<i>Boronia granitica</i>	Granite Boronia	V	E	Granite Boronia is known from scattered localities on the New England Tablelands and North West Slopes north from the Armidale area to the Stanthorpe district in southern Queensland	Granite Boronia grows amongst granite outcrops, often in rock crevices, north from Inverell district.	No habitat	No	No habitat	No	Unlikely
<i>Bothriochloa biloba</i>	Lobed Blue-grass	~	V	Woodlands and grasslands on the western slopes and plains of NSW and QLD	Commonly found on clay soils	Low	Unlikely	Low	Unlikely	Unlikely
<i>Cadellia pentastylis</i>	Ooline	V	V	This species occurs along the western edge of the North West Slopes from north of Gunnedah to west of Tenterfield with some records from in Queensland. The natural range of Ooline is from 24°S to 30°S in the 500 to 750 mm per annum rainfall belt.	Ooline occurs in low- to medium-nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Cyperus conicus</i>	A sedge	E1	~	This species occurs rarely in the Pilliga area of NSW and is also found in Victoria, Qld, the NT and WA	The species grows in open woodland on sandy soil. In central Australia, it grows near waterholes and on the banks of streams in sandy soils. In Qld the species is usually found on heavy soils. It has been recorded from Callitris forest in the Pilliga area, growing in sandy soil with <i>Cyperus gracilis</i> , <i>C. squarrosus</i> and <i>C. fulvus</i> .	Moderate	Potential	Low	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Desmodium campylocaulon</i>	Creeping Tick-Trefoil	E1	~	Occurs chiefly in the Collarenebri and Moree districts in the north-western plains of NSW. Also occurs in the NT and Darling Downs district of south-eastern Queensland (OEH 2013b)	In NSW the species grows on cracking black soils in the Narrabri, Moree and Walgett local government areas. It is associated with other species including <i>Acacia harpophylla</i> , <i>Astrebla pectinata</i> and <i>Sorghum</i> , <i>Dichanthium</i> and <i>Panicum</i> species. It flowers summer and autumn (OEH 2013b)	Low	Unlikely	No habitat	No	Unlikely
<i>Dichanthium setosum</i>	Bluegrass	V	V	New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia.	Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Digitaria porrecta</i>	Finger Panic Grass	E1	E	Occurs in NSW and Queensland. In NSW it is found on the North West Slopes and Plains, from near Moree south to Tambar Springs and from Tamworth to Coonabarabran.	Habitat includes native grassland, woodlands or open forest with a grassy understorey, on richer soils.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Diuris tricolor</i>	Painted Diuris	V	~	Sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the far north of NSW.	Grows in sclerophyll forest among grass, often with native Cypress Pine (<i>Callitris spp.</i>). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats.	High	Likely	Moderate	Potential	This species is known in the study region and has potential to occur in the study area. An AoS has been undertaken for this species.
<i>Haloragis exalata</i> subsp. <i>velutina</i>	Tall Velvet Sea-berry	V	V	Disjunctly distributed in the central coast, south coast and north-western slopes botanical subdivisions of NSW	Protected and shaded damp situations in riparian habitats.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Homopholis belsonii</i>	Belson's Panic	E1	V	North from the Warialda district and into Queensland	Habitat and ecology poorly known. Grows in dry woodland (e.g. Belah) on poor soils.	Low	Potential	Low	Unlikely	Unlikely
<i>Lepidium aschersonii</i>	Spiny Peppergrass	V	V	Not widespread, occurring in the marginal central-western slopes and north-western plains regions of NSW (and potentially the south western plains). A several populations recorded at Narrabri. Also known from the West Wyalong, Barmedman and Temora areas.	Found on ridges of gilgai clays dominated by <i>Acacia harpophylla</i> (Brigalow), with <i>Austrodanthonia</i> and/or <i>Austrostipa</i> species in the understorey. The species grows as a component of the ground flora, in grey loamy clays. Vegetation structure varies from open to dense Brigalow, with sparse grassy understorey and occasional heavy litter.	Low	Potential	Low	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Lepidium monoplacoides</i>	Winged Peppergrass	E1	E	Widespread in the semi-arid western plains region of NSW. Recorded in previous ELA survey in Western Pilliga.	Known to occur on seasonally moist to waterlogged sites, on heavy fertile soils. In W Pilliga, it was found in White Cypress Pine - Bullock - ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion vegetation and associated with gilgais.	Moderate	Known	Low	Unlikely	Unlikely
<i>Monotaxis macrophylla</i>	Large-leafed Monotaxis	E1	~	Large-leaf Monotaxis is recorded from several highly disjunct populations in NSW: eastern edge of Deua NP (west of Moruya), Bemboka portion of South East Forests National Park, Cobar area (Hermitage Plains), the Tenterfield area, and Woodenbong (near the Queensland border). It is also in Queensland.	Grows on rocky ridges and hillsides. There is a great diversity in the associated vegetation within NSW (less though in Queensland), encompassing coastal heath, arid shrubland, forests and montane heath from almost sea level to 1300 m altitude.	Moderate	Potential	Low	Unlikely	Unlikely
<i>Myriophyllum implicatum</i>		CE	~	This species was previously thought to be extinct in NSW; however the plant was recently discovered in the Pilliga National Park, south of Narrabri. It is known from QLD and is listed as 'Least Concern' under that States Nature Conservation Act (1992) (OEH 2013b).	The species occurs in moist situations, extending away from fresh water. A recent population was found in NSW in a large open partly inundated gilgai depression on cracking clay soil (OEH 2013b).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Philothea ericifolia</i>		~	V	Upper Hunter Valley and Pilliga to Peak Hill district	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies	Low	Unlikely	Low	Unlikely	Unlikely
<i>Platyzoma microphyllum</i>	Braid Fern	E1	~	Species records exist in NSW only in the Yetman district. However, the species is widespread across northern Australia, from WA to the NT, eastern Qld and just into central-northern NSW (OEH 2013b).	It grows in sandy or swampy soils, or in clay soils adjacent to streams and lagoons and subject to periodic flooding. It has been recorded in NSW at Bruxner Highway growing as one localised patch in deep sandy soil, with <i>Leptospermum</i> species, <i>Brachyloma daphnoides</i> and <i>Lomandra</i> species (OEH 2013b).	Low	Unlikely	Low	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Polygala linariifolia</i>	Native Milkwort	E1	~	Found north from Copeton Dam and the Warialda area to southern QLD; also found on the NSW north coast near Casino and Kyogle, and there is an isolated population in far western NSW near Weebah Gate, west of Hungerford. This species also occurs in Western Australia.	Occurs in sandy soils in dry eucalypt forest and woodland with a sparse understorey. The species has been recorded from the Inverell and Torrington districts growing in dark sandy loam on granite in shrubby forest of <i>Eucalyptus caleyi</i> , <i>Eucalyptus dealbata</i> and <i>Callitris</i> , and in yellow podsolic soil on granite in layered open forest.	High	Known	High	Known	This species is known in the study region and is recorded in the study area during previous surveys. An AoS has been undertaken for this species.
<i>Pomaderris queenslandica</i>	Scant Pomaderris	E1	~	Records are widely scattered, but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast.	The species is found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Moderate	Known	Low	Unlikely	Unlikely
<i>Prasophyllum</i> sp. <i>Wybong</i> (C.Phelps ORG 5269)	a leek-orchid	~	CE	Endemic to NSW. It is known from seven populations in eastern NSW near Ilford, Premer, Muswellbrook, Wybong, Yeoval, Inverell and Tenterfield	Known to occur in open eucalypt woodland and grassland	Low	Unlikely	Low	Unlikely	Unlikely
<i>Pterostylis cobarensis</i>	Greenhood Orchid	V	V	It is known chiefly from the Nyngan-Cobar-Bourke district in the far western plains of New South Wales. Recorded districts include Narrabri, Nyngan, Cobar, Nymagee, Mt Gundabooka, Mt Grenfell and Mutawintji National Park. There are also records from the Darling Downs district of Queensland.	The Greenhood Orchid is found in Eucalypt woodlands, open mallee or <i>Callitris</i> shrublands on low stony ridges and slopes in skeletal sandy-loam soils.	High	Known	High	Known	This species is known in the study area. An AoS has been undertaken for this species.
<i>Pultenaea setulosa</i>	Stony Bush-pea	~	V	Slopes and tablelands of NSW	Dry sclerophyll forest	Low	Unlikely	Low	Unlikely	Unlikely
<i>Rulingia procumbens</i>		V	V	The species is endemic to NSW and mainly confined to the Dubbo-Mendooran-Gilgandra region, but also in the Pilliga and Nymagee areas.	It grows in sandy sites, often along roadsides. Recorded in <i>Eucalyptus dealbata</i> and <i>E. sideroxylon</i> communities, <i>Melaleuca uncinata</i> scrub, under mallee eucalypts with a <i>Calytrix tetragona</i> understorey, and in a recently burnt Ironbark and <i>Callitris</i> area. It also occurs in <i>E. fibrosa</i> subsp. <i>nubila</i> , <i>E. dealbata</i> , <i>E. albens</i> and <i>Callitris glaucophylla</i> woodlands north of Dubbo.	High	Known	Moderate	Unlikely	Unlikely

Scientific name	Common name	TSC Act	EPBC Act	Distribution	Habitat	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in the study area	Likelihood of occurrence in the study area	Potential for impact by proposal
<i>Sida rohlenae</i>	Shrub Sida	E1	~	It has a limited distribution in QLD, the NT, SA and WA. In NSW it has been recorded south of Enngonia, south of Bourke and north-west of Coonamble	It occurs in flood-out areas, creek banks and at the base of rocky hills. NSW specimens have been found along roadsides in hard red loam to sandy-loam soils.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Swainsona murrayana</i>	Slender Darling Pea	V	V	The species is found throughout NSW. 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.	The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. 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.	Low	Unlikely	Low	Unlikely	Unlikely
<i>Thesium australe</i>	Austral Toadflax	V	V	Small populations are scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia.	Austral Toadflax occurs in grassland or grassy woodland and often found in damp sites in association with <i>Themeda australis</i> (Kangaroo Grass).	Low	Unlikely	Low	Unlikely	Unlikely
<i>Tylophora linearis</i>	-	V	E	The species is found in the Barraba, Mendooran, Temora and West Wyalong districts in the northern and central western slopes of NSW.	It grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of <i>Eucalyptus fibrosa</i> , <i>E. sideroxylon</i> , <i>E. albens</i> , <i>Callitris endlicheri</i> , <i>C. glaucophylla</i> and <i>Allocasuarina luehmannii</i> .	High	Known	High	Known	This species is known in the study area. An AoS has been undertaken for this species.

Table 20: Endangered Ecological Communities likelihood of occurrence within the north-east Pilliga Forest and study area

Threatened ecological community	TSC Act	EPBC Act	Description	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in study area	Likelihood of occurrence in study area	Potential for impact by the proposed activity
ENDANGERED ECOLOGICAL COMMUNITIES								
<u>TSC</u> : Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions <u>EPBC</u> : Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)	E	E	The ecological community is a low woodland or forest community dominated by <i>Acacia harpophylla</i> (Brigalow), with pockets of <i>Casuarina cristata</i> (Belah) and <i>Eucalyptus populnea</i> subsp. <i>bimbil</i> (Poplar Box). The canopy tends to be quite dense and the understorey and ground cover are only sparse. It is found in the Brigalow Belt South Bioregion in NSW and as isolated occurrences in the Darling Riverine Plains and Nandewar Bioregions.	Low	Known to occur to on the northern edge of the Pilliga Forest	Not observed within study area	No	Unlikely
<i>Cadellia pentastylis</i> (Ooline) community in the Nandewar and Brigalow Belt South Bioregions	V	~	The Ooline community is an unusual and distinctive forest community with the canopy dominated by the tree <i>Cadellia pentastylis</i> (Ooline). Other canopy species include <i>Eucalyptus albens</i> (White Box), <i>E. beyeriana</i> and <i>E. melanophloia</i> , <i>E. chloroclada</i> (Dirty Gum), <i>E. pilligaensis</i> (Narrow-leaved Grey Box), <i>E. viridis</i> (Green Mallee) and <i>Callitris glaucophylla</i> (White Cypress Pine). The understorey is made up of a range of shrubs such as wattles and grasses. It is now known from only seven main locations on the North West Slopes in NSW, between Narrabri and the Queensland border, and also in Queensland.	Low	Unlikely, not known within north-east Pilliga Forest	Not observed within study area	No	Unlikely
<u>TSC</u> : Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion <u>EPBC</u> : Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	E	E	Represents occurrences of one type of semi-arid to humid subtropical woodland where <i>Eucalyptus coolabah</i> subsp. <i>coolabah</i> (Coolibah) and/or <i>Eucalyptus largiflorens</i> (Black Box) are the dominant canopy species and where the understorey tends to be grassy. 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. The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions.	Low	Unlikely, known to occur on the floodplain of the Namoi River	Not observed within study area	No	Unlikely
<u>TSC</u> : Myall Woodlands in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW south western slopes bioregions <u>EPBC</u> : Weeping Myall Woodlands	E	E	Occurs on red-brown earths and heavy textured grey and brown alluvial soils where annual rainfall is in the range 375 and 500 mm. The structure can varies from low woodland and low open woodland to low sparse woodland or open shrubland. 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. The understorey includes an open layer of chenopod shrubs and other woody plant species and an open to continuous groundcover of grasses and herbs. The shrub stratum may have been reduced by clearing or heavy grazing. It is scattered across the eastern parts of alluvial plains of the Murray-Darling river system.	Low	Unlikely, known to occur on the Liverpool Plains	Not observed within study area	No	Unlikely
<u>TSC</u> : White Box Yellow Box Blakely's Red Gum Woodland <u>EPBC</u> : White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	E	CE	The community has an overstorey dominated, or was once dominated by <i>Eucalyptus albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) or <i>E. blakelyi</i> (Blakely's Red Gum) trees. It is characterised by a species-rich understorey of native tussock grasses, herbs and forbs. In the Nandewar Bioregion, <i>E. microcarpa</i> or <i>E. moluccana</i> may also be dominant or co-dominant. The tree-cover is generally discontinuous and consists of widely-spaced trees of medium height in which the canopies are clearly separated. The shrub layer can be non-existent. In NSW the community is found from the Queensland border in the north, to the Victorian border in the south along the tablelands and western slopes areas.	Low	Potential, the potential presence of this community in the Pilliga Forest requires further consideration against the final determination based on floristic, structural and soil characteristics	Not observed within study area	No	Unlikely

Threatened ecological community	TSC Act	EPBC Act	Description	Availability of habitat in the north-east pilliga forest	Likelihood of occurrence in the north-east pilliga forest	Availability of habitat in study area	Likelihood of occurrence in study area	Potential for impact by the proposed activity
Fuzzy Box Woodland on alluvial soils of the south western slopes, Darling Riverine Plains and Brigalow Belt South bioregions	E	~	The community is a tall woodland or open forest usually dominated by <i>Eucalyptus conica</i> (Fuzzy Box), which often grows with <i>E. microcarpa</i> (Inland Grey Box), <i>E. melliodora</i> (Yellow Box) or <i>Brachychiton populneus</i> (Kurrajong). <i>Allocasuarina luehmannii</i> (Buloke) is common in places. Shrubs are generally sparse and the ground cover moderately dense, but this can change with the season. It is found on the alluvial soils of the South West Slopes, Brigalow Belt South and Darling Riverine Plains Bioregions (mainly in the Dubbo-Narromine-Parkes-Forbes area).	Moderate	Known to occur on the floodplain of Bohena Creek and major tributaries	Not observed within study area	No	Unlikely
<u>TSC</u> : Inland Grey Box Woodland in the Riverina, NSW south western slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions <u>EPBC</u> : Grey Box (<i>Eucalyptus microcarpa</i>) Grassy Woodlands and Derived Native Grasslands of south-eastern Australia	E	E	The community is a woodland dominated by <i>Eucalyptus microcarpa</i> (Inland Grey Box). It is often found in association with <i>E. populnea</i> subsp. <i>bimbil</i> , <i>Callitris glaucophylla</i> (White Cypress Pine), <i>Brachychiton populneus</i> (Kurrajong), <i>Allocasuarina luehmannii</i> (Bullock) or <i>E. melliodora</i> (Yellow Box), and sometimes with <i>E. albens</i> (White Box). It occurs in landscapes of low-relief such as flat to undulating plains, low slopes and rises and, to a lesser extent, drainage depressions and flats. The ecological community may extend to more elevated hillslopes on the fringes of its range where it intergrades with other woodland or dry sclerophyll forest communities. In NSW the community principally occurs within the Riverina and South West Slopes Bioregions and is also found in portions of the Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions.	Low	Unlikely	Not observed within study area	No	Unlikely
<u>TSC</u> : Native Vegetation on Cracking Clay Soils of the Liverpool Plains <u>EPBC</u> : Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	E	CE	The ecological community is mainly a native grassland community containing a range of small forb and herb species, but can be found with scattered / patchy shrubs and trees. The main grass species include <i>Austrostipa aristiglumis</i> (Plains Grass), <i>Dichanthium sericeum</i> (Queensland Bluegrass) and <i>Panicum queenslandicum</i> (Coolibah Grass). It occurs on flat to low slopes, of no more than 5 percent (or less than 1 degree) inclination. As slope increases, grassy woodlands dominated by trees such as <i>Acacia pendula</i> (Weeping Myall), <i>Eucalyptus coolabah</i> (Coolabah), <i>E. populnea</i> (Poplar Box) or <i>E. melliodora</i> (Yellow Box) occur. The ground layer component of these woodlands may be similar to the grassland but the soils will not be the same cracking clays as on the plains.	Low	Unlikely, known to occur on the Liverpool Plains	Not observed within study area	No	Unlikely
<u>TSC</u> : Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions <u>EPBC</u> : Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	E	E	The community is 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. The main canopy is dominated by rainforest species such as <i>Cassine australis</i> var. <i>angustifolia</i> (Red Olive Plum), <i>Geijera parvifolia</i> (Wilga), <i>Notelaea microcarpa</i> var. <i>microcarpa</i> (Native Olive) and <i>Ehretia membranifolia</i> (Peach Bush), with taller eucalypts and cypress pines from surrounding woodland vegetation emerging above the main canopy. <i>Carissa ovata</i> (Currant Bush) is often present and typical vines include <i>Parsonsia eucalyptophylla</i> (Gargaloo) and <i>Pandorea pandorana</i> (Wonga Vine). It has a scattered distribution near Gunnedah, Barraba, Bingara and north of Wyallda on the NSW North West Slopes and Plains, and also in Queensland.	Low	Unlikely	Not observed within study area	No	Unlikely
Marsh Club-rush sedgeland in the Darling Riverine Plains Bioregion	CE	~	The community is dominated by <i>Bolboschoenus fluviatilis</i> (Marsh Club-rush), which forms dense stands up to 2 m tall. The community is further characterised by an understorey including <i>Carex appressa</i> (Tussock Sedge), <i>Eleocharis plana</i> (Ribbed Spike Rush), <i>Lachnagrostis filiformis</i> (Blown Grass), <i>Paspalum distichum</i> (Water Couch) and <i>Ranunculus undosus</i> (Swamp Buttercup). It is distinguished from other surrounding communities by a lack of trees and the dominance of <i>Bolboschoenus fluviatilis</i> (generally over 40% of the vegetation cover) although the structure may vary depending on past disturbance. The community is associated with grey clay soils usually with a surface layer of organic matter several centimetres thick. The community has a very fragmented distribution and is mainly restricted to the Gwydir wetlands but may occur elsewhere in the Darling Riverine Plains Bioregion.	Low	Unlikely	Not observed within study area	No	Unlikely

Appendix B: Vegetation survey results

Flora species recorded within the study area

1. Families are group under the headings 1. Pteridophytes, 2. Gymnosperms, 3. Dicotyledons, 4. Monocotyledons.
2. An '*' before species indicates exotic species
3. A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons.
4. Not all species can be accurately identified to species level due to absence of flowering or fruiting material.
5. Cover Abundance (C-A) + = few, small cover (<5%), r = solitary, small cover (<5%), 1 = numerous (<5%), 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = >75%
6. Species in **bold** are listed under the TSC Act or EPBC Act

Family	Species	Common name	Plot			
			Dewhurst 13-18	Dewhurst 30	Dewhurst 31	Meander
1. Pteridophytes						
Sinopteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Rock Fern	1	+	+	
2. Gymnosperms						
Cupressaceae	<i>Callitris endlicheri</i>	Black Cypress-pine			r	

Family	Species	Common name	Plot			
			Dewhurst 13-18	Dewhurst 30	Dewhurst 31	Meander
	<i>Callitris glaucophylla</i>	White Cypress-pine	1	1	r	
3. Dicotyledons						
Apiaceae	<i>Platysace lanceolata</i>	Lance-leaf Platysace			1	
Apocynaceae	<i>Tylophora linearis</i>					r
Asteraceae	<i>Brachyscome multifida</i> var. <i>multifida</i>	Cut-leaf Daisy	+			
	<i>Calotis cuneifolia</i>	Purple Burr-daisy		r		
	<i>Cassinia arcuata</i>	Sifton Bush, Chinese-shrub	+	+	1	
	<i>Centipeda cunninghamii</i>	Common Sneezeweed	+			
	<i>Epaltes australis</i>	Spreading Nut-heads	+			
	<i>Euchiton sphaericus</i>		+			
	* <i>Hypochaeris radicata</i>	Catsear, False Dandelion	r			
	* <i>Sonchus oleraceus</i>	Common Sow-thistle, Milk-thistle	r			
Cactaceae	* <i>Opuntia stricta</i>	Prickly Pear, Common Pest Pear	+			
Campanulaceae	<i>Wahlenbergia</i> sp. (unidentified)	Australian Bluebell	r			
Casuarinaceae	<i>Allocasuarina luehmannii</i>	Bulloak	2	1	r	
Chenopodiaceae	<i>Einadia nutans</i>	Climbing Saltbush		r		
Clusiaceae	<i>Hypericum gramineum</i>	Small St Johns-wort	+			
Dilleniaceae	<i>Hibbertia obtusifolia</i>	Guinea-flower			r	
Droseraceae	<i>Drosera peltata</i>	Pale Sundew	+			
Ericaceae - Styphelioideae	<i>Leucopogon muticus</i>	Blunt Beard-heath	+			
	<i>Lissanthe strigosa</i>	Peach Heath		r	+	
	<i>Melichrus urceolatus</i>	Urn Heath	r	+		

Family	Species	Common name	Plot			
			Dewhurst 13-18	Dewhurst 30	Dewhurst 31	Meander
Fabaceae Faboideae	<i>Daviesia acicularis</i>	Sandplain Bitter-pea			1	
	<i>Glycine clandestina</i>	Twining Glycine	+			
	<i>Pultenaea foliolosa</i>			r	2	
	<i>Templetonia stenophylla</i>	Leafy Templetonia		r		
Fabaceae Mimosoideae	<i>Acacia caroleae</i>				1	
	<i>Acacia deanei</i> subsp. <i>deanei</i>	Green Wattle, Deane's Wattle	1	+		
	<i>Acacia pravifolia</i>	Coil-pod Wattle		1		
	<i>Acacia spectabilis</i>	Mudgee Wattle	+	r		
Goodeniaceae	<i>Brunonia australis</i>	Blue Pincushion	+	+		
	<i>Goodenia cycloptera</i>	Serrated Goodenia		+		
	<i>Goodenia macbarronii</i>		1			
	<i>Goodenia rotundifolia</i>			+	1	
Haloragaceae	<i>Haloragis heterophylla</i>	Raspwort	1			
	<i>Haloragis</i> sp. (unidentified)				r	
Myrtaceae	<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	+	2	2	
	<i>Homoranthus flavescens</i>				+	
	<i>Melaleuca uncinata</i>	Broom Honey myrtle			+	
	<i>Micromyrtus sessilis</i>				r	
Polygalaceae	<i>Polygala linariifolia</i>					r
Primulaceae	* <i>Anagallis arvensis</i>	Pimpernel	+			
Proteaceae	<i>Persoonia sericea</i>				r	
Rubiaceae	<i>Pomax umbellata</i>	Pomax	r			

Family	Species	Common name	Plot			
			Dewhurst 13-18	Dewhurst 30	Dewhurst 31	Meander
Sapindaceae	<i>Dodonaea heteromorpha</i>	Propellor Bush		1		
Stackhousiaceae	<i>Stackhousia muricata</i>			+		
4. Monocotyledons						
Anthericaceae	<i>Laxmannia gracilis</i>	Slender Wire Lily	+	+		
Cyperaceae	<i>Carex inversa</i>	Knob Sedge	1			
	<i>Cyperus fulvus</i>	Sticky Sedge	+			
	<i>Fimbristylis dichotoma</i>		1			
	<i>Gahnia aspera</i>	Rough-leaved Saw-sedge	+	1	1	
Juncaceae	<i>Juncus</i> sp. (unidentified)	Rush	1			
Lomandraceae	<i>Lomandra filiformis</i> subsp. <i>filiformis</i>	Wattle Mat-rush			1	
	<i>Lomandra leucocephala</i> subsp. <i>leucocephala</i>	Woolly-head Mat-rush			+	
	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush, Honey Reed, Spike Mat-rush	+			
	<i>Lomandra multiflora</i>	Many-flowered Mat-rush	+	1	1	
	<i>Lomandra multiflora</i> (terete form)	Many-flowered Mat-rush		r		
Orchidaceae	<i>Caladenia fuscata</i>	Dusky Fingers	r			
	<i>Cyanicula caerulea</i>	Blue Fairy, Blue Caladenia	r	+	+	
	<i>Pterostylis mutica</i>	Midget Greenhood		+		
	<i>Pterostylis cobarensis</i>	Greenhood Orchid		r		+
Phormiaceae	<i>Dianella longifolia</i>	Smooth Flax-lily	+			
	<i>Dianella revoluta</i>	Blue Flax-lily, Spreading Flax-lily	r	r	+	
Poaceae	<i>Aristida caput-medusae</i>	Many-headed Wiregrass	+			

Family	Species	Common name	Plot			
			Dewhurst 13-18	Dewhurst 30	Dewhurst 31	Meander
	<i>Aristida jerichoensis</i> var. <i>jerichoensis</i>	Jericho Wiregrass	+	1	2	
	<i>Aristida ramosa</i>	Purple Wiregrass	r		2	
	<i>Aristida</i> sp.	Wiregrass	+			
	<i>Austrodanthonia</i> sp.	Wallaby Grass		+		
	<i>Austrostipa setacea</i>	Corkscrew Grass		1		
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	+			
	<i>Digitaria breviglumis</i>		+			
	<i>Digitaria diffusa</i>		r		+	
	<i>Enteropogon acicularis</i>	Curly Windmill Grass		+		
	<i>Eragrostis brownii</i>	Brown's Lovegrass	+		r	
	<i>Eragrostis lacunaria</i>	Purple Lovegrass	+	+		
	<i>Microlaena stipoides</i>	Meadow Rice-grass, Weeping Grass	+		+	
	<i>Panicum decompositum</i>	Native Millet	2			
	<i>Panicum simile</i>	Two-colour Panic	+	+		
	<i>Paspalidium gracile</i>	Slender Panic	+			

Biometric Plot Data**Dewhurst 13-18**

Stratum	Growth form	Species name	Cover (%)	Height to crown (m)		
				min	avg	max
Upper	M	<i>Allocasuarina luehmannii</i>	15	2	10	12
Upper	M	<i>Callitris glaucophylla</i>	5	9	10	10
Mid	M	<i>Allocasuarina luehmannii</i>	2	2	3	4
Mid	M	<i>Acacia deanei</i>	2	2	3	4
Ground	G	<i>Panicum decompositum</i>	10		0.3	

Site	NPS	NOS	NMS	NGCG	NGCS	NGCO	Litter	Bare	Cryptogam	EPC	NTH	OR	FL	Site Value	Long	Lat
Dewhurst 13-18	46	5.5	12	20	4	8	72	1	0	0	0	0.5	67	62	764824	6617337

Dewhurst 30

Stratum	Growth form	Species name	Cover (%)	Height to crown (m)		
				min	avg	max
Upper	T	<i>Eucalyptus crebra</i>	15	8	18	20
Upper						
Mid	M	<i>Allocasuarina luehmannii</i>	2.5	1	5	10
Mid	M	<i>Callitris glaucophylla</i>	5	2	5	10
Ground	S	<i>Acacia pravifolia</i>	2		0.5	
Ground	O	<i>Lomandra multiflora</i>			0.5	

Site	NPS	NOS	NMS	NGCG	NGCS	NGCO	Litter	Bare	Cryptogam	EPC	NTH	OR	FL	Site Value	Long	Lat
Dewhurst 30	33	6	7.5	0	4	4	84	6	10	0	1	1	109	78	755378	6600368

Dewhurst 31

Stratum	Growth form	Species name	Cover (%)	Height to crown (m)		
				min	avg	max
Upper	T	<i>Eucalyptus crebra</i>	15	6	15	16
Upper						
Mid	M	<i>Acacia caroleae</i>	2	1	2	3
Mid						
Ground	S	<i>Pultenaea foliolosa</i>	20		1	
Ground	G	<i>Aristida jerichoensis</i>	10		0.3	

Site	NPS	NOS	NMS	NGCG	NGCS	NGCO	Litter	Bare	Cryptogam	EPC	NTH	OR	FL	Site Value	Long	Lat
Dewhurst 31	29	13.2	2.7	10	31	6	54	2	0	0	0	1	48	50	754747	6599519

Appendix C: HBT survey details

ID	Tree_SP	DBH_CM	Less_5CM	5CM_15CM	15CM_30CM	Over_30CM	BASAL	SPOUT	Tree_NO	Easting	Northing
91	stag	80	2	3	0	0	0	0	103	754771	6599517
91	<i>E. crebra</i>	40	2	0	0	0	0	0	102	754789	6599542
93	<i>E. crebra</i>	40	3	1	0	0	0	0	104	754811	6599543
89	<i>E. crebra</i>	40	2	0	0	0	0	0	100	754724	6599547
94	stag	50	3	0	3	0	0	0	105	754814	6599564
90	<i>E. crebra</i>	40	2	0	0	0	0	0	101	754768	6599571
96	<i>E. crebra</i>	30	1	0	0	0	0	0	109	754609	6599590
98	<i>E. crebra</i>	120	0	2	0	0	0	1	111	754560	6599644
99	<i>E. crebra</i>	60	3	0	0	0	0	0	112	754551	6599647
67	<i>E. crebra</i>	30	2	0	0	0	0	0	70	755353	6600299
66	<i>E. crebra</i>	60	3	0	0	0	0	0	69	755393	6600304
64	<i>E. crebra</i>	40	0	1	0	1	0	0	67	755401	6600307
65	<i>E. crebra</i>	40	3	1	0	0	10	0	68	755396	6600313
63	<i>E. crebra</i>	30	0	1	0	0	0	1	66	755428	6600317
62	<i>E. crebra</i>	40	1	0	0	1	0	1	65	755425	6600321
61	<i>E. crebra</i>	60	5	3	0	0	0	0	64	755430	6600325
407	stag	90	0	2	1	0	0	0	425	755253	6600328
68	<i>E. crebra</i>	40	1	0	0	0	0	0	71	755360	6600337

ID	Tree_SP	DBH_CM	Less_5CM	5CM_15CM	15CM_30CM	Over_30CM	BASAL	SPOUT	Tree_NO	Easting	Northing
70	<i>E. crebra</i>	20	2	0	0	0	0	0	73	755377	6600338
69	<i>E. crebra</i>	60	4	2	0	0	0	0	72	755376	6600338
70	<i>E. crebra</i>	70	2	0	1	1	0	0	74	755390	6600339
71	<i>E. crebra</i>	100	4	1	0	0	0	0	75	755426	6600348
75	<i>E. crebra</i> dead	50	3	0	1	0	0	1	79	755356	6600357
76	stag	20	1	0	0	0	0	1	81	755349	6600365
73	stag	30	2	1	0	0	0	0	77	755416	6600375

Appendix D: Anabat detector results

Dewhurst 13 – 18 and 30 - 31: 10 Anabat nights 26 – 28 August 2013

Bat calls were analysed using the program AnalookW (Version 3.8 25 October 2012, written by Chris Corben, www.hoarybat.com). Call identifications were made using regional based guides to the echolocation calls of microbats in New South Wales (Pennay et al. 2004); and south-east Queensland and north-east New South Wales (Reinhold et al. 2001) and the accompanying reference library of over 200 calls from north-eastern NSW. Available: (<http://www.forest.nsw.gov.au/research/bats/default.asp>).

Bat calls are analysed using species-specific parameters of the call profile such as call shape, characteristic frequency, initial slope and time between calls (Reinhold et al. 2001). To ensure reliable and accurate results the following protocols (adapted from Lloyd et al. 2006) were followed:

Search phase calls were used in the analysis, rather than cruise phase calls or feeding buzzes (McKenzie et al. 2002).

- Recordings containing less than three pulses were not analysed and these sequences were labeled as short (Law et al. 1999).
- Four categories of confidence in species identification were used (Mills et al. 1996):
 - o Definite – identity not in doubt.
 - o Probable – low probability of confusion with species of similar calls.
 - o Possible – medium to high probability of confusion with species with similar calls.
 - o Unidentifiable – calls made by bats which cannot be identified to even a species group.
- *Nyctophilus* spp. are difficult to identify confidently from their calls and no attempt was made to identify this genus to species level (Pennay et al. 2004).
- Sequences not attributed to microbat echolocation calls were labeled as junk or non-bat calls and don't represent microbat activity at the subject site.
- Sequences labelled as low were of poor quality and therefore not able to be identified to any microbat species, they can however be used as an indicator of microbat activity at the subject site.

The calls of *Chalinolobus gouldii*, *Mormopterus planiceps* (species 4) long penis form (South-eastern Freetail Bat), *Mormopterus planiceps* (species 3) short penis form (Inland Freetail Bat) and *Scotorepens balstoni* can be difficult to separate. Calls were identified as M. sp 4 if the call shape was flat and the frequency was between 26 – 30.5 kHz and as M. sp 3 if the call shape was flat and the frequency was between 31 – 36 kHz. *C. gouldii* was distinguished by alternation in call frequency between pulses. *S. balstoni* was identified by a curved shape to the call, a greater slope to the call compared with M. sp 3 and a frequency of the knee lower than 37 kHz. When no distinguishing characteristics were present calls may have been identified as belonging to either two or three possible species (e.g. *C. gouldii* / M. sp 3).

Falsistrellus tasmaniensis (Eastern Falsistrelle) was identified and calls were widespread across most subject sites. However all calls were assigned a low certainty level (possible) despite many calls having characteristics that could not be attributed to other species because this species has not been recorded at this location, nor within excess of 50 km despite significant survey effort over time. The nearest

records are from Coolah Tops, 75 km to the south-east. Coolah Tops retains a connection to the Pilliga through the Warrumbungle Range so it is possible that the calls were made by *F. tasmaniensis*. However, due to the paucity of reference calls for this species and other similar species, it is also possible that the calls were made by any of the more common species in the *Scotorepens* genus calling in a way that has not been captured in reference calls (see below).

The calls of *F. tasmaniensis*, *Scoteanax rueppellii* (Greater Broad-nosed Bat), *Scotorepens greyii* (Little Broad-nosed Bat) *Scotorepens orion* (Eastern Broad-nosed Bat) and *S. sp* (Central-eastern Broad-nosed Bat) can be difficult to separate in this geographic region as their call frequencies and some other call characteristics overlap falling between 32 and 40 kHz. Calls were only positively identified when defining characteristics were present such as call shape and when the characteristic frequency allowed discrimination of a species. There were a significant number of calls that it was not possible to identify to species and they remain grouped together in groups of two or three potential species depending on recorded characteristics.

The calls of *Miniopterus schreibersii oceanensis* are difficult to separate from *Vespadelus vulturnus* in this geographic region, both falling between 43 and 48 kHz. *M. schreibersii oceanensis* was identified using the following criteria; the pulse shape and time between pulses was irregular, the calls had a downward sweeping tail, the pre-characteristic section was longer with a drop of more than 2 kHz from the knee to the characteristic section.

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 31	26/08/2013	<i>Miniopterus schreibersii oceanensis</i>	9	1	7	1
Dewhurst 31	26/08/2013	<i>Miniopterus schreibersii oceanensis</i> / <i>Vespadelus vulturnus</i>	1	1	0	0
Dewhurst 31	26/08/2013	<i>Nyctophilus</i> sp	1	1	0	0
Dewhurst 31	26/08/2013	<i>Scotorepens</i> sp / <i>Scotorepens greyii</i> / <i>Falsistrellus tasmaniensis</i>	1	1	0	0
Dewhurst 31	26/08/2013	<i>Vespadelus vulturnus</i>	31	18	6	7
Dewhurst 31	26/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	3	3	0	0
Dewhurst 31	26/08/2013	low	30			
Dewhurst 31	26/08/2013	short	39			
		Total sequences	115			
		Total Id'ed	46			
Dewhurst 31	27/08/2013	<i>Chalinolobus gouldii</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Chalinolobus picatus</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Falsistrellus tasmaniensis</i>	29	0	29	0
Dewhurst 31	27/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens orion</i>	13	13	0	0
Dewhurst 31	27/08/2013	<i>Miniopterus schreibersii oceanensis</i>	15	6	3	6
Dewhurst 31	27/08/2013	<i>Mormopterus</i> sp4	4	4	0	0

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 31	27/08/2013	<i>Scotorepens orion</i> / <i>Scotorepens greyii</i> / <i>Falsistrellus tasmaniensis</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens balstoni</i>	5	5	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens balstoni</i> / <i>Chalinolobus gouldii</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens orion</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens orion</i> / <i>Falsistrellus tasmaniensis</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens orion</i> / <i>Scoteanax rueppellii</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens orion</i> / <i>Scoteanax rueppellii</i> / <i>Falsistrellus tasmaniensis</i>	2	2	0	0
Dewhurst 31	27/08/2013	<i>Vespadelus vulturnus</i>	24	14	10	0
Dewhurst 31	27/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	9	9	0	0
Dewhurst 31	27/08/2013	low	37			
Dewhurst 31	27/08/2013	short	36			
		Total sequences	181			
		Total Id'ed	108			
Dewhurst 31	26/08/2013	<i>Chalinolobus gouldii</i>	52	51	0	1
Dewhurst 31	26/08/2013	<i>Falsistrellus tasmaniensis</i>	20	0	20	0
Dewhurst 31	26/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens greyii</i> / <i>Scotorepens sp</i>	1	1	0	0

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 31	26/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens orion</i>	1	1	0	0
Dewhurst 31	26/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scoteanax rueppellii</i> / <i>Scotorepens orion</i>	1	1	0	0
Dewhurst 31	26/08/2013	<i>Miniopterus schreibersii oceanensis</i>	5	4	1	0
Dewhurst 31	26/08/2013	<i>Nyctophilus</i> sp	1	0	1	0
Dewhurst 31	26/08/2013	<i>Scotorepens balstoni</i>	2	1	0	1
Dewhurst 31	26/08/2013	<i>Vespadelus vulturnus</i>	14	14	0	0
Dewhurst 31	26/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	5	5	0	0
Dewhurst 31	26/08/2013	<i>Vespadelus vulturnus</i>	5	0	3	2
Dewhurst 31	26/08/2013	low	11			
Dewhurst 31	26/08/2013	short	12			
		Total sequences	130			
		Total Id'ed	107			
Dewhurst 31	27/08/2013	<i>Chalinolobus gouldii</i>	91	87	3	1
Dewhurst 31	27/08/2013	<i>Chalinolobus gouldii</i> / <i>Scotorepens balstoni</i>	2	2	0	0
Dewhurst 31	27/08/2013	<i>Chalinolobus picatus</i>	3	1	2	
Dewhurst 31	27/08/2013	<i>Falsistrellus tasmaniensis</i>	50	0	50	0
Dewhurst 31	27/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens orion</i>	1	1	0	0
Dewhurst 31	27/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens</i> sp	4	4	0	0

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 31	27/08/2013	<i>Miniopterus schreibersii oceanensis</i>	48	45	0	3
Dewhurst 31	27/08/2013	<i>Mormopterus</i> sp4	4	3	0	1
Dewhurst 31	27/08/2013	<i>Nyctophilus</i> sp	12	12	0	0
Dewhurst 31	27/08/2013	<i>Scotorepens balstoni</i>	9	9	0	0
Dewhurst 31	27/08/2013	<i>Vespadelus vulturnus</i>	11	10	1	0
Dewhurst 31	27/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	3	3	0	0
Dewhurst 31	27/08/2013	low	10			
Dewhurst 31	27/08/2013	short	20			
		Total sequences	268			
		Total Id'ed	238			
Midway 30 & 31	26/08/2013	<i>Chalinolobus gouldii</i>	77	72	4	1
Midway 30 & 31	26/08/2013	<i>Chalinolobus gouldii</i> / <i>Mormopterus</i> sp3	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Chalinolobus gouldii</i> / <i>Mormopterus</i> sp4	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Chalinolobus gouldii</i> / <i>Scotorepens balstoni</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Chalinolobus gouldii</i> / <i>Scotorepens balstoni</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Chalinolobus morio</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Falsistrellus tasmaniensis</i>	11	0	11	0
Midway 30 & 31	26/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens orion</i>	1	1	0	0

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Midway 30 & 31	26/08/2013	<i>Miniopterus schreibersii oceanensis</i> / <i>Vespadelus vulturnus</i>	2	2	0	0
Midway 30 & 31	26/08/2013	<i>Miniopterus schreibersii oceanensis</i>	1	0	1	0
Midway 30 & 31	26/08/2013	<i>Mormopterus</i> sp3	2	2	0	0
Midway 30 & 31	26/08/2013	<i>Mormopterus</i> sp4	5	4	1	0
Midway 30 & 31	26/08/2013	<i>Mormopterus</i> sp4 / <i>Chalinolobus gouldii</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Mormopterus</i> sp4/ <i>Mormopterus</i> sp3	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Nyctophilus</i> sp	6	6	0	0
Midway 30 & 31	26/08/2013	<i>Scotorepens balstoni</i>	12	12	0	0
Midway 30 & 31	26/08/2013	<i>Scotorepens greyii</i> / <i>Scotorepens</i> sp	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Scotorepens greyii</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Scotorepens orion</i> / <i>Scotorepens greyii</i>	1	1	0	0
Midway 30 & 31	26/08/2013	<i>Scoteanax rueppellii</i>	2	0	2	0
Midway 30 & 31	26/08/2013	<i>Vespadelus vulturnus</i>	79	74	3	2
Midway 30 & 31	26/08/2013	low	26			
Midway 30 & 31	26/08/2013	short	101			
		Total sequences	335			

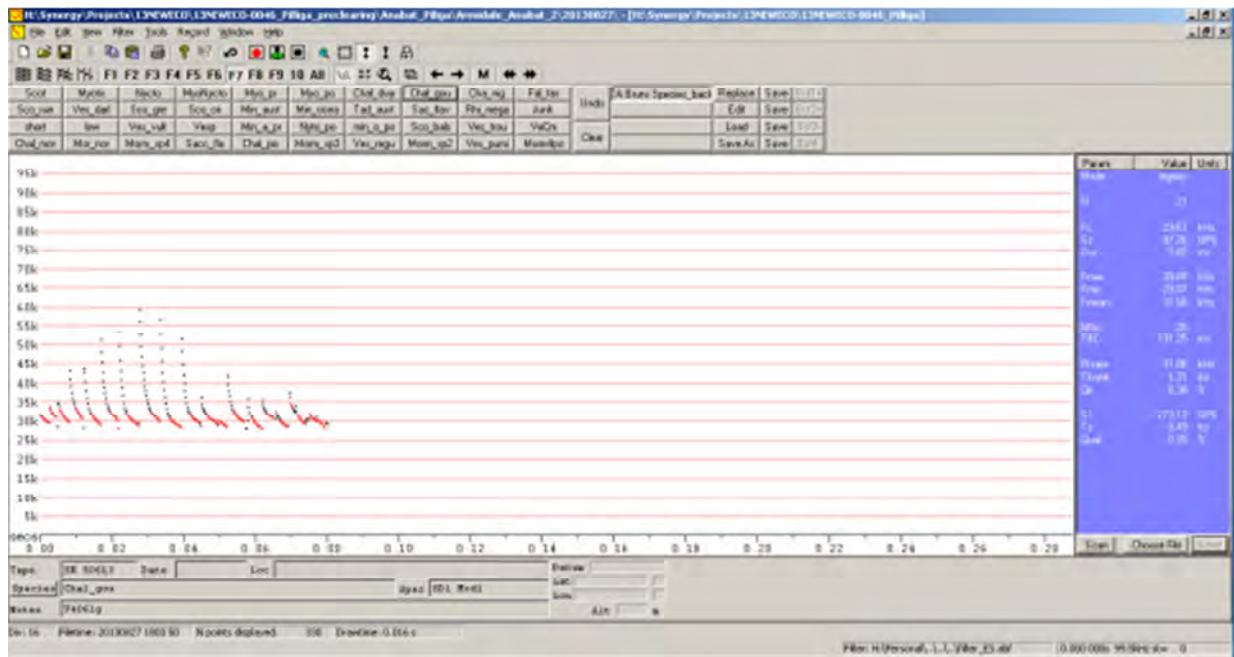
Site name	Night	Species name	Number of calls	Definite	Possible	Probable
		Total Id'ed	208			
Midway 30 & 31	27/08/2013	<i>Chalinolobus gouldii</i>	49	44	2	3
Midway 30 & 31	27/08/2013	<i>Chalinolobus gouldii</i> / <i>Scotorepens balstoni</i>	1	1	0	0
Midway 30 & 31	27/08/2013	<i>Chalinolobus morio</i>	2	2	0	0
Midway 30 & 31	27/08/2013	<i>Falsistrellus tasmaniensis</i>	2	0	2	0
Midway 30 & 31	27/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens greyii</i>	1	1	0	0
Midway 30 & 31	27/08/2013	<i>Miniopterus schreibersii oceanensis</i>	9	6	2	1
Midway 30 & 31	27/08/2013	<i>Mormopterus</i> sp4	23	22	0	1
Midway 30 & 31	27/08/2013	<i>Nyctophilus</i> sp	1	1	0	0
Midway 30 & 31	27/08/2013	<i>Saccolaimus flaviventris</i>	1	1	0	0
Midway 30 & 31	27/08/2013	<i>Scotorepens balstoni</i>	9	9	0	0
Midway 30 & 31	27/08/2013	<i>Scotorepens orion</i>	1	0	1	0
Midway 30 & 31	27/08/2013	<i>Tadarida australis</i>	4	4	0	0
Midway 30 & 31	27/08/2013	<i>Vespadelus trougtoni</i> / <i>Chalinolobus morio</i>	1	1	0	0
Midway 30 & 31	27/08/2013	<i>Vespadelus vulturnus</i>	29	26	1	2

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Midway 30 & 31	27/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	4	4	0	0
Midway 30 & 31	27/08/2013	low	32			
Midway 30 & 31	27/08/2013	short	84			
		Total sequences	253			
		Total Id'ed	137			
Dewhurst 13-18	28/08/2013	<i>Nyctophilus</i> sp	1	1	0	0
Dewhurst 13-18	28/08/2013	<i>Vespadelus vulturnus</i>	8	7	1	0
Dewhurst 13-18	28/08/2013	low	3			
Dewhurst 13-18	28/08/2013	short	7			
Dewhurst 13-18	29/08/2013	<i>Miniopterus schreibersii oceanensis</i>	1	0	1	0
Dewhurst 13-18	29/08/2013	<i>Saccolaimus flaviventris</i>	2	2	0	0
Dewhurst 13-18	29/08/2013	<i>Tadarida australis</i>	1	1	0	0
Dewhurst 13-18	29/08/2013	<i>Vespadelus vulturnus</i>	9	8	0	1
Dewhurst 13-18	29/08/2013	<i>Vespadelus vulturnus</i> / <i>Miniopterus schreibersii oceanensis</i>	1	1	0	0
Dewhurst 13-18	29/08/2013	low	7			

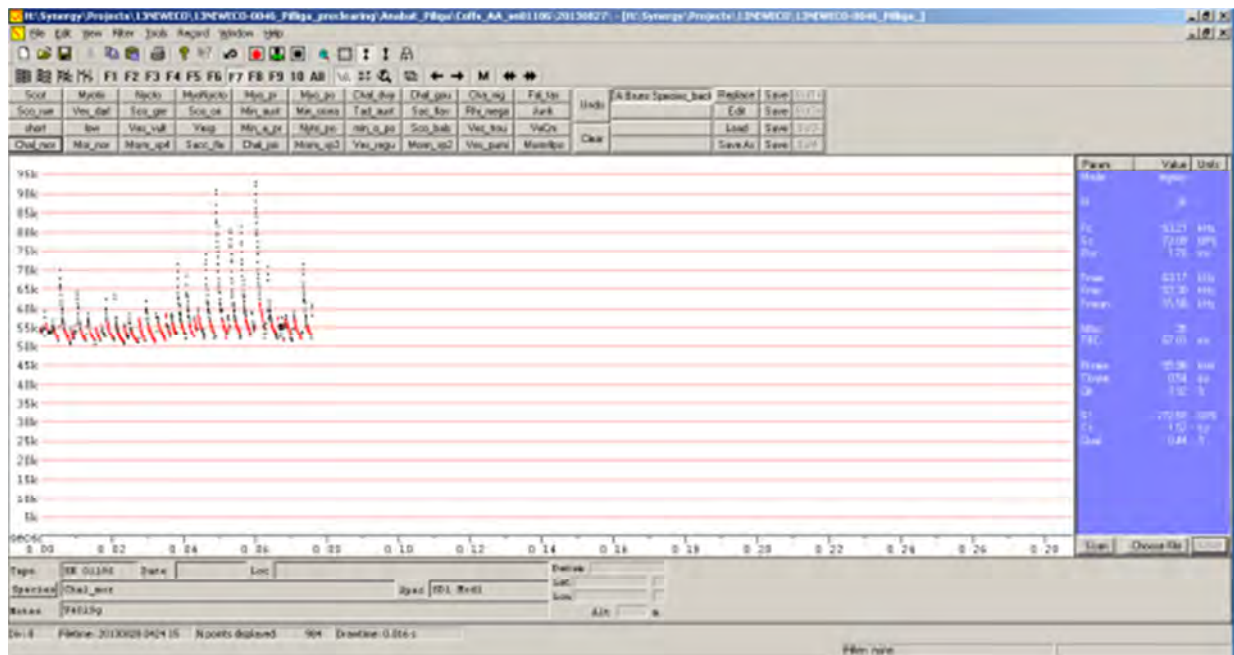
Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 13-18	29/08/2013	short	18			
		Total sequences	58			
		Total Id'ed	33			
Dewhurst 30	26/08/2013	<i>Chalinolobus gouldii</i>	35	32	1	2
Dewhurst 30	26/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens</i> sp / <i>Scotorepens greyii</i>	1	1	0	0
Dewhurst 30	26/08/2013	<i>Falsistrellus tasmaniensis</i>	3	0	3	0
Dewhurst 30	26/08/2013	<i>Miniopterus schreibersii oceanensis</i>	5	1	3	1
Dewhurst 30	26/08/2013	<i>Vespadelus vulturnus</i>	9	7	2	0
Dewhurst 30	26/08/2013	low	5			
Dewhurst 30	26/08/2013	short	3			
		Total sequences	61			
		Total Id'ed	53			
Dewhurst 30	27/08/2013	<i>Chalinolobus gouldii</i>	82	82	0	0
Dewhurst 30	27/08/2013	<i>Falsistrellus tasmaniensis</i> / <i>Scotorepens orion</i> / <i>Scotorepens greyii</i>	1	1	0	0
Dewhurst 30	27/08/2013	<i>Falsistrellus tasmaniensis</i>	2	0	2	0
Dewhurst 30	27/08/2013	<i>Miniopterus schreibersii oceanensis</i>	2	1	1	0
Dewhurst 30	27/08/2013	<i>Mormopterus</i> sp3	1	1	0	0
Dewhurst 30	27/08/2013	<i>Mormopterus</i> sp4	1	1	0	0
Dewhurst 30	27/08/2013	<i>Scotorepens balstoni</i>	1	1	0	0
Dewhurst 30	27/08/2013	<i>Vespadelus vulturnus</i>	4	3	0	1

Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 30	27/08/2013	low	2			
Dewhurst 30	27/08/2013	short	6			
		Total sequences	102			
		Total Id'ed	94			
Dewhurst 13-18	28/08/2013	<i>Miniopterus schreibersii oceanensis</i>	1	0	0	1
Dewhurst 13-18	28/08/2013	<i>Vespadelus vulturnus</i>	1	1	0	0
Dewhurst 13-18	28/08/2013	low	2			
Dewhurst 13-18	28/08/2013	short	19			
Dewhurst 13-18	29/08/2013	<i>Chalinolobus gouldii</i>	1	1	0	0
Dewhurst 13-18	29/08/2013	<i>Mormopterus</i> sp4	1	1	0	0
Dewhurst 13-18	29/08/2013	<i>Saccolaimus flaviventris</i>	1	0	0	1
Dewhurst 13-18	29/08/2013	low	1			
Dewhurst 13-18	29/08/2013	short	20			
		Total sequences	47			
		Total Id'ed	26			
Dewhurst 30	26/08/2013	<i>Chalinolobus gouldii</i>	4	0	1	3
Dewhurst 30	26/08/2013	<i>Miniopterus schreibersii oceanensis</i>	7	0	4	3
Dewhurst 30	26/08/2013	<i>Nyctophilus</i> sp	7	6	0	1
Dewhurst 30	26/08/2013	<i>Vespadelus vulturnus</i>	1	1	0	0

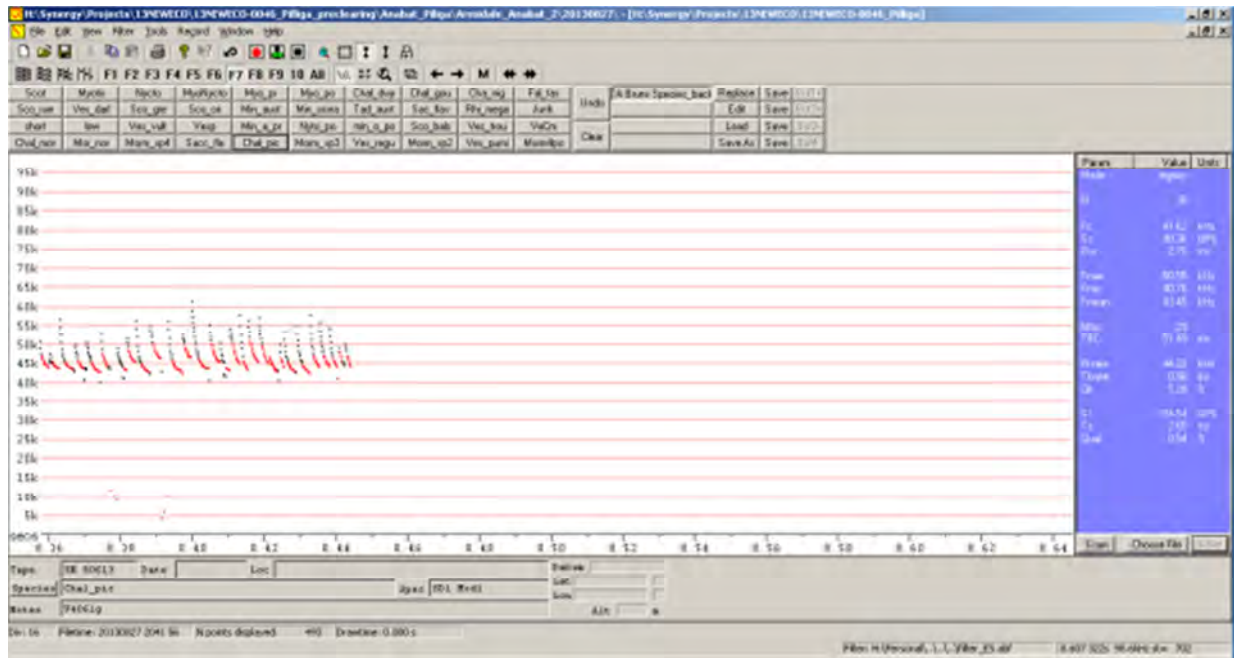
Site name	Night	Species name	Number of calls	Definite	Possible	Probable
Dewhurst 30	26/08/2013	low	16			
Dewhurst 30	26/08/2013	short	11			
		Total sequences	46			
		Total Id'ed	19			
Dewhurst 30	27/08/2013	<i>Miniopterus schreibersii oceanensis</i>	4	1	3	0
Dewhurst 30	27/08/2013	<i>Mormopterus</i> sp4	3	2	0	1
Dewhurst 30	27/08/2013	<i>Nyctophilus</i> sp	4	1	2	1
Dewhurst 30	27/08/2013	<i>Scotorepens greyii</i>	1	0	1	0
Dewhurst 30	27/08/2013	<i>Vespadelus vulturnus</i>	3	1	1	1
Dewhurst 30	27/08/2013	low	9			
Dewhurst 30	27/08/2013	short	5			
		Total sequences	29			
		Total Id'ed	15			



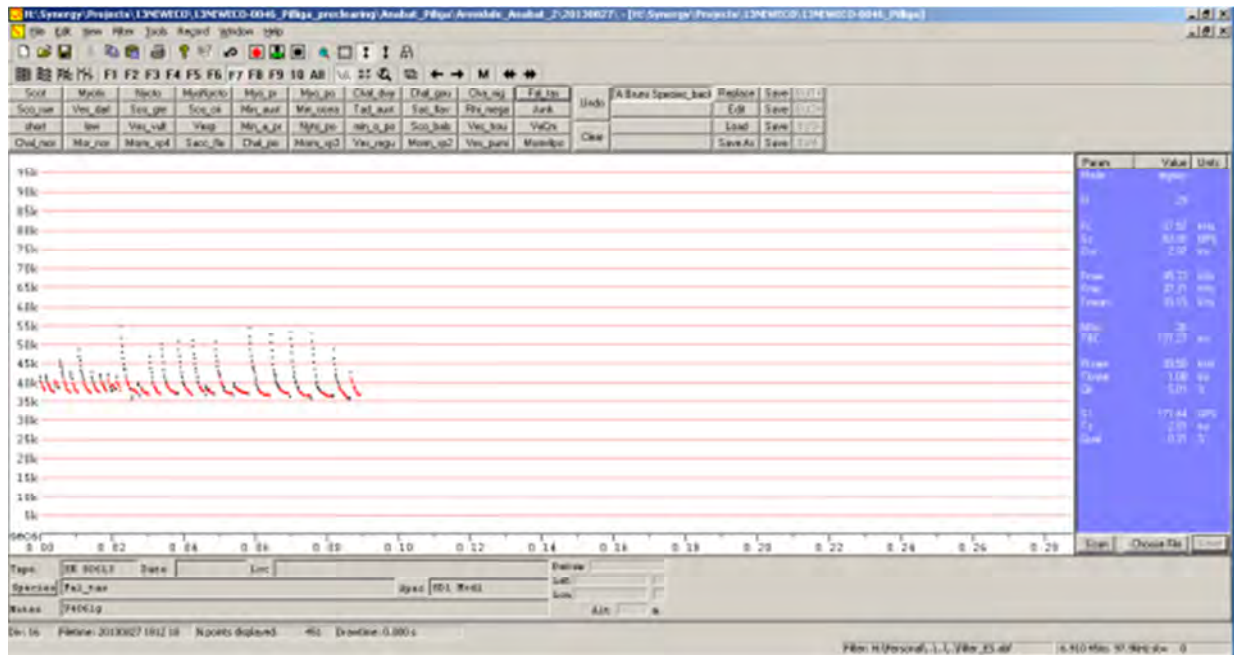
Call profile for *Chalinelobus gouldii* at 18:03 on 27 August 2013.



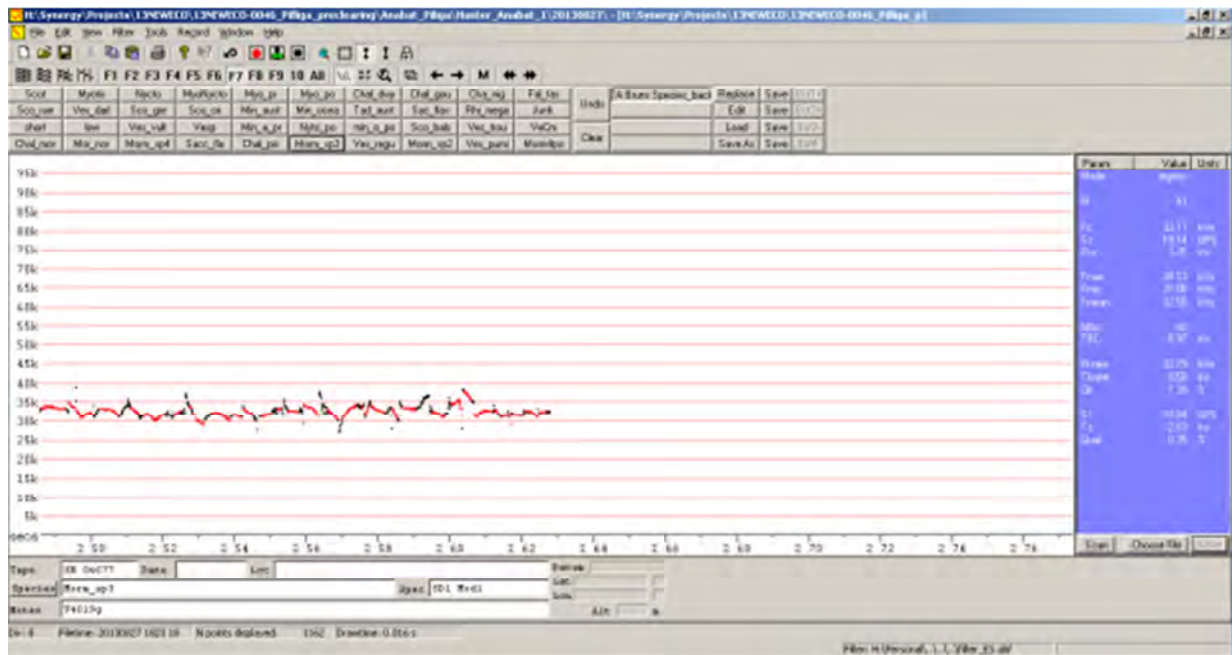
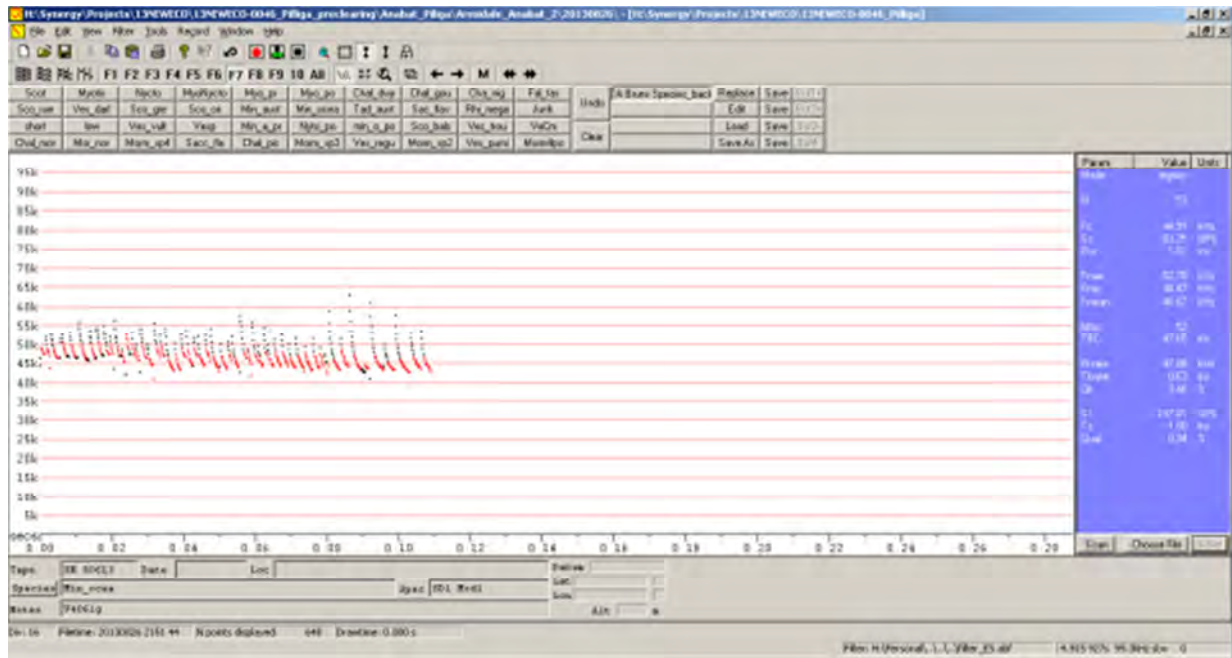
Call profile for *Chalinelobus morio* at 04:24 on 28 August 2013.

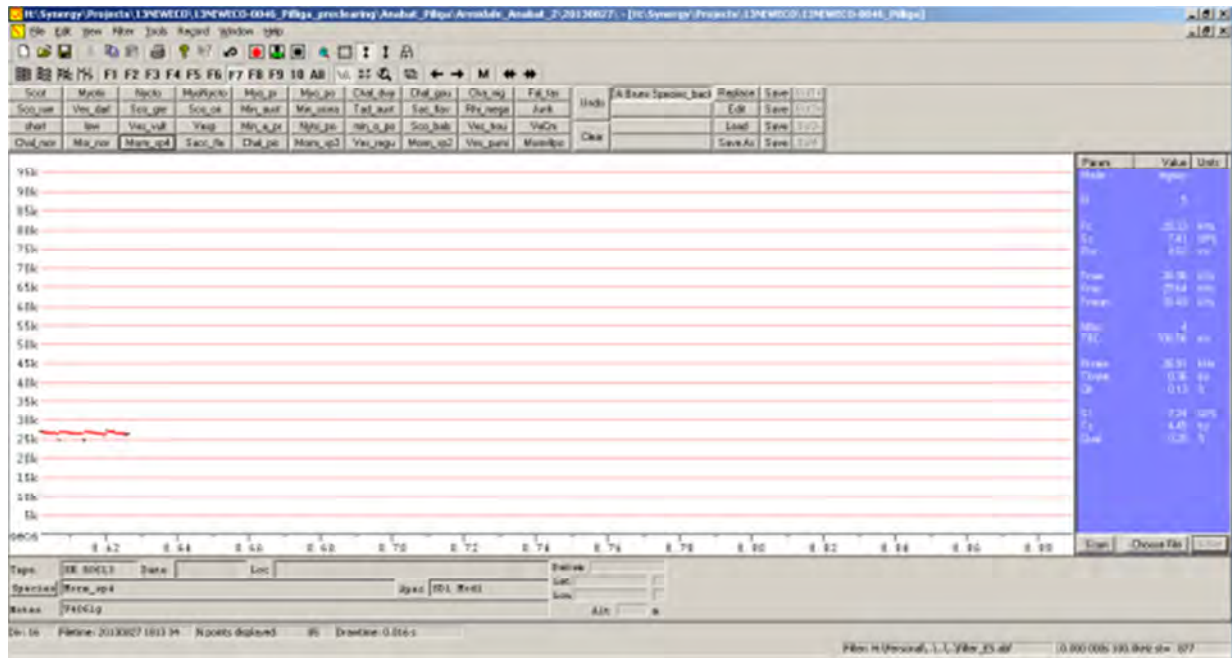


Call profile for *Chalinelobus picatus* at 20:41 on 27 August 2013

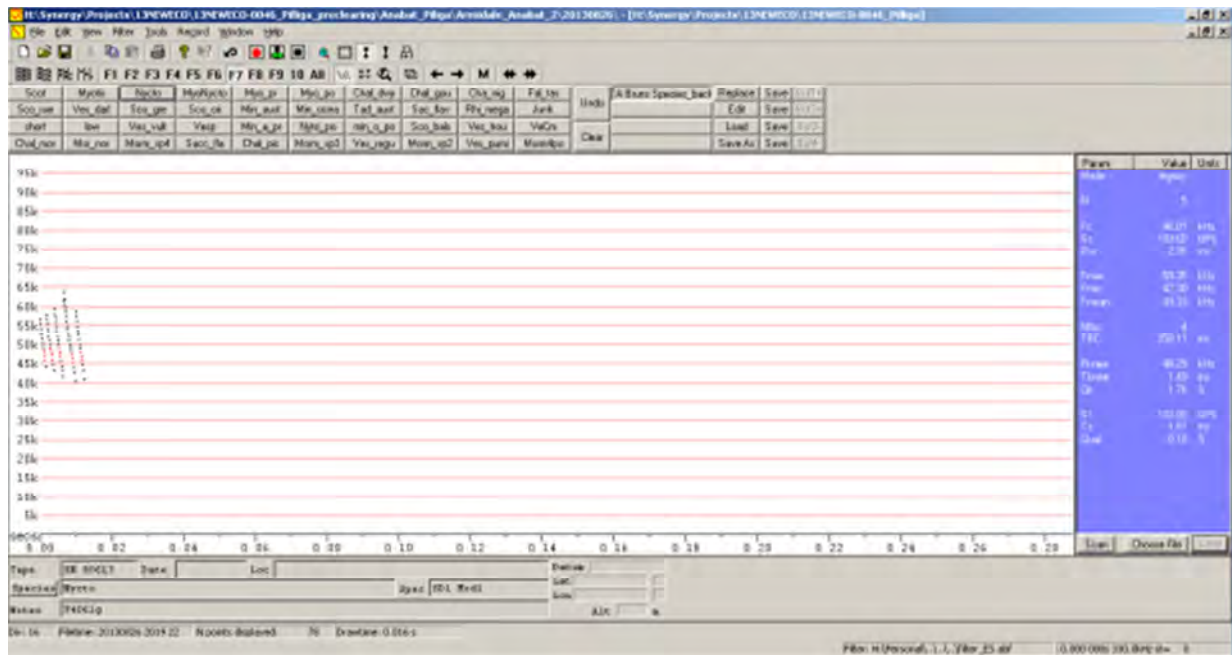


Possible call profile for *Falsistrellus tasmaniensis* at 18:12 on 27 August 2013

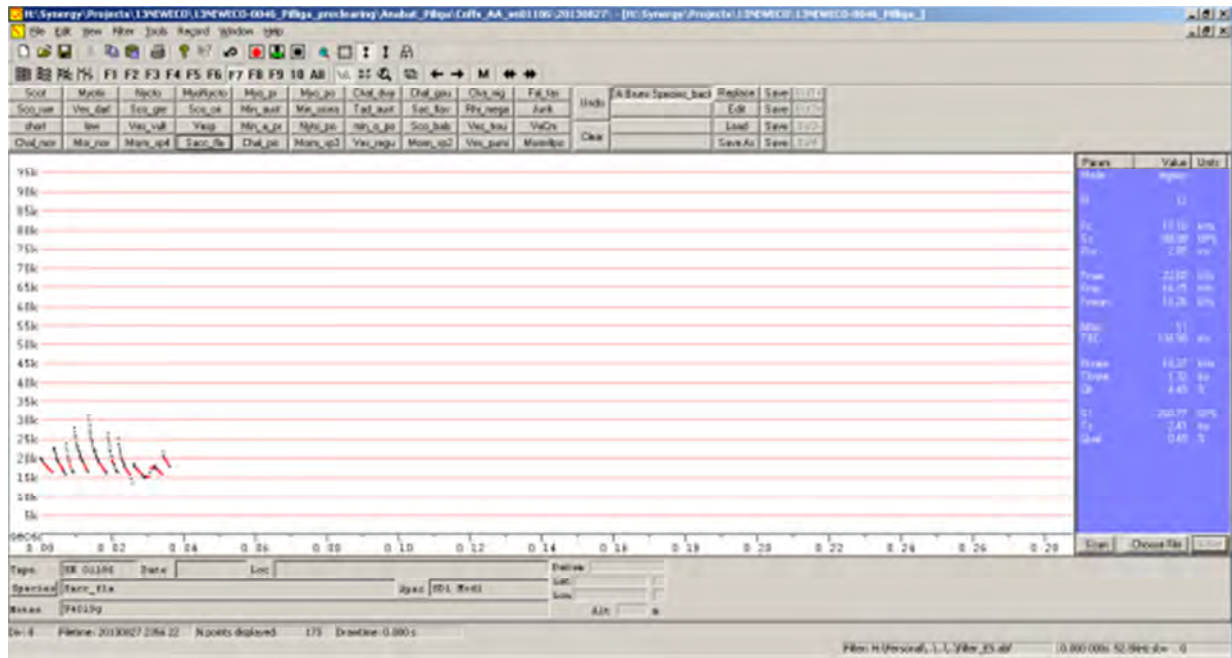




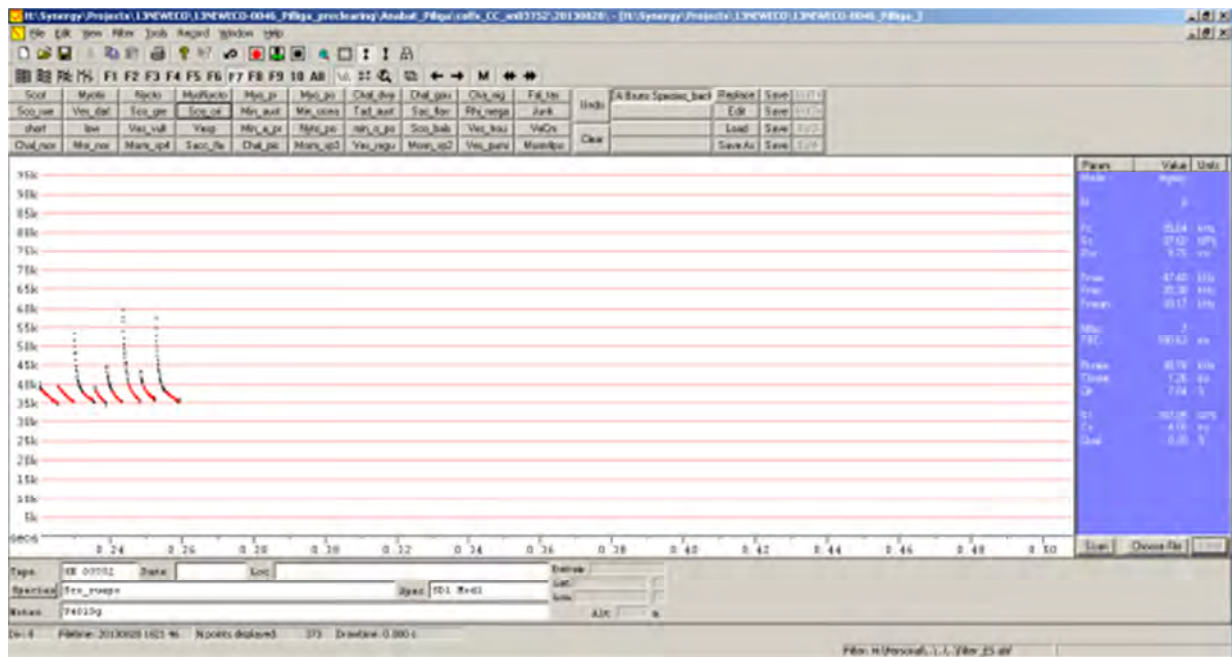
Call profile for *Mormopterus* species 4 at 18:13 on 27 August 2013.



Possible call profile for *Nyctophilus* sp. at 20:19 on 26 August 2013.

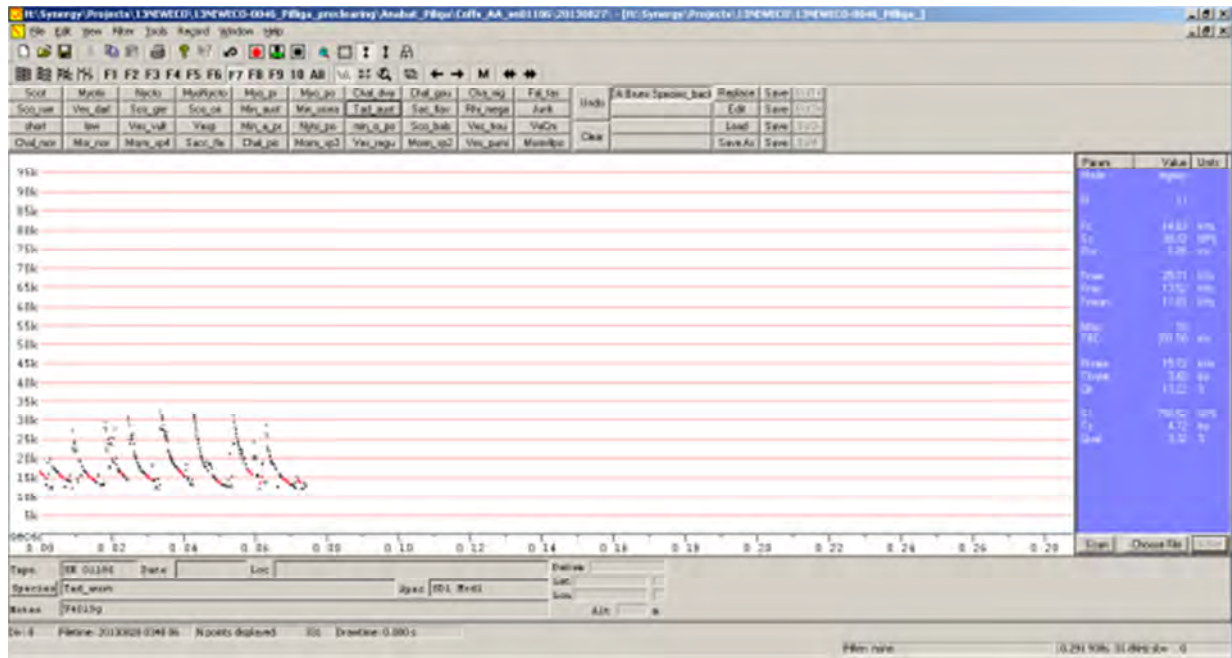


Call profile for *Saccolaimus flaviventrus* at 23:56 on 27 August 2013

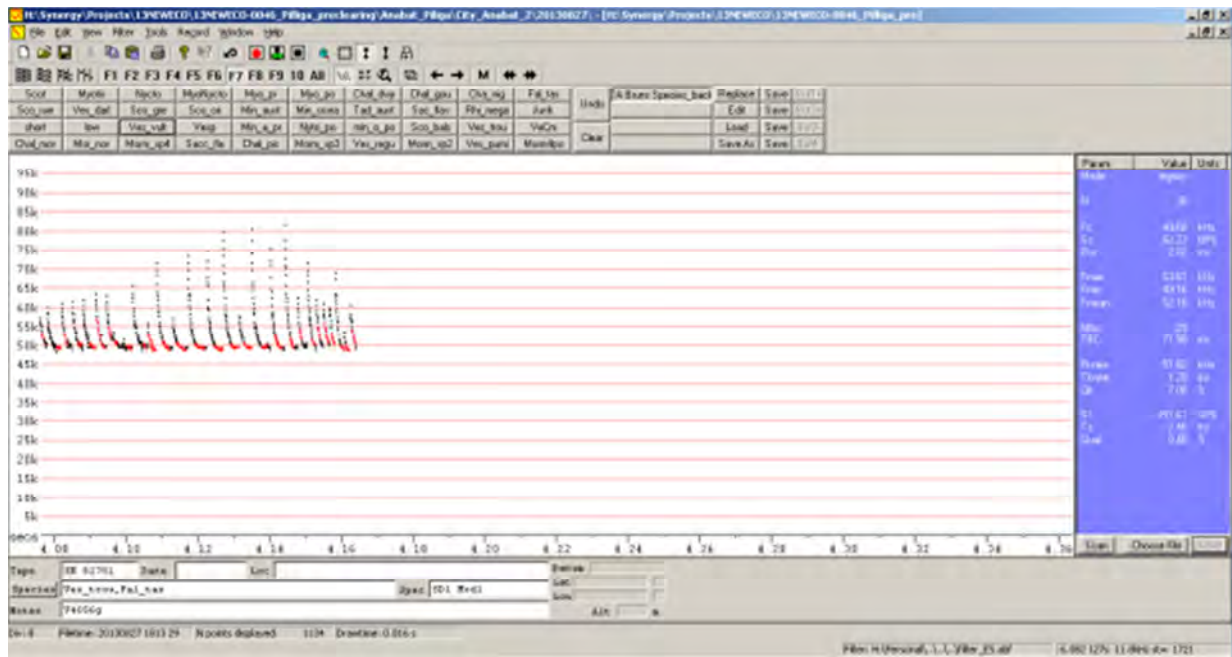


Possible call profile for *Scoteanax rueppellii* at 18:21 on 28 August 2013

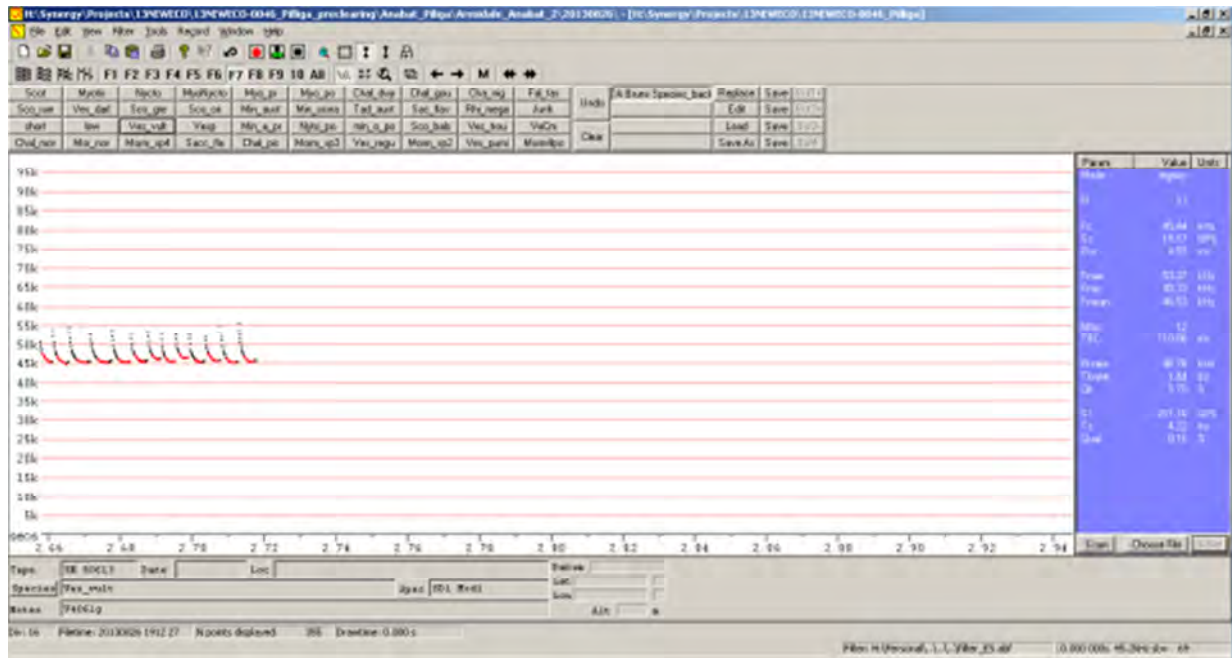




Call profile for *Tadarida australis* at 03:48 on 28 August 2013.



Call profile for *Vespadelus troughtoni* at 18:13 on 27 August 2013.



Call profile for *Vespadelus vulturnus* at 19:12 on 26 August 2013.

Appendix E: Fauna species list recorded during field surveys

Common name	Scientific name	TSC Act*	EPBC Act*	Dewhurst30	Dewhurst31	Dewhurst13-18	Midway30 & 31	RPS(2012)	ELA(2010-2013)
AMPHIBIANS									
Broad-palmed Frog	<i>Litoria latopalmata</i>	P						X	
Ornate Burrowing Frog	<i>Platyplectrum ornatum</i> g	P						X	
Salmon Striped Frog	<i>Limnodynastes salmini</i>	P						X	
BIRDS (68 species)									
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>	P				X			
Australian King-Parrot	<i>Alisterus scapularis</i>	P		X					
Australian Owlet-nightjar#	<i>Aegotheles cristatus</i>	P			X			X	
Australian Pelican*	<i>Pelicanus conspicillatus</i>	P				X			
Australian Raven	<i>Corvus coronoides</i>	P						X	
Australian Ringneck	<i>Barnardius zonarius</i>	P		X		X			
Black-faced Cuckoo-shrike#	<i>Coracina novaehollandiae</i>	P			X			X	
Black-fronted Dotterel	<i>Elseyornis melanops</i>	P				X			
Blue-faced Honeyeater	<i>Entomyzon cyanotis</i>							X	
Brown Honeyeater	<i>Lichmera indistincta</i>	P						X	
Brown Thornbill	<i>Acanthiza pusilla</i>	P		x				X	
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	P						X	
Buff-rumped Thornbill	<i>Acanthiza reguloides</i>	P		X	X	X		X	
Chestnut-rumped Thornbill	<i>Acanthiza uropygialis</i>	P		X	X				
Cicadabird	<i>Coracina tenuirostris</i>	P						X	
Cockatiel	<i>Nymphicus hollandicus</i>	P				X			
Common Bronzewing	<i>Phaps chalcoptera</i>	P						X	

Common name	Scientific name	TSC Act**	EPBC Act**	Dewhurst30	Dewhurst31	Dewhurst13-18	Midway 30 & 31	RPS (2012)	ELA (2010-2013)
Dusky Woodswallow	<i>Artamus cyanopterus</i>	P			X			X	
Eastern Rosella	<i>Platycercus eximius</i>	P		X				X	
Eastern Yellow Robin	<i>Eopsaltria australis</i>	P		X	X	X		X	
Emu	<i>Dromaius novaehollandiae</i>	P		X	X				
Eurasian Coot	<i>Fulica atra</i>	P				x			
Galah	<i>Eolophus roseicapillus</i>	P			X	X		X	
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	V		X					
Golden Whistler	<i>Pachycephala pectoralis</i>	P		X	X	X			
Grey Butcherbird	<i>Cracticus torquatus</i>	P		X	X	X		X	
Grey Fantail	<i>Rhipidura albiscapa</i>	P		X	X	X		X	
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	P		x		X		X	
Grey Teal	<i>Anas gracilis</i>	P				X			
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	V		X				X	
Hardhead	<i>Aythya australis</i>	P				X			
Hooded Robin	<i>Melanodryas cucullata</i>	V				X			
Inland Thornbill	<i>Acanthiza apicalis</i>	P		X					
Jacky Winter	<i>Microeca fascinans</i>	P		X				X	
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	P						X	
Leaden Flycatcher	<i>Myiagra rubecula</i>	P						X	
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	P				X			
Magpie-lark	<i>Grallina cyanoleuca</i>	P						X	
Masked Woodswallow	<i>Artamus personatus</i>	P						X	
Mistletoebird	<i>Dicaeum hirundinaceum</i>							X	
Noisy Friarbird	<i>Philemon corniculatus</i>	P		X	X	X		X	
Noisy Miner	<i>Manorina melanocephala</i>	P		X	X			X	
Olive-backed Oriole	<i>Oriolus sagittatus</i>	P		X	X	X			
Pacific Black Duck	<i>Anas superciliosa</i>	P				X			

Common name	Scientific name	TSC Act**	EPBC Act**	Dewhurst30	Dewhurst31	Dewhurst13-18	Midway 30 & 31	RPS (2012)	ELA (2010-2013)
Pied Cormorant*	<i>Phalacrocorax varius</i>	P				X			
Pied Currawong	<i>Strepera graculina</i>	P		X	X	X		X	
Rufous Whistler	<i>Pachycephala rufiventris</i>	P				X		X	
Silvereye	<i>Zosterops lateralis</i>								
Speckled Warbler	<i>Chthonicola sagittata</i>	V			X				
Spotted Pardalote	<i>Pardalotus punctatus</i>	P		X		X		X	
Striated Pardalote	<i>Pardalotus striatus</i>	P		X	X			X	
Striped Honeyeater	<i>Plectorhyncha lanceolata</i>	P		X	X				
Superb Fairy-wren	<i>Malurus cyaneus</i>	P		x	X	X		X	
Varied Sittella	<i>Daphoenositta chrysoptera</i>	VP			X				
Variegated Fairy-wren	<i>Malurus lamberti</i>	P			X			X	
Weebill	<i>Smicrornis brevirostris</i>	P		X	X	X		X	
Western Gerygone	<i>Gerygone fusca</i>	P						X	
White-bellied Sea-eagle*	<i>Haliaeetus leucogaster</i>	P	Mar, M			X			
White-browed Babbler	<i>Pomatostomus superciliosus</i>	P				X			
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	P		X	X	X		X	
White-necked Heron	<i>Ardea pacifica</i>	P				X			
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>	P						X	
White-throated Gerygone	<i>Gerygone albogularis</i>	P		X		X		X	
White-throated Needletail	<i>Hirundapus caudacutus</i>	P	Mar, M					X	
White-throated Treecreeper	<i>Cormobates leucophaea</i>	P		X	X	X		X	
Willie Wagtail	<i>Rhipidura leucophrys</i>	P		X				X	
Yellow Thornbill	<i>Acanthiza nana</i>	P		X	X			X	
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	P		X	X	X		X	
MAMMALS (32 species)									
Bristle-faced Free-tailed Bat>	<i>Mormopterus eleryi</i>	E						X	

Common name	Scientific name	TSC Act**	EPBC Act**	Dewhurst30	Dewhurst31	Dewhurst13-18	Midway 30 & 31	RPS (2012)	ELA (2010-2013)
Chocolate Wattle Bat	<i>Chalinolobus morio</i>	P						X	
Common Brushtail Possum	<i>Trichosurus vulpecula</i>	P							R-2-2
Common Bent-wing Bat	<i>Miniopterus schreibersii</i> *	V		X	X	X	X	X	
Eastern Bentwing Bat	<i>Miniopterus schreibersii oceanensis</i>	V		X	X		X		
Eastern Broad-nosed Bat	<i>Scotorepens orion</i>	P		X	X		X		
Eastern Cave Bat	<i>Vespadelus trougtoni</i>	V					X		
Eastern False Pipistrell	<i>Falsistrellus tasmaniensis</i>	V		X	X		X		
Eastern Grey Kangaroo	<i>Macropus giganteus</i>	P						X	R-2-2
European Fox	<i>Vulpes vulpes</i>	U		X				X	PR-A PR-2-2
Feral Cat	<i>Felis catus</i>	U						X	
Gould's Long-eared Bat	<i>Nyctophilus gouldii</i>	P		X			X		
Gould's Wattle Bat	<i>Chalinolobus gouldii</i>	P		X			X	X	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	V		X			X		
Inland Broad-nosed Bat	<i>Scotorepens balstoni</i>	P						X	
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	P		X	X		X		
Little Broad-nosed Bat	<i>Scotorepens greyii</i>	P		X	X		X	X	
Little Forest Bat	<i>Vespadelus vulturnus</i>	P		X	X	X	X		
Little Pied Bat	<i>Chalinolobus picatus</i>	V			X			X	
Orion Broad-nosed Bat	<i>Scotorepens orion</i>	P		X			X		
Rat	<i>Rattus</i> sp.	?							PR-A
Red-necked Wallaby	<i>Macropus rufogriseus</i>	P						X	
Swamp Wallaby	<i>Wallabia bicolor</i>	P						X	
Western Broad-nosed Bat	<i>Scotorepens balstoni</i>	P			X		X		
White-striped Freetail Bat	<i>Tadarida australis</i>	P						X	

Common name	Scientific name	TSC Act**	EPBC Act**	Dewhurst30	Dewhurst31	Dewhurst13-18	Midway 30 & 31	RPS (2012)	ELA (2010-2013)
Yellow-bellied Sheath-tail Bat	<i>Saccolaimus flaviventris</i>	V				X	X	X	
Yellow-footed Antechinus	<i>Antechinus flavipes</i>	P		X					H4-B
	<i>Miniopterus</i> sp.	P			X				
	<i>Mormopterus</i> sp.	P			X		X	X	
	<i>Nyctophilus</i> sp.	P			X		X	X	
	<i>Scotorepens</i> sp.	P		X					
	<i>Vespadelus</i> sp.	P						X	

REPTILES (12 species)

Bearded Dragon	<i>Pogona barbata</i>	P						X	
Boulenger's Skink	<i>Morethia boulengeri</i>	P						X	H4-A
Eastern Robust Slider	<i>Lerista punctatovittata</i>	P						X	
Eastern Spiny-tailed Gecko	<i>Strophurus williamsi</i>	P						X	
Eastern Stone Gecko	<i>Diplodactylus vittatus</i>	P						X	
Lace Goanna	<i>Varanus varius</i>	P						X	
Nobbi Dragon	<i>Amphibolurus nobbi</i>	P						X	
Robust Ctenotus	<i>Ctenotus robustus</i>	P						X	
Sand Goanna	<i>Varanus gouldii</i>	P						X	
Snake-eyed Skink	<i>Cryptoblepharus virgatus</i>	P						X	
Timid Slider	<i>Lerista timida</i>	P						X	
Tree-base Litter-skink	<i>Lygisaurus foliorum</i>	P						X	
Unidentified Skink		P			X				

* not recorded in previous surveys; # call playback Midway 30 & 31, > potentially recorded in the study area, but call could not be confirmed.

** P = protected; U = unprotected; V = vulnerable; M = migratory; Mar = marine

Appendix F: Assessment of significance under the TSC Act

The following appendix provides an assessment of the potential significance of the impacts from the proposed activity on ecological values listed under the TSC Act. The ecological values considered relevant to this assessment are identified in Section 4.2 of this report.

The assessment of impact has been conducted where necessary with consideration to the 7-part test criteria (or assessment of significance), as outlined in the text box below:

7-Part Test Assessment of Significance

1. *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.*
2. *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.*
3. *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,*
4. *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, an*
 - II. *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed activity, 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*
5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).*
6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.*
7. *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 flora and fauna species have been grouped for the assessment process with other values that contain similar characteristics and those that are likely to be impacted in a similar manner.

The flora and fauna groupings for the assessment of significance for species listed under the TSC act include:

Flora

- *Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis* and *Tylophora linearis*

Birds

- Parrots:
 - o Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot and Turquoise Parrot
- Owls:
 - o Barking Owl & Masked Owl
- Birds of prey:
 - o Spotted Harrier, Black-breasted Buzzard, Little Eagle and Square-tailed Kite
- Woodland birds – large ground foraging:
 - o Bush Stone-curlew
- Woodland birds – ground and mid-storey foraging (passerines):
 - o Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin
- Woodland birds – canopy foraging (excluding parrots):
 - o Regent Honeyeater, Painted Honeyeater and Black-chinned Honeyeater

Mammals

- Arboreal mammals and Flying Fox:
 - o Grey-headed Flying Fox and Squirrel Glider
- Ground and log dependent mammals:
 - o Black-striped Wallaby, Pilliga Mouse and Spotted-tailed Quoll
- Grassy woodland mammals:
 - o Rufous Bettong
- Predominantly tree-roosting bats:
 - o Yellow-bellied Sheath-tail-bat and South-eastern Long-eared Bat
- Predominantly cave-roosting bats:
 - o Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat and Little Pied Bat

THREATENED FLORA

***Diuris tricolor*, *Polygala linariifolia*, *Pterostylis cobarensis* and *Tylophora linearis*.**

Significant impacts for these threatened flora species are assessed on the number of individuals or populations directly impacted by the proposed activity relative to the study area. Considerations are also given to important and critical habitat, as well as likely indirect impacts on potential habitat. No critical habitat under the TSC Act has been declared for these species.

Detailed targeted surveys within the broader north-east Pilliga Forest have identified significant populations of these threatened species. Modelled data predicts the existence of 18,180 *Diuris tricolor*, 122,713 *Polygala linariifolia*, 3,349,724 *Pterostylis cobarensis* and 183,908 *Tylophora linearis* individuals in the Pilliga and Pilliga Outwash CMA subregions (ELA 2012). The removal of one *Polygala linariifolia*, three *Pterostylis cobarensis* and three *Tylophora linearis*, would result in the reduction of less than 0.01% of the predicted population in the two modelled CMA subregions.

The proposed activity will result in the removal of a very small proportion of potential habitat for these species relative to available habitat across the Pilliga region. Habitat for these species is widespread across the Pilliga region, with significant populations of *Pterostylis cobarensis* and *Tylophora linearis* identified outside of the study area including populations within State Forests, National Parks, Nature Reserves and State Conservation Areas. Therefore, significant impacts to the lifecycle and important habitat to these species are unlikely to result from the proposed activity.

The proposed activity has the potential to increase the spread of weed species through the introduction of plant and/or seed material from vehicles and other equipment or through increased penetration of the forest along new access tracks and other disturbed areas. Weed and fungal invasion has the potential to degrade the habitat of these species and weed species may directly compete with them. To address these potential threats, Santos has prepared a weed management strategy and a comprehensive rehabilitation strategy will be prepared which will address issues of restoration, weed invasion and feral animal invasion over the life of the Program.

Significant impacts on the threatened flora species are considered unlikely given:

- The small extent of impacts from the proposed activity relative to extant populations and available habitat across the study region.
- That available potential habitat will not be significantly reduced to an extent likely to cause a significant decline in the species populations.
- The demonstrated and anticipated rehabilitation of areas of impact.
- Potential indirect impacts, such as weed invasion are being actively managed.

BIRDS

Parrots

The Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot and Turquoise Parrot are considered in this impact assessment. Only the Glossy Black Cockatoo has been recorded in the study area.

The proposed activity could potentially impact on the life cycles of these threatened parrots by reducing the amount of foraging, roosting and breeding habitat available to the species, by increasing mortality rates via vehicle collisions and by spreading weeds. Swift Parrots breed in Tasmania. Thus, only potential foraging and roosting habitat would be reduced by the exploration works for these species. Glossy Black Cockatoos, Little Lorikeets, and Turquoise Parrots forage, roost and potentially breed within the study area.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened parrot species. However, this loss is considered relatively minor in the context of similar habitats within the study region, constituting up to 0.01% of available habitat for the threatened parrot species.

The disturbance from the proposed activity is considered unlikely to isolate larger areas of potential habitat or impact on important habitat for the threatened parrot species. This is especially true given the highly mobile nature of these parrots. Swift Parrots are able to migrate large distances from their breeding habitats in southern NSW to northern NSW, and from Tasmania to northern NSW, respectively. Glossy Black Cockatoos, Little Lorikeets, and Turquoise Parrots also move distances to access their foraging resources, although Little Lorikeets have been found to be less nomadic during breeding periods (DoE 2013b).

The scale of the fragmentation in relation to the total area of potential habitat and individual fragments of habitat within the study region is considered relatively minor in relation to these highly mobile species. In addition, following the construction of linear infrastructure for the proposed activity, vegetation above the buried gathering system (ground and shrub layers) would be largely rehabilitated, reducing the width of the disturbed habitat between undisturbed habitat fragments and thus, limiting the level of habitat fragmentation.

Although HBTs will be impacted by the proposed activity, the scale of loss in the context of the HBTs available in the study region is not significant based on the extent of habitat present. In addition, no critical habitat, recovery plans or threat abatement plans exist or are relevant for the Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot or Turquoise Parrot in the study area.

The proposed activity is unlikely to constitute a significant impact on the threatened parrot species given that the extent of the proposed activity:

- Has been designed to minimise the total area of habitat to be impacted
- Would only remove a small proportion of the total area of habitat available to these species
- Would not isolate or significantly fragment areas of potential habitat given the highly mobile nature of these species

On the basis of the above considerations, it is unlikely that the activities will result in a significant impact on the survival of the Glossy Black-Cockatoo, Little Lorikeet, Swift Parrot or Turquoise Parrot.

Owls

The Barking Owl and Masked Owl are considered in this impact assessment. These species predominately inhabit woodland and/or dry eucalypt forest where there are suitable hollow-bearing trees for nesting. They both have large home ranges (up to 2,000 ha of Barking Owl and 1,000 ha for Masked Owl) and use a variety of habitats to forage, including closed forest and more open areas.

Neither species was recorded within the study area, however the proposed activity may potentially impact on the life cycles of the two owl species by reducing the amount of potential foraging and roosting habitat for both species and breeding habitat for Barking Owl available. The Pilliga Forest, particularly the western Pilliga, is a stronghold of the Barking Owl which supports the largest remaining population of the species in NSW (NPWS 2003; Kavanagh and Stanton 2009).

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened owl species. This loss is considered relatively minor in the context of similar habitat within the study region, constituting up to 0.01% of available habitat for the threatened owl species.

The greatest concern resulting from the proposed activity is the potential removal of breeding habitat (HBTs) for the Barking Owl and whether breeding pairs are present or near vegetation to be removed. The direct impact to potential breeding habitat for the Barking Owl is 2.44 ha. Barking Owls nest in areas that are less disturbed than surrounding areas, and are highly susceptible to disturbance during the breeding season. If breeding sites are disturbed, this could lead to the abandonment of the breeding site by a nesting pair of birds. Barking Owls predominately use large Red Gum and Narrow-leafed Ironbark HBTs for nesting, but can use large dead ringbarked trees (Kavanagh and Stanton 2009). Masked Owls are unlikely to use the study area to breed as this species roosts and breeds in moist eucalypt forested gullies (DoE 2013b).

A number of measures have been implemented to minimise the impact area. The activities have been designed and micro-sited to minimise the number of HBTs which would be removed. As such, it is unlikely that the activities would significantly impact Masked Owls. For this species, only foraging habitat would be lost. This removal of foraging habitat would not represent a significant loss to Masked Owls, as the species is highly mobile with the ability to hunt over areas of between 500 and 1000 ha, and the total impact areas are much less than the species' territory.

A recovery plan has been prepared for Large Forest Owls (DECC 2006) and the Barking Owl (NPWS 2003). The proposed activity is consistent with the objectives of these recovery plans. In addition, the proposed activities are not inconsistent with the objectives of the threat abatement plan relevant to the species.

The actions proposed will result in the operation of the key threatening processes "Clearing of native vegetation" and "Loss of hollow-bearing trees".

2.44 ha of remnant vegetation would be cleared as a result of the proposed activity including a maximum of 25 HBTs. No Barking Owls were identified during the current study, and no known breeding sites are likely to be affected by the proposed activity. The scale of these impacts in the context of the habitat and HBTs available within the study region is considered relatively minor. In consideration of the above, the proposed activity is unlikely to constitute a significant impact on the Barking Owl as it:

- Has been designed to minimise the total area of foraging and roosting habitat to be impacted including the number of HBTs to be removed
- Would only impact upon foraging and roosting habitat, which is widespread within the study area and the study region, and as such constitutes the removal of only a very minor proportion of this habitat
- Would not isolate areas of potential habitat from currently interconnecting areas of potential habitat for these highly mobile species

Birds of prey

The Spotted Harrier, Black-breasted Buzzard, Little Eagle and Square-tailed Kite are considered in this impact assessment. These species are found in a range of woodland, forest and open habitats, however, all have been associated with some form of riparian habitat, such as timbered watercourses or inland wetlands that can be used for breeding or foraging.

None of these species have been recorded within the study area. However, the activities could potentially impact on the life cycles of the bird of prey species by reducing the amount of potential foraging, breeding or roosting habitat available to these species. All of the birds of prey are highly mobile species that have extensive home ranges. Black-breasted Buzzard, Spotted Harrier, and Square-tailed Kite have been identified as species that are negatively impacted by land clearing.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (primarily foraging habitat) for the Spotted Harrier, Black-breasted Buzzard, Little Eagle and Square-tailed Kite. This loss is considered relatively minor in the context of similar habitats within the Study region constituting up to 0.01% of available habitat for the birds of prey.

No impacts to riparian habitats or timbered watercourses are expected as a result of the proposed activity. As the habitat most frequently used by birds of prey would be predominately avoided, the majority of these birds would also be less likely to be impacted by indirect disturbance from noise or traffic, and by habitat degradation through weed invasion. In addition, indirect impacts have and will

been minimised through appropriate controls, best-practice construction techniques, rehabilitation of disturbed areas and weed control programs.

With consideration to the above, the proposed activity is considered unlikely to constitute a significant impact on the Black-breasted Buzzard, Little Eagle, Spotted Harrier and Square-tailed Kite as it:

- Would not impact on the most important habitat areas for these species (riparian habitats and timbered watercourses).
- Has been designed to minimise the total area of foraging and roosting habitat to be impacted.
- Would only remove a small proportion of the total area of habitat available to these species in the study region.
- Would not isolate areas of potential habitat from currently interconnecting areas of potential habitat for these highly mobile species.

Woodland birds – large ground foraging

The Bush Stone-curlew is considered in this impact assessment. The Bush Stone-curlew inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.

The Bush Stone-curlew has not been recorded within the study area. However, the proposed activity could potentially impact on the life cycle of this threatened woodland bird by reducing the amount of foraging, roosting and breeding habitat available to the species. Bush Stone-curlews forage and potentially breed across the study region.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the Bush Stone-curlew. This loss is considered relatively minor in the context of similar habitat within the study region, constituting up to 0.01% of available habitat for this threatened woodland bird.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that Bush Stone-curlews could avoid these areas of potential habitat. Indirect impacts could include noise, edge effects, increased traffic volumes, and incursion of weeds that effectively reduces the foraging resources of the species. The implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs.

A recovery plan has been prepared for the Bush Stone-curlew (NPWS 2006) which has the overall objective of managing at least five populations of the species across NSW to ensure they are secure and consistently increasing in both extent of occurrence and area of occupancy. The proposed activity is being conducted in a manner that is not inconsistent with the objectives of the recovery plan. In addition, the activities are not inconsistent with the objectives of the threat abatement plans relevant to the species.

It is considered unlikely that the proposed activity will constitute a significant impact on the Bush Stone Curlew as:

- The woodland areas which would be impacted by the activities are widespread within the study region. Therefore, the impact area is not considered to be of high importance for the species. In addition, no critical habitat has been declared by the Director General for the Bush Stone Curlew.

- The proposed activity has been designed to minimise the total area of foraging and roosting habitat to be impacted.
- The implementation of mitigation measures is considered sufficient to manage the threat of indirect impacts.

Woodland birds – ground and mid-storey foraging (passerines)

The Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin are considered in this impact assessment. These species inhabit a range of woodland habitats associated with the proposed activity. The habitats also range in structural density and complexity.

Only the Grey-crowned Babbler, Speckled Warbler, Varied Sittella and Hooded Robin have been recorded within the study area.

The proposed activity could potentially impact on the life cycles of these woodland birds by reducing the amount of foraging, sheltering and breeding habitat available to the species. Scarlet Robins do not breed in the area. Diamond Firetails, Gilbert's Whistlers, Grey-crowned Babblers, Hooded Robins, Speckled Warblers, and Varied Sittellas forage and potentially breed across the areas impacted by the proposed activity. These species have also been identified as species that are negatively impacted by land clearing, with Diamond Firetails, Gilbert's Whistler, and Speckled Warblers also negatively impacted by inappropriate fire regimes (and therefore habitat loss) (Biosis 2002).

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened ground and mid-storey foraging woodland birds. This loss is considered relatively minor in the context of similar habitat within the study region, constituting up to 0.01% of available habitat for these threatened birds.

The proposed activity would not involve impacts upon the riparian corridors in the study region, thus retaining riparian woodland habitats, which are considered to represent the habitat most frequently used by these species for foraging and/or breeding and roosting. The woodland areas away from the riparian corridors, which would be impacted by the activities, are widespread within the study region. As such the small area to be impacted by the proposed activity is not considered to be of high importance for ground and mid-storey foraging woodland birds.

In addition, no critical habitat has been declared by the Director General for Diamond Firetails, Gilbert's Whistlers, Grey-crowned Babblers, Hooded Robins, Scarlet Robins, Speckled Warblers, or Varied Sittellas.

Many of the ground and mid-storey foraging woodland birds require remnants of minimum sizes. Diamond Firetails appear unable to persist in areas which lack remnants larger than 200 ha. Hooded Robins appear unable to survive in remnants smaller than 100-200 ha. Scarlet Robins are less common in isolated patches of 30 ha or less where there is no tree cover within 200 m and less than 20% cover within 1 km. Speckled Warblers require remnants larger than 100 ha in size (NSW Scientific Committee 2001a). Isolation of populations in small remnants increases vulnerability to local extinction as a result of stochastic events and can decrease their genetic viability in the long term.

Nevertheless, the design of the proposed activity is considered unlikely to isolate large areas of potential habitat from one another. While some species, such as Grey-crowned Babblers which have laborious flight, may be unable to fly across well pads, vegetation surrounding these sites would be

retained and allow for these species to move between the study areas. Vegetation above any linear infrastructure would be rehabilitated, reducing the width of the disturbed habitat type and thus, reducing the level of fragmentation.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that ground and mid-storey foraging woodland birds could avoid these areas of potential habitat. Habitats fragmented by new access roads, or well pads, would experience increased edge effects, including increased traffic volumes, which ground and mid-storey foraging woodland birds could avoid. Weeds could invade remaining areas of habitat reducing the foraging resources of Diamond Firetail, Gilbert's Whistler, and Speckled Warbler, which amongst other food resources, feed on native grasses, vegetative material and seeds. However, the implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs. Furthermore, the proposed activity is not inconsistent with the objectives of any threat abatement plan relevant to ground and mid-storey foraging woodland species.

In conclusion, the proposed activity is unlikely to constitute a significant impact on, Grey-crowned Babbler, Diamond Firetail, Gilbert's Whistler, Scarlet Robin, Speckled Warbler, Varied Sittella and Hooded Robin as the proposed activity:

- Would not involve impacts upon the riparian corridors in the study region.
- Has been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted.
- Would only remove a minor proportion of the total area of habitat available to these species. In addition, the activities will retain significant proportions of grassy woodland habitats in the study region.
- Is unlikely to isolate or reduce areas of potential habitat from interconnecting areas of similar habitat to the point that thresholds for remnants of minimum sizes for these species are met.

Woodland birds – canopy foraging (excluding parrots)

The Black-chinned Honeyeater, Regent Honeyeater and Painted Honeyeater are considered in this impact assessment. The Black-chinned Honeyeater occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark, White Box, Inland Grey Box, Yellow Box and Forest Red Gum. The Painted Honeyeater inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. The Regent Honeyeater inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of *Casuarina cunninghamiana* (River Oak).

None of these species have been recorded within the study area. However, the proposed activity could potentially impact on the life cycles of Black-chinned, Painted, and Regent Honeyeaters by reducing the amount of foraging, roosting and breeding habitat available to the species. Regent Honeyeaters are not considered likely to breed in the study region. Black-chinned and Painted Honeyeaters forage, roost and breed across the study region. All three of the species have been identified as species that are negatively impacted by land clearing (and therefore habitat loss) (Biosis 2002).

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the threatened canopy feeding woodland birds. This loss is considered relatively minor in the context of similar habitat within the study region, constituting up to 0.01% of available habitat for these threatened woodland birds.

The proposed activity would avoid riparian vegetation communities, thus retaining grassy woodland habitats used by Black-chinned, Painted, and Regent Honeyeaters. The woodland areas which would be impacted by the proposed activity are widespread within the study region and the locality. As such the small area to be impacted by the proposed activity is not considered to be of high importance for the canopy foraging woodland birds. In addition, no critical habitat has been declared for the Black-chinned, Painted, or Regent Honeyeaters.

The proposed activity could also impact on the life cycles of Black-chinned Honeyeaters through decreases in the sizes of intact habitat. Similar to some ground and mid-storey foraging woodland birds, Black-chinned Honeyeater does not persist in remnants less than 200 ha in area (NSW Scientific Committee 2001b). However, while locally nomadic, they tend to forage in home ranges of around 5 ha (OEH 2013b).

The proposed activity would also retain the majority of vegetation representing foraging, roosting and/or breeding habitat for these species. Thus, the remaining habitat remnants would not be completely fragmented from other remnants. Adjacent patches would together form larger patches of vegetation that Black-chinned, Painted, and Regent Honeyeaters would be able to use, provided these species did not avoid areas degraded by noise and light disturbance.

Areas of habitat that would not be removed could be indirectly impacted by disturbance to the point that Black-chinned, Painted and Regent Honeyeaters could avoid these areas of potential habitat. However, the implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these indirect impacts. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, weed and feral animal control programs.

Furthermore, the proposed activity is not inconsistent with the objectives of any threat abatement plan relevant to these species, nor the recovery plan prepared for the Regent Honeyeater (DNRE 1999), which has the overall objective of ensuring the species persists in the wild and is down-listed from endangered to vulnerable.

The proposed activity is unlikely to constitute a significant impact on the Black-chinned, Painted, or Regent Honeyeaters as the proposed activity:

- Has been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted.
- Would only remove a minor proportion of the total area of habitat available to these species within the study region.
- Would not isolate areas of potential habitat from currently interconnecting areas of habitat or reduce intact habitat to the point that Black-chinned, Painted, and Regent Honeyeaters can no longer persist.

MAMMALS

Arboreal mammals and megabats:

The Grey-headed Flying Fox and Squirrel Glider are considered in this impact assessment. The Squirrel Glider inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest with a shrubby or *Acacia* midstorey. Grey-headed Flying-foxes forage over a range of habitats, and Squirrel Gliders occur in a number of open Eucalypt woodland communities supporting preferred feed trees and habitat elements such as tree hollows and a shrub mid-storey layer in the case of Squirrel Gliders (OEH 2013b).

These species have not been recorded within the study area, however Squirrel Glider was recently potentially recorded through hair sampling by ELA within 10 km of the study area (habitat different to that found in the study area). The proposed activity could impact on the life cycles of Grey-headed Flying-foxes and Squirrel Gliders by reducing the amount of foraging, roosting and breeding habitat available to the species, or degrading their habitat. Grey-headed Flying-foxes do not roost or breed in the study area, but may use it to forage, while Squirrel Gliders forage and potentially breed across the study areas. The potential habitats of these species would be reduced directly through the clearing of vegetation, including, HBTs that could be used by Squirrel Gliders to breed and shelter. No critical habitat has been declared for these species.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for these threatened arboreal mammal and megabat species. This loss is considered relatively minor in the context of similar habitats within the study region constituting up to 0.01% of available habitat for these species.

While the proposed activity would result in the removal of some habitat, the activities have sought to avoid riparian vegetation communities (e.g. Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box) with high densities of HBTs, thus retaining the majority of hollows in this area for Squirrel Gliders, and foraging habitat for Grey-headed Flying-foxes. Other habitat elements such as logs would be stockpiled and redistributed during rehabilitation works, or would be relocated to surrounding areas.

Areas of habitat that would not be removed could be indirectly reduced/affected by fragmentation and disturbance (i.e. habitat could be degraded) impacting on Grey-headed Flying-foxes and Squirrel Gliders.

Many of the disturbances that could potentially result from the proposed activity are listed as key threats to Grey-headed Flying Foxes and Squirrel Gliders, such as the loss and modification of habitat. Furthermore, disturbance to roosting sites, unregulated shooting, and electrocution on powerlines are listed as key threats to Grey-headed Flying Fox. Fragmentation of habitat, loss of hollow-bearing trees and flowering understorey and mid-storey shrubs are key threats to Squirrel Glider (OEH 2013b).

The implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these indirect impacts and disturbances outlined above. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, fauna friendly fencing (in accordance with Santos' Fencing Standard), and weed and feral animal control initiatives. Furthermore, the proposed activity is not inconsistent with the objectives of any recovery plans and threat abatement plans relevant to these species.

In consideration of the above, the proposed activity is not likely to have a significant impact on Grey-headed Flying-foxes and Squirrel Gliders in the study area.

Ground and log dependent mammals:

The mid-storey and log dependent mammals considered in this impact assessment are the Black-striped Wallaby, Pilliga Mouse and Spotted-tailed Quoll.

It is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2011). It is important to note

that this taxonomic change has not yet been formally recognised; hence this assessment considers the Pilliga Mouse as currently listed.

The Black-striped Wallaby prefers habitat characterised by dense woody or shrubby vegetation within three metres of the ground. This dense vegetation must occur near a more open, grassy area to provide suitable feeding habitat. The Pilliga Mouse is restricted to an isolated area of low-nutrient deep sand which has long been recognised as supporting a distinctive vegetation community (Pilliga Scrub), but may forage outside this vegetation type. The Spotted-tailed Quoll is found in a variety of habitats, including sclerophyll forest and woodlands, coastal heathlands and rainforests. No critical habitat has been declared for these species.

Of these species, the Black-striped Wallaby and Pilliga Mouse have been recorded within the study region.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (primarily foraging and sheltering) for Black-striped Wallaby, Pilliga Mouse and Spotted-tailed Quoll. No breeding habitat for the Pilliga Mouse will be impacted as a result of the proposed activity. This loss is considered relatively minor in the context of similar habitats within the study region, constituting up to 0.01% of available habitat for these species.

Areas of habitat that would not be removed could be indirectly reduced/affected by fragmentation and disturbance (i.e. habitat could be degraded) impacting on these species and/or creating barrier effects at the local level for Pilliga Mice. Black-striped Wallabies are mobile with home ranges of 90 ha and Spotted-tailed Quolls are highly mobile with ranges between 2,000 and 5,000 ha.

Following construction, linear infrastructure will be partially rehabilitated, reducing the width of the disturbed habitat and thus any level of fragmentation. Furthermore, habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study region, limiting any fragmentation impact on the Pilliga Mouse.

Many of the disturbances that could potentially result from the proposed activity are listed as key threats to the ground and log dependent mammals. Clearing and fragmentation of habitat and degradation of habitat (through grazing, weeds, collection of firewood, or inappropriate levels of Broombush harvesting) are listed as key threats to these species. Inappropriate fire regimes affecting habitat elements and predation by introduced animals including cats, foxes, and dogs are key threats to Black-striped Wallabies and Pilliga Mice. Deliberate or accidental killing by poisoning or shooting/trapping are threats to Black-striped Wallabies and Spotted-tailed Quolls. Further, risk of local extinction because populations are small and isolated is a key threat to Black-striped Wallaby. Competition from House Mice is a key threat to Pilliga Mice. Competition with introduced predators such as cats and foxes is a key threat to Spotted-tailed Quoll (OEH 2013b).

The implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these indirect impacts and disturbances outlined above. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, and weed and feral animal control initiatives. Furthermore, the proposed activity is not inconsistent with the objectives of the threat abatement plans relevant to these mid-storey and log dependent mammals.

In respect to the above, it is considered that the explorative activities will not have a significant impact on the Black-striped Wallaby, Pilliga Mouse and Spotted-tailed Quoll in the study area.

Grassy woodland mammals:

The grassy woodland mammal considered in this impact assessment is the Rufous Bettong. This species inhabits a variety of forests from tall, moist eucalypt forest to open woodland, with a sparse or tussock grass understorey. No critical habitat has been declared for this species.

This species has not been recorded in the study area, however the activities could impact on the life cycle of Rufous Bettongs by reducing the amount of foraging, sheltering and breeding habitat (clearing of vegetation) available to the species, or degrading its habitat. The species is highly mobile, requiring large areas of habitat with foraging movements recorded as 2 to 4.5 km a night.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat (foraging, breeding or roosting/sheltering) for the Rufous Bettong. This loss is considered relatively minor in the context of similar habitats within the study region, constituting up to 0.01 % of available habitat for this species.

The woodland areas which would be impacted by the proposed activity are widespread within the study region. As such the small area to be impacted by the proposed activity is not considered to be of high importance for the Rufous Bettong. In addition, habitat elements within impacted areas such as logs would be stockpiled and redistributed during partial rehabilitation works, or would be relocated to surrounding areas.

Habitat connectivity for the Rufous Bettong would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area. This greatly mitigates against a number of disturbances (such as fragmentation and degradation of foraging habitat due to weeds or introduced predators) that would otherwise impact species that are restricted in range and not highly mobile. In addition, the implementation of mitigation and management measures for the proposed activity is considered sufficient in reducing these disturbances. Such measures include appropriate traffic controls, best-practice construction techniques, rehabilitation of disturbed areas, minimisation of fragmentation, and weed and feral animal control initiatives.

In consideration of the above, it is unlikely that the explorative activities will have a significant impact on the Rufous Bettong in the study area.

Predominantly tree-roosting bats:

The predominantly tree-roosting bats considered in this impact assessment are the Yellow-bellied Sheath-tail-bat and South-eastern Long-eared Bat. Only the Yellow-bellied Sheath-tail-bat has been recorded within the vicinity of the study area.

The Yellow-bellied Sheath-tail-bat roosts singly or in groups of up to six, in tree hollows and buildings. The South-eastern Long-eared Bat inhabits a variety of vegetation types, including mallee, Bullock and box eucalypt dominated communities. The South-eastern Long-eared Bat roosts in tree hollows, crevices, and under loose bark. No critical habitat has been determined for either species.

Both species of bat are likely to forage, roost and breed in the area, with the Yellow-bellied Sheath-tail-bats migrating to the southern parts of Australia during late summer or autumn months. The Pilliga area is considered a strong-hold for the South-eastern Long-eared Bats (Churchill 1998). The proposed activity largely avoids vegetation communities with high densities of hollows (primarily the Pilliga Box – Poplar Box – White Cypress, Rough-barked Apple and Fuzzy Box vegetation types), retaining areas with higher densities of potential roosting and breeding sites for both species.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential habitat

(foraging, breeding or roosting/sheltering) for the two bat species. This loss is considered relatively minor in the context of similar habitats within the study region, constituting up to 0.01% of available habitat for these species.

Indirect impacts on these bat species, including disturbance from noise and or light could add to the impacts associated with habitat loss and or modification. It is possible that South-eastern Long-eared Bats would avoid areas of noise disturbance while foraging. Yellow-bellied Sheathtail-bats are considered less likely to be affected by noise as the species forages aerially, above the canopy. However, bats of many species have been found roosting in areas disturbed by noise (Schaub et al. 2008); thus, it is unlikely that these bat species would be disturbed by noise while roosting. In addition, indirect impacts have largely been minimised through appropriate management controls and best-practice construction techniques. Following construction, linear infrastructure will be partially rehabilitated, reducing the width of the disturbed habitat and thus any level of fragmentation. Weed spread would be controlled to limit the potential for habitat degradation and therefore limit impacts on habitat containing bat prey. More importantly, noise would largely be kept to a minimum and constant, rather than intermittent.

The proposed activity is unlikely to constitute a significant impact on the Yellow-bellied Sheathtail-bat or the South-eastern Long-eared Bat as:

- It avoids impacts on the most important habitat areas for these species (large alluvial woodland areas and riparian habitats containing roosting sites).
- It has been designed to minimise the total area of foraging, roosting and breeding habitat to be impacted including the number of hollow bearing trees to be removed.
- It would only remove a small proportion of the total area of habitat available to these species.
- Indirect disturbances have / will be adequately managed to mitigate potential impacts relating to noise, light, and habitat degradation.

Predominantly cave-roosting bats:

The Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat and Little Pied Bat are considered in this impact assessment. Only the Little Pied Bat, Eastern Bentwing-bat and Eastern Cave Bat have been recorded within the study region.

The Eastern Bentwing-bat occupies a range of forested environments (including wet and dry sclerophyll forests). The Eastern Cave Bat is usually found in dry open forest and woodland, near cliffs or rocky overhangs. The Large-eared Pied Bat is found in well-timbered areas containing gullies in dry open forest and woodland close to caves or other roost sites. The Little-Pied Bat occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. No critical habitat has been declared for these species.

The proposed activity could potentially impact on the life cycles of the bat species by reducing the amount of foraging and roosting and breeding habitat available for the Little Pied Bat and the amount of foraging habitat for the Eastern Bentwing-bats, Eastern Cave Bats and Large-eared Pied Bats. However, these species are predominantly cave-roosting and breeding (Churchill 1998) and since the proposed activity does not impact on caves, it is predominantly foraging habitat that would be reduced by the activities. An exception exists for the Little Pied Bat that can also use tree hollows for roosting.

The proposed activity will result in the removal and/or modification of up to 2.44 ha of potential foraging habitat for these four bats. This loss is considered relatively minor in the context of similar habitats within the study region, constituting up to 0.01% of available habitat for these species. The

small area to be impacted by the proposed activity compared to the available habitat is not considered to be of high importance for the bat species.

Retention of vegetation outside the impact areas would continue to support these bat species in the study region. Furthermore, the proposed activity has been designed to be located in areas with lower densities of HBTs and away from prime foraging habitat such as near water sources.

The proposed activity could impact the predominantly cave-roosting species through decreases in the sizes of intact habitat. Little Pied Bats, when roosting in trees, have been found to maintain roosts within 200 m of each other. Eastern Cave Bats have been recorded using only 33 ha over 5 consecutive days (Churchill 1998). Eastern Bentwing Bat, Eastern Cave Bat and Little Pied Bat could also be impacted through the potential increases in the numbers of introduced predators as a result of the proposed activity. These species are threatened by predation by cats and foxes.

Further, indirect impacts on these bat species, including disturbance from noise and or light could add to the impacts associated with foraging habitat loss and / or modification. However, overseas studies on bats that listen for their prey in addition to using echolocation have found that these bats avoid areas with noise disturbance while foraging (Schaub et al. 2008). It is possible that Large-eared Pied Bats forage in a similar manner to the bat species investigated as they forage under the canopy and close to the ground. As such, it is possible that Large-eared Pied Bats would avoid areas of noise disturbance while foraging. Eastern Bentwing-bats, Eastern Cave Bats and Little Pied Bats are considered less likely to be affected by noise as these species forage aerially, above or within the canopy, or catch their prey from water.

Following construction, linear infrastructure will be partially rehabilitated, reducing the level of habitat fragmentation and maintaining a suitable size of intact foraging habitat for the bat species. Weed spread would be controlled to limit the potential for habitat degradation and therefore limit impacts on habitat containing bat prey. More importantly, noise would largely be kept to a minimum and constant, rather than intermittent.

The proposed activity is unlikely to constitute a significant impact on the Eastern Bentwing-bat, Eastern Cave Bat, Large-eared Pied Bat, or the Little Pied Bat as the proposed activity:

- Largely does not impact breeding / roosting habitat as no caves fall within the study area.
- Has been designed to minimise the total area of foraging habitat to be impacted.
- Would only remove a small proportion of the total area of habitat available to these species in the study region.
- Has been designed and managed in a way to limit the impact of indirect impacts.
- Would not isolate areas of potential foraging habitat from currently interconnecting areas of potential habitat for these species.

Appendix G: Assessment of Significance under the EPBC Act

This section provides an assessment of the potential significance of impacts from the proposed activity on Matters of National Environmental Significance (MNES). The EPBC Act Administrative Guidelines on Significance set out 'Significant Impact Criteria' that are to be used to assist in determining whether a proposed action is likely to have a significant impact on matters of national environmental significance.

MNES considered relevant to this assessment include:

- Flora

Pterostylis cobarensis and *Tylophora linearis*

- Mammals

Spotted-tailed Quoll, South-eastern Long-eared Bat, Large-eared Pied Bat, Grey-headed Flying-fox, and Pilliga Mouse

- Birds

Regent Honeyeater and Swift Parrot

- Migratory species

Regent Honeyeater, White-bellied Sea Eagle, White-throated Needletail, Rainbow Bee-eater, Fork-tailed Swift

FLORA

***Pterostylis cobarensis* (Cobar Greenhood Orchid) - Vulnerable**

Pterostylis cobarensis is a terrestrial orchid. The species is known chiefly from the Nyngan-Cobar-Bourke district in the far western plains of NSW. Its presence has been recorded in districts including Narrabri, Nyngan, Cobar, Nymagee, Mt Gundabooka, Mt Grenfel and Mutawintji National Park.

Within the study area, *P. cobarensis* has been recorded within Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest. Detailed targeted surveys within the study area and study region area have identified populations of *Pterostylis cobarensis*. Three individuals were recorded at the Dewhurst 30 subject site.

The species flowers from September to November (generally October). Vegetative reproduction is not common in this group of Greenhoods, but some species may form more than one dropper annually. Plants are deciduous and die back to the large, underground tubers after seed release. New rosettes are produced following soaking autumn and winter rains. Pollination of the species is by the males of small gnats which are attracted to the flower by some pseudosexual perfume. *Pterostylis cobarensis* occurs as frequent to abundant plants in usually very localised populations (OEH 2013b).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

Detailed targeted surveys for *Pterostylis cobarensis* have been undertaken both within the study area and across the broader Pilliga to model the population in this area (ELA 2012). From these studies it has been estimated that the total population of *Pterostylis cobarensis* within the Pilliga and Pilliga Outwash CMA subregions is 349, 724 (ELA 2012). The removal of three individuals at the Dewhurst 30 subject site constitutes a <0.01% loss of individuals from the modelled population.

The proposed activity will impact on approximately 2.44 ha of vegetation that may include some areas that support potential habitat for this species. The total amount of potential habitat likely to be impacted by the proposed activity constitutes less than 0.01% of the total habitat within the study region. Given the relatively small scale of impacts to this species, it is unlikely that the proposed activity would lead to a long-term decrease in the population of *P. cobarensis* in the study area.

Reduce the area of occupancy of an important population

The proposed activity is likely to reduce the potential habitat for *P. cobarensis* through the clearing of approximately 2.44 ha of vegetation which represents potential habitat for this species.

The majority of vegetation representing potential habitat for *P. cobarensis* will be retained as part of the proposed activity. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for *P. cobarensis* in the study area and an even smaller portion (0.01%) of potential habitat within the study region; hence the proposed activity is unlikely to reduce the area of occupancy of this species.

Fragment an existing important population into two or more populations

P. cobarensis has the potential to be impacted on by habitat fragmentation where pollination (by small gnats) or seed dispersal (largely wind and seed fall) is interrupted. Fragmentation associated with the proposed activity is considered unlikely to alter pollination or seed dispersal pathways associated with the lifecycle of *P. cobarensis* and are therefore considered unlikely to fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of *P. cobarensis* could include areas that are necessary for dispersal, for the long-term maintenance of the species or to maintain genetic diversity.

Potential habitat for *P. cobarensis* is extensive both within the study area and broader study region. The loss of less than 0.01% of the total habitat within the study region is considered unlikely to be critical to the survival of this species.

Disrupt the breeding cycle of an important population

The breeding cycle of *P. cobarensis* could potentially be disrupted through the loss of habitat or the displacement of pollinators through fragmentation. The loss of less than 0.01% of potential habitat across the study region and minor fragmentation affects associated with the proposed activity are considered unlikely to disrupt the breeding cycle of this species.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species which equates to 0.01% of the total potential habitat of this species within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study area.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive weed species such as *Eragrostis curvula* (African Lovegrass) and *Hyparrhenia hirta* (Coolatai Grass) have the potential to invade into suitable habitat for *P. cobarensis* from disturbance associated with the proposed activity. Weed and fungal invasion has the potential to degrade the habitat of this species and weed species may directly compete with the species.

Santos implements pest plant procedures to ensure the rapid and progressive rehabilitation of the study area on completion of construction works for temporary impacts (e.g. flow lines) and over the life of the proposed activity for longer term impacts (e.g. wells).

Introduce disease that may cause the species to decline, or

Phytophthora cinnamomi (Cinnamon Fungus) is a microscopic soil-borne plant pathogen that can invade and destroy the root systems of susceptible native and introduced plant species. As rainfall is one of the key factors influencing the distribution of *P. cinnamomi*, the pathogen is generally restricted to coastal NSW. As such, the risk of infection of *P. cinnamomi* in the study area is considered lower than that in coastal sites.

Machinery utilised for construction and operation of the proposed activity may carry the spores of *P. cinnamomi* if they have been working in coastal areas which are known to be infected by the pathogen. However, all construction machinery and vehicles would be inspected and thoroughly cleaned prior to entry to site in accordance with the mitigation measures outlined in **Section 6.1**

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The loss of potential habitat is less than 0.01% within the study region.
- The regional extent of suitable habitat is sufficient that the proposed activity will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.
- The proposed activity will not disrupt the breeding cycle of the species as vegetation patches would not be separated by distances that would interfere with the pollination of the species (by males of small gnats).
- Weed management procedures will be implemented within the study area.

***Tylophora linearis* - Endangered**

Tylophora linearis is a slender, almost hairless twiner. The species is known only from NSW and Queensland. In NSW, it is found in the Barraba, Mendooran, Temora and West Wyalong districts in the northern and central western slopes. Records include Crow Mountain near Barraba, Goonoo, Pilliga West, Cumbil, and Eura State Forests, Coolbaggie Nature Reserve, Goobang National Park, and Beni Conservation Area. The species grows in dry scrub and open forest. It has been recorded from low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla* and *Allocasuarina luehmannii*. It also grows in association with *Acacia hakeoides*, *A. lineata*, *Melaleuca uncinata*, *Myoporum* species and *Casuarina* species. The species flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later. Where the species occurs, it has been recorded in very low abundances (OEH 2013b).

Within the study area, *T. linearis* has been recorded within Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest.

Detailed targeted surveys within the study area and broader study region have identified large populations of *T. linearis*.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

Detailed targeted surveys for *T. linearis* have been undertaken both within the study area and across the broader Pilliga region to model the population in this area (ELA 2012). Modelled data predicts the existence of 183, 908 *Tylophora linearis* individuals in the Pilliga and Pilliga Outwash CMA subregions (ELA 2012). The removal of three individuals from the subject site would result in the loss of less than 0.01% of the population in these CMA subregions.

The proposed activity will impact on approximately 2.44 ha of vegetation that may include some areas that support potential habitat for this species. The total amount of potential habitat likely to be impacted by the proposed activity constitutes less than 0.01% of the total habitat within the study region. Given the relatively small scale of impacts to this species, it is unlikely that the proposed activity would lead to a long-term decrease in the population of *T. linearis* in the study region.

Reduce the area of occupancy of the species

The proposed activity is likely to reduce the potential habitat for *T. linearis* through the clearing of approximately 2.44 ha of vegetation which represents potential habitat for this species.

The majority of vegetation representing potential habitat for *T. linearis* will be retained as part of the proposed activity. The amount of habitat that would be directly impacted comprises only a small portion (0.01%) of potential habitat for *T. linearis* in the study region; hence the proposed activity is unlikely to reduce the area of occupancy of this species.

Fragment an existing population into two or more populations

T. linearis has the potential to be impacted on by habitat fragmentation where pollination (assumed to be insect pollinated, Forster et al. 2004) or seed dispersal (seed fall and wind) is interrupted. Fragmentation associated with the proposed activity is considered unlikely to alter pollination or seed dispersal pathways associated with the lifecycle of *T. linearis* and are therefore considered unlikely to fragment an existing population into two or more populations

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of *T. linearis* could include areas that are necessary for dispersal, for the long-term maintenance of the species or to maintain genetic diversity.

Potential habitat for *T. linearis* is extensive both within the study area and broader Pilliga region. The loss of less than 0.01% of the total habitat within the study region is considered unlikely to be critical to the survival of this species.

Disrupt the breeding cycle of a population

The breeding cycle of *T. linearis* could potentially be disrupted through the loss of habitat or the displacement of pollinators through fragmentation. The loss of less than 0.01% of potential habitat across the study region and minor fragmentation affects associated with the proposed activity are considered unlikely to disrupt the breeding cycle of this species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species which equates to less than 0.01% of the total modelled population of this species within the study region

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Invasive weed species such as *Eragrostis curvula* (African Lovegrass) and *Hyparrhenia hirta* (Coolatai Grass) have the potential to invade into suitable habitat for *T. linearis* from disturbance associated with the proposed activity. Weed and fungal invasion has the potential to degrade the habitat of this species and weed species may directly compete with the species.

Santos implements pest plant procedures to ensure the rapid and progressive rehabilitation of the study area on completion of construction works for temporary impacts (e.g. flow lines) and over the life of the proposed activity for longer term impacts (e.g. wells).

Introduce disease that may cause the species to decline, or

Phytophthora cinnamomi (Cinnamon Fungus) is a microscopic soil-borne plant pathogen that can invade and destroy the root systems of susceptible native and introduced plant species. As rainfall is one of the key factors influencing the distribution of *P. cinnamomi*, the pathogen is generally restricted to coastal NSW. As such, the risk of infection of *P. cinnamomi* in the study area is considered lower than that in coastal sites.

Machinery utilised for construction and operation of the proposed activity may carry the spores of *P. cinnamomi* if they have been working in coastal areas which are known to be infected by the

pathogen. However, all construction machinery and vehicles would be inspected and thoroughly cleaned prior to entry to site in accordance with the mitigation measures outlined in **Section 6.1**.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The small extent of impacts from the proposed activity relative to available habitat in the landscape.
- The regional extent of suitable habitat types is sufficient that the proposed activity will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.
- The proposed activity will not disrupt the breeding cycle of the species as vegetation patches would not be separated by distances that would interfere with the pollination of the species.
- Weed management procedures will be implemented within the study area.

MAMMALS

***Dasyurus maculatus* (Spotted-tailed Quoll) - Endangered**

The Spotted-tailed or Tiger Quoll occupies a range of environments within a disjunct distribution along the east coast of Australia, extending from south-eastern Queensland through NSW and Victoria to Tasmania. The species is found in a variety of habitats, including sclerophyll forest and woodlands, coastal heathlands and rainforests. Occasional sightings are made in open country, grazing lands, rocky outcrops and other treeless areas (DoE 2013b). This species feeds on a wide variety of birds, reptiles, mammals and invertebrates and uses several 'latrines' within its territory for defecation (OEH 2013b). It is essentially terrestrial, but is also an agile climber (OEH 2013b). Nesting occurs in rock shelters, hollow logs, caves or tree hollows and they use numerous dens within the home range. Estimates of home ranges vary from 800 ha to 20 km² and individuals may move several kilometres in a night (NPWS 1999).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The proposed activity could lead to a long-term decrease in the size of a population of Spotted-tailed Quolls if it significantly reduced or degraded foraging, sheltering and breeding habitat available to the species, contributed to the direct mortality of the species, or led to an increase in introduced predators such as cats and foxes which would compete with the species for foraging resources.

The species was not observed during field surveys and there are no existing records for the species within the study area. Previous records of Spotted-tailed Quoll in the Pilliga are sparse, with a record in the Pilliga Nature Reserve from 2006 and three records adjacent to the Pilliga forests (OEH 2013a). One record is from the Warrumbungles from 2008 and two records are south-east of the Pilliga forests from 1994 and 2004. While the species occurs more frequently in coastal areas, there are scattered

records for Spotted-tailed Quolls west of the study area along the Barwon River. Therefore it is considered that the species has the potential to occur in the study area.

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

As such, it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of Spotted-tailed Quolls.

Reduce the area of occupancy of the species

The area of occupancy for Spotted-tailed Quolls would be reduced if significant amounts of foraging, sheltering and breeding habitat were lost in the study region, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study region to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study region, hence the proposed activity is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing population into two or more populations

Spotted-tailed Quolls are capable of large movements, and numerous records have been made for overnight movements of several kilometres for the species (NPWS 1999; Belcher et al. 2008). The proposed activity is unlikely to create barriers to movement of this species. Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study region, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed activity would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is critical to the survival of the species includes foraging, sheltering and breeding habitat. While all habitat types would be important to the species, Spotted-tailed Quolls would likely be able to withstand some level of impact to its habitat. The levels tolerated would depend on the amount and quality of foraging, sheltering and breeding habitat impacted, the time they were impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the area/Namoi CMA region.

The potential habitat proposed to be removed by the action constitutes less than 0.01% of the available habitat within the study region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The proposed activity could impact on or disrupt the breeding cycle of Spotted-tailed Quolls if it impacted on breeding habitat directly, disturbed the species during the breeding season, or reduced/degraded foraging resources used during the breeding season.

There is potential for the study area to be used for breeding by this species. The study area contains habitat elements necessary for breeding, including hollows and fallen logs; however this species has not been detected during field surveys.

As the species has not been detected within the study area and due to the relatively small scale of the impacts of the proposed activity, it is considered unlikely that the proposed activity will disrupt the breeding cycle of a population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

Invasive species that are harmful to the Spotted-tailed Quolls such as cats and foxes are already established in the study region. The proposed activity is unlikely to exacerbate the impacts of invasive species or lead to increased competition for Spotted-tailed Quolls for resources.

Introduce disease that may cause the species to decline, or

Spotted-tailed Quolls are susceptible to the spread of epidemics, such as a parasitic protozoan, by cats (NPWS 1999). However, cat populations are already well established in the study region.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The species has some potential to occur within the study area, however, it is most common in coastal areas.
- The proposed activity will disturb a very small proportion (<0.01%) of available habitat within the study region.
- The species is very mobile, able to utilise a variety of habitats within the landscape and is known to travel several kilometres a night.
- The regional extent of suitable foraging habitat types is sufficient that the development will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

***Nyctophilus corbeni* (South-eastern Long-eared Bat) - Vulnerable**

Overall, the distribution of the South-eastern Long-eared Bat coincides approximately with the Murray Darling Basin (DoE 2013b). It is common in the Pilliga region (OEH 2013b). The species inhabits a variety of vegetation types, including mallee, *Allocasuarina luehmannii* (Bull-oak) and box-eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland (OEH 2013b). The species roosts in tree hollows, crevices, and under loose bark. It is a slow flying

agile bat, using the understorey to hunt non-flying prey, especially caterpillars and beetles, and will even hunt on the ground. Movement patterns are not well known, although roost sites have been recorded as an average of 1.89 ± 1.61 km (range 0.34–7.06 km) from the capture point of bats (Schulz and Lumsden 2010). It appears the species requires large, intact areas of habitat to persist (Turbill *et al.* 2008).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

Nyctophilus species were recorded using anabat recorders during the current study, although identification between species on the basis of anabat recordings is not conclusive. A number of previous surveys have also detected the species near the study area, with a large number of individuals recorded (NPWS 2000, NPA 2002, Ecotone 2009). The Atlas of NSW Wildlife records show the species' presence throughout the study region, and NSW OEH considers the Pilliga region to be a distinct stronghold for this species.

As the South-eastern Long-eared Bat is known to occur in the study region and has its core distribution centred on the Pilliga region, it is likely that South-eastern Long-eared Bat populations within the study area would be defined as an important population under the EPBC Act.

The proposed activity will lead to the loss of approximately 2.44 ha of habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

As the proposed activity represents a small proportion of the available habitat in the study region, the proportion of hollow-bearing trees to be removed is also likely to be low. As such it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of South-eastern Long-eared Bat.

Reduce the area of occupancy of an important population

The area of occupancy for South-eastern Long-eared Bats would be reduced if significant amounts of foraging, roosting and breeding habitat were lost in the study region, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study region to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study region hence the proposed activity is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

South-eastern Long-eared Bats can travel 3 kilometres in a foraging excursion (Churchill 2008). As the species is highly mobile over the distances involved with the proposed impacts, the proposed activity will not create barriers in relation to the foraging activities of the species.

This species locates prey via echolocation and "passive listening". The effectiveness of these prey detection mechanisms may be impacted by noise associated with the construction and/or operation of the proposed activity. However, noise impacts will be highly localised and large areas of habitat will remain undisturbed. Should the South-eastern Long-eared Bat avoid areas of habitat degraded by noise, individuals of this species would be able to traverse these areas to undisturbed patches within the study region.

Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study region, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed activity would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of South-eastern Long-eared Bats includes foraging, roosting and breeding habitat. While all habitat types would be important to the species, South-eastern Long-eared Bats would likely be able to withstand some level of impact to its habitat.

The proposed activity would retain the majority of foraging, roosting and breeding habitat in the study region for South-eastern Long-eared Bats, with only a small proportion (0.01%) of habitat impacted in the study region. Thus, the foraging, roosting and breeding habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

The proposed activity could impact on or disrupt the breeding cycle of South-eastern Long-eared Bats if it impacted on breeding habitat directly, or reduced/degraded foraging resources used during the breeding season.

The proposed activity would impact on foraging and breeding habitat, and reduce/degrade foraging resources indirectly through habitat fragmentation. However, the area directly impacted represents a small proportion available in the study region with the majority of breeding and foraging habitat retained in the study region. South-eastern Long-eared Bats would be able to use undisturbed habitat to complete their life cycles.

As such, the proposed activity is unlikely to disrupt the breeding cycle of the South-eastern Long-eared Bat.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species that are harmful to the South-eastern Long-eared Bat such as cats and foxes are already established in the study region. The proposed activity is unlikely to exacerbate the impacts of invasive species or lead to increased competition for South-eastern Long-eared Bats for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed activity would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The species is highly mobile and will be able to move across disturbed areas into nearby undisturbed locations.
- The regional extent of suitable habitat is sufficient that the proposed activity will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.
- The regional extent of suitable roosting and breeding habitat is sufficient that the proposed activity will not result in the substantial disruption of elements of this species' breeding cycle.

***Chalinolobus dwyeri* (Large-eared Pied Bat) - Vulnerable**

The Large-eared Pied Bat is an insectivorous bat distributed from Shoalwater Bay in Queensland through to Ulladulla in NSW. This species tends to occur in small populations of around 50 individuals, particularly around sandstone escarpments and cliff lines. Important populations for this species occur in the Hunter Valley, Sydney Basin and Southern Tablelands of NSW. There are scattered records from the New England Tablelands and North West Slopes.

The relatively short, broad wing combined with the low weight per unit area of wing suggests that the species is manoeuvrable and forages below the canopy (OEH 2013b; DoE 2013b). The preferred breeding habitat for the species are caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the *Hirundo ariel* (Fairy Martin). The species has been known to use hollow-bearing trees as roost sites (DoE 2013b). Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years (OEH 2013b). Breeding females have recently been recorded in sandstone caves at Coonabarabran, NSW (DoE 2013b).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The species was not observed during field surveys and there are no existing records for the species within the study area. However, previous surveys have detected the species near the study area in Pilliga East State Forest (NPWS 2000; NPA 2002). The closest records according to the Atlas of NSW Wildlife are approximately 10 km to the south in Pilliga Nature Reserve and 25 km to the north east near Mt Kaputar National Park. Thus, the species has the potential to occur in the study area. This potential predominantly relates to foraging habitat, as preferred breeding habitat for this species (i.e. caves) is not known from within the study area.

As the species has not been recorded in the study area and preferred breeding habitat is not known to occur, it is considered unlikely that an 'important population' of Large-eared Pied Bat occurs within

the study area. Therefore the proposed activity is unlikely to lead to a long-term decrease in the size of an important population.

Reduce the area of occupancy of an important population

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed activity is unlikely to reduce the area of occupancy of an important population.

Fragment an existing important population into two or more populations

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed activity is unlikely to fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of Large-eared Pied Bats includes foraging, roosting and breeding habitat. Breeding habitat is critical to the survival of the species as the species roosts in caves and these are limited. Any impacts to breeding habitat could potentially threaten the survival of the species.

Unlike breeding habitat, Large-eared Pied Bats would likely be able to withstand some level of impact to foraging and roosting habitat

The proposed activity would retain the majority of foraging and roosting and breeding habitat in the study region for the Large-eared Pied Bat, with only a small proportion (0.01%) of habitat impacted in the study region. Thus, the foraging and roosting habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

As an 'important population' of Large-eared Pied Bats is considered unlikely to occur within the study area, the proposed activity is unlikely to disrupt the breeding cycle of an important population.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential foraging and roosting habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species that are harmful to the Large-eared Pied Bat such as cats and foxes are already established in the study region. The proposed activity is unlikely to exacerbate the impacts of invasive species or lead to increased competition for South-eastern Long-eared Bats for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed activity would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The species is highly mobile and will be able to move from disturbed areas into nearby undisturbed locations.
- The regional extent of suitable foraging habitat types is sufficient that the proposed activity is unlikely to result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.
- The proposed activity will not disrupt the breeding cycle of the species as no breeding areas are known within the study area, and no caves or sandstone outcrops (breeding habitat) will be impacted by the proposed activity.

***Pteropus poliocephalus* (Grey-headed Flying-fox) – Vulnerable**

The Grey-headed Flying-fox occurs primarily along the eastern coastal plain from Bundaberg in Queensland, through NSW and south to eastern Victoria. A colony has also established in Melbourne (FFG SAC 2001). Small numbers may occur as far west as Warrnambool (Menkhorst 1995). Regular movements are made over the Great Dividing Range to the western slopes of NSW and Queensland.

This species is a canopy-feeding frugivore, blossom-eater and nectarivore of rainforests, open forests, woodlands, *Melaleuca* swamps and *Banksia* woodlands. As such, it plays an important ecosystem function by providing a means of seed dispersal and pollination for many indigenous tree species (Eby 1996; Pallin 2000). Grey-headed Flying-foxes also feed on introduced trees including commercial fruit crops

Grey-headed Flying-foxes congregate in large numbers at roosting sites (camps) that may be found in rainforest patches, *Melaleuca* stands, mangroves, riparian woodland or modified vegetation in urban areas. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring (Lunney and Moon 1997; Augee and Ford 1999). They forage opportunistically, often at distances up to 30 km from camps, and occasionally up to 60-70 km per night, in response to patchy food resources (Augee and Ford 1999; Tidemann 1999).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:**Lead to a long-term decrease in the size of an important population of a species**

The Grey-headed Flying-fox was not recorded within the study area during field surveys however a number of previous surveys have detected the species near the study area and the Atlas of NSW Wildlife records show the species' presence throughout the study region.

Grey-headed Flying-foxes forage over a range of habitats. The proposed activity will lead to the loss of approximately 2.44 ha of habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

As the proposed activity represents a small proportion of the available habitat in the study region, the proportion of hollow-bearing trees to be removed is also likely to be low. As such it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of Grey-headed Flying-fox.

Reduce the area of occupancy of an important population

The area of occupancy for the Grey-headed Flying-fox would be reduced if significant amounts of foraging habitat were lost in the study region, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study region to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study region hence the proposed activity is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

Grey-headed Flying-fox can travel up to 50 kilometres in a foraging excursion. As the species is highly mobile over the distances involved with the proposed impacts, the proposed activity will not create barriers in relation to the foraging activities of the species.

No roosting habitat will be impacted for the Grey-headed Flying-fox as a result of this proposal.

Habitat connectivity will be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study region, allowing any potential populations to move across the wider landscape. Thus, it is unlikely that the proposed activity would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of Grey-headed Flying-fox includes foraging, roosting and breeding habitat. The proposed activity would impact on 2.44 ha of potential foraging habitat for the species. No roosting habitat will be impacted as a result of this proposal.

Considering only a small proportion (0.01%) of foraging habitat for the Grey-headed Flying-fox will be impacted in the NGDP area, it is considered that the proposed activity is unlikely to adversely affect habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

The proposed activity would not impact on breeding habitat for the Grey-headed Flying-fox. As such, the proposed activity is unlikely to disrupt the breeding cycle of the species.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential habitat for this species, which equates to less than 0.01% of the available habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species that are harmful to the Grey-headed Flying-fox such as cats and foxes are already established in the study region. The proposed activity is unlikely to exacerbate the impacts of invasive species or lead to increased competition for Grey-headed Flying-fox for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed activity would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The species is highly mobile and will be able to move from disturbed areas into nearby undisturbed locations.
- The regional extent of suitable foraging habitat types is sufficient that the proposed activity is unlikely to result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.
- The proposed activity will not disrupt the breeding cycle of the species as no breeding areas are known within the study area or be impacted by the proposed activity.

***Pseudomys pilligaensis* (Pilliga Mouse) - Vulnerable**

It is important to note that the Pilliga Mouse is now considered a southern population of the widespread *Pseudomys delicatulus* (Delicate Mouse) based on genetic analyses, morphological studies and recent surveys which revealed a continuous distribution of the Delicate Mouse to the Pilliga region (Breed and Ford 2007; Ford 2008, as cited in SEWPaC 2011). It is important to note that this taxonomic change has not yet been formally recognised under the EPBC Act (SEWPaC 2011), hence this assessment considers the Pilliga Mouse as currently listed.

The Pilliga Mouse is restricted to the Pilliga region of New South Wales, where low-nutrient deep sand supports a distinctive vegetation type (Pilliga Scrub). The Pilliga Mouse is very sparsely distributed and appears to prefer areas with a light ground cover. Recent studies indicate that the Pilliga Mouse is found in greatest abundance in recently burnt moist gullies, areas dominated by broombush and areas containing an understorey of *Acacia burrowii* (Kurricabah) with a *Corymbia trachyphloia* (Brown Bloodwood) overstorey (Paull 2009). Consistent features of the latter two habitats are a relatively

high plant species richness, a moderate to high low shrub cover; and a moist groundcover of plants, litter and fungi. Consistent features of gully habitat are an extensive cover by low grasses and sedges, with little shrub cover and large areas of ash-covered ground. Some evidence exists of marked population fluctuations by this species. It is nocturnal and appears to live in burrows (OEH 2013b).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of an important population of a species

The species was not recorded within the study area however is known to occur more broadly in the study region. It is unlikely that the study area supports part of an important population of Pilliga Mouse given that lack of suitable breeding habitat available.

The proposed activity will lead to the loss of approximately 2.44 ha of potential dispersing habitat for this species. This loss is considered relatively minor in the context of similar habitats within the study region, constituting less than 0.01% of available dispersing habitat for this species.

As the proposed activity represents a small proportion of the available habitat in the study region, it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of Pilliga Mouse.

Reduce the area of occupancy of an important population

The area of occupancy for Pilliga Mouse would be reduced if significant amounts of dispersing, foraging and breeding habitat were lost in the study region, or if habitats were degraded to the point that the species avoided or could not cross degraded areas and could not move through the study region to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study region, hence the proposed activity is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing important population into two or more populations

The home range sizes of the Pilliga Mouse are not well documented, although Tokushima and Jarman (2008) measured average movement distances of 40 m (range 0–181 m) for recaptured individuals. They did not discount that larger movement patterns could occur. Indeed, Paull (2002) noted that the species can experience marked population fluctuations in response to environmental changes caused by fire or rain. There are also seasonal fluctuations in Pilliga Mouse numbers, with the cooler autumn and winter months showing a time of population congregation for this species and the warmer spring and summer months a time for dispersal, indicating that the species has the ability to move some distances.

Patches will only be separated from other adjacent patches by road and flow line corridors, which will be approximately 10 m on average during construction, and up to 5 m following construction. The extent to which habitat fragmentation may impact on Pilliga Mouse habitat is not fully understood, however it is recognised that clearing associated with the proposed activity could represent a real or perceived barrier to movement.

A fragmentation analysis was undertaken as part of the assessment for the NSW Coal seam Gas exploration appraisal program (ELA 2013b). Based on the results of this analysis, twelve out of twenty

five movement pathways between modelled breeding and foraging habitat will be potentially impacted by the Program, however no potential movement pathways are proposed to be impacted by the proposed activity. All of the movement pathways are currently impacted by forestry roads. The species is known to undergo seasonal congregations and dispersals (NPA 2002) suggesting that the species has the ability to move significant distances and is currently doing so within an environment currently bisected by much higher number of existing roads, trails and drainage lines than proposed as part of this action. In this way, the proposed activity is not expected to introduce new fragmentation effects; however, they may contribute to existing impacts in some areas of habitat in the short term until natural regeneration occurs along the flow lines following installation.

Given that the Pilliga Mouse persists in habitat that is already fragmented by roads and tracks due to a long history of forestry activities and that they are known to be able to disperse over some distances, the proposed activity is considered unlikely to fragment an important population of the Pilliga Mouse.

Adversely affect habitat critical to the survival of a species

Habitat that is critical to the survival of Pilliga Mouse includes foraging and breeding habitat.

The proposed activity would retain the majority of foraging and breeding habitat in the study region for Pilliga Mouse, with only a small proportion (0.01%) of dispersing habitat impacted in the study region. Thus, the habitat lost or degraded is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of an important population

When assessing the potential for impacts to the breeding cycle of the Pilliga Mouse, it is necessary to consider impacts to areas of breeding habitat and the size of the species' home range. Broombush was previously defined as the preferred breeding habitat for the Pilliga Mouse (Paull 2009). Recent surveys undertaken in the study region (e.g. NICE and CUCCLG 2012) indicate that breeding habitat for the Pilliga Mouse potentially occurs in a broader range of vegetation associations than previously thought. Vegetation associations within the Pilliga Forest where Pilliga Mouse has previously been recorded are generally characterised by a high diversity, moderate density, low (<1 m) sclerophyllous shrubby layer. These characteristics are widespread within the study region and more broadly across the eastern, southern and central Pilliga Forest. As the proposed activity is not likely to impact on breeding habitat, the breeding cycle of the Pilliga Mouse is unlikely to be disrupted.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of habitat for this species, which equates to 0.01% of the potential dispersing habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. No breeding habitat for the Pilliga Mouse will be impacted and the majority of vegetation representing potential habitat for the species would be retained in the study region.

Therefore, it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive species that are harmful to the Pilliga Mouse such as house mice, cats and foxes are already established in the study region. The proposed activity is unlikely to exacerbate the impacts of invasive species or lead to increased competition for Pilliga Mouse for resources.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed activity would be unlikely to introduce a disease that may cause this species to decline.

Interfere substantially with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on this species for the following reasons:

- No breeding habitat for the Pilliga Mouse will be impacted and the majority of vegetation representing potential foraging habitat for the species would be retained in the study region.
- The proposed activity will lead to the loss of a very small proportion (less than 0.1%) of available dispersing habitat within the study region.
- The regional extent of suitable foraging habitat types is sufficient that the proposed activity will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

BIRDS

***Anthochaera phrygia* (Regent Honeyeater) – Endangered**

The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia, particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Birds are also found in drier coastal woodlands and forests in some years. There are three known key breeding regions: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands, although other potential breeding sites, close to the study area, include the Warrumbungles National Park and Pilliga Nature Reserve (NPWS 1999a). The species is known to make large scale nomadic movements across the landscape, which is thought to coincide with flowering times of different eucalypt species on which they feed (SEWPAC 2013).

There are no existing records for the species within the study area and the Regent Honeyeater was not identified during surveys. The species has been recorded nearby with two records in the Pilliga Nature Reserve, and one in Pilliga East State Forest. Breeding behaviour has been recorded in the Pilliga Nature Reserve; however the important Bundarra-Barraba breeding area is located 150 km to the east. It is considered likely that the species would utilise habitats present in the study area for foraging on occasion.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

The proposed activity could lead to a long-term decrease in the size of a population of Regent Honeyeaters if it significantly reduced or degraded foraging, roosting and breeding habitat available to the species, or contributed to the direct mortality of the species.

The proposed activity will lead to the loss of approximately 36 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area and much less in Namoi CMA region. The loss of potential foraging/roosting habitat will occur in small areas across the landscape for the well leases and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As such, it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of the Regent Honeyeater.

Reduce the area of occupancy of the species

The area of occupancy for Regent Honeyeaters could be reduced if significant amounts of foraging and roosting habitat were lost in the study area, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the study region, hence the proposed activity is considered unlikely to reduce the area of occupancy of the species.

Fragment an existing population into two or more populations

The proposed activity could potentially fragment foraging/roosting habitat. Regent Honeyeaters are nomadic and can make large regional movements across their range. Regent Honeyeaters would be able to traverse the length and width of the study area to access potential foraging resources despite the potential fragmentation caused by the proposed activity. Habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing an existing population to move across the wider landscape. Thus, it is unlikely that the proposed activity would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat critical to the survival of the species includes breeding habitat, and foraging/roosting habitat. Breeding habitat is critical to the survival of the species as Regent Honeyeaters only use a small number of specific areas to breed. Any impacts to breeding habitat could threaten the survival of the species. Unlike breeding habitat, Regent Honeyeaters would likely be able to withstand minor impacts to foraging/roosting habitat, i.e. not all habitat representing foraging/roosting habitat is critical to the survival of the species. The levels tolerated would depend on the amount and quality of foraging/roosting habitat impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the study area and study region.

There are three known key breeding regions remaining for the species: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. The species has also been recorded displaying breeding behaviour in Pilliga Nature Reserve and Warrumbungles National Park (NPWS 1999a), located to the south of the study area. The study area is not a known key breeding area for the species, and thus the proposed activity would not directly impact on breeding habitat.

The foraging/roosting habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the study region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The proposed activity could impact on or disrupt the breeding cycle of the Regent Honeyeater if it impacted on breeding habitat directly, or reduced/degraded foraging resources used during the breeding season. The study area is not a known key breeding area for the species, and thus the proposed activity would not directly impact on breeding habitat.

The vegetation type impacted by the proposed activity is not considered to contain profusely flowering winter-flowering species and as such the study area is considered to only represent transient foraging/roosting habitat which is unlikely to be considered a significant foraging resource for the Regent Honeyeater during breeding.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study area region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing foraging/roosting habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

It is unlikely that the proposed activity would result in the introduction of invasive species that would impact on Regent Honeyeater in the study area. The species suffers from competition from larger aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds. However, the proposed activity is unlikely to lead to an increase in the incidence of these species in the study area.

Introduce disease that may cause the species to decline, or

Disease is not listed as a threat to this species. The proposed activity would be unlikely to introduce a disease that may cause this species to decline.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the Regent Honeyeater for the following reasons:

- The proposed activity will disturb a very small proportion (<0.1%) of available foraging/roosting habitat within the study region- the species is highly mobile and thus able to utilise areas across the landscape.
- The proposed activity will not disrupt the breeding cycle of the species as important breeding habitat will not be impacted.
- The regional extent of suitable foraging habitat types is sufficient that the proposed activity will not result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline.

***Lathamus discolor* (Swift Parrot) – Endangered**

The Swift Parrot is a wide-ranging, highly mobile species which is endemic to south-eastern Australia (SEWPAC 2013). It is known to use habitat within the Namoi CMA region (OEH 2013b). Swift Parrots breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW this species mostly occurs on the coast and south west slopes.

On the mainland birds occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations (OEH 2013b). Favoured feed trees include winter flowering species such as *Eucalyptus robusta* (Swamp Mahogany), *Corymbia maculata* (Spotted Gum), *C. gummifera* (Red Bloodwood), *E. sideroxylon* (Mugga Ironbark), and *E. albens* (White Box). Commonly used lerp infested trees include *E. microcarpa* (Inland Grey Box), *E. moluccana* (Grey Box) and *E. pilularis* (Blackbutt). Following winter they return to Tasmania where they breed from September to January.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

Lead to a long-term decrease in the size of a population

There are no existing records for the species within the study area. The closest records according to the Atlas of NSW Wildlife are approximately 24 km to the east in Boggabri and 55 km to the south east near Gunnedah. The vegetation type impacted by the proposed activity is not considered to contain profusely flowering winter-flowering species and as such the study area is considered to only represent transient foraging habitat.

The proposed activity will lead to the loss of approximately 2.44 ha of potential foraging habitat for this species, which equates to less than 0.1% of the available habitat within the study region. The loss of habitat will occur in small areas across the landscape for the well pads and linear corridors for the flow lines which generally follow existing tracks and infrastructure. Up to 40% of clearing associated with the well pads and 60% of clearing associated with the flowlines and water and gas gathering systems will be rehabilitated.

As such, it is considered unlikely that the proposed activity would lead to a long-term decrease in the size of a population of the Swift Parrot

Reduce the area of occupancy of the species

The area of occupancy for Swift Parrots could be reduced if significant amounts of foraging/roosting habitat were lost in the study area, or if habitats were degraded to the point that the species avoided degraded areas and could not move through the study area to undisturbed areas.

The loss of habitat through clearing is small relative to the amount of habitat retained in the study area and the study region, hence the proposed activity is considered unlikely to reduce the area of occupancy of the species

Fragment an existing population into two or more populations

The proposed activity could potentially fragment foraging/roosting habitat. Swift Parrots are migratory and can make large movements across their range. Swift Parrots would be able to traverse the length and width of the study area to access potential foraging resources despite the potential fragmentation caused by the proposed activity. Habitat connectivity would be maintained at a regional level, with contiguous vegetation and habitat connectivity retained around the study area, allowing an existing population to move across the wider landscape. Thus, it is unlikely that the proposed activity would fragment an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species

Habitat that is necessary to the survival of the species includes breeding habitat, and foraging and roosting habitat. Breeding habitat is critical to the survival of the species as Swift Parrots only breed in Tasmania. Any impacts to breeding habitat could threaten the survival of the species. Unlike breeding habitat, Swift Parrots would likely be able to withstand some level of impact to foraging/roosting habitat, i.e. not all habitat representing foraging/roosting habitat is critical to the survival of the species.

The levels tolerated would depend on the amount and quality of foraging/roosting habitat impacted, the location of the habitat in the landscape, and the amount of habitat remaining in the study area and study region.

The foraging/roosting habitat proposed to be removed by the action constitutes less than 0.1% of the available habitat within the study region and is unlikely to be critical to the survival of the species.

Disrupt the breeding cycle of a population

The study area is not used as a breeding area for the species, and thus the proposed activity would not directly impact on breeding habitat. The species would not use the study area as foraging habitat during the breeding season as it remains in Tasmania during its breeding season (spring and summer months), only migrating to mainland Australia during its non-breeding season (autumn and winter months). Thus, the proposed activity is unlikely to disrupt the breeding cycle of the species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed activity will lead to the loss of approximately 2.44 ha of potential foraging/roosting habitat for this species, which equates to less than 0.1% of the available habitat within the study region.

The amount of habitat directly removed is unlikely to be on the scale that would result in a decline of the species. The majority of vegetation representing foraging/roosting habitat for the species would be retained in the study area.

Therefore it is unlikely that the proposed activity will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

It is unlikely that the proposed activity would result in the introduction of invasive species that would impact on Swift Parrots in the study area.

Introduce disease that may cause the species to decline, or

A disease that could potentially infect Swift Parrots is beak and feather disease. However, the proposed activity would be unlikely to introduce a disease that may cause this species to decline, given the disease is transmitted by other birds of the same species.

Interfere with the recovery of the species.

In consideration of the above factors, the proposed activity is unlikely to substantially interfere with the recovery of the species.

Conclusion

The proposed activity is not considered likely to have a significant impact on the species for the following reasons:

- The species is not known to occur in the study area.
- The proposed activity will disturb a very small proportion (<0.1%) of available foraging/roosting habitat within the study region - the species is highly mobile and thus able to utilise areas across the landscape.
- The vegetation within the study area is not considered to represent core foraging habitat.
- The species' migratory route will not be affected by the proposed activity.
- The proposed activity will not disrupt the breeding cycle of the species as it breeds exclusively in Tasmania.

MIGRATORY SPECIES

***Anthochaera phrygia* (Regent Honeyeater) – Migratory**

Regent Honeyeater is listed as an endangered and migratory species under the EPBC Act. A description of the species and distribution in NSW is provided in under the endangered species assessment above.

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed activity would remove potential foraging and roosting habitat within the study area. No breeding habitat representing important habitat would be impacted.

The majority of vegetation representing foraging and roosting habitat for the species would be retained in the study region. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Regent Honeyeaters throughout the study region. This species could also access vegetation outside of the study area as it is capable of making large regional movements in the order of hundreds of kilometres.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

It is unlikely that the proposed activity would result in the introduction of invasive species that would impact on Regent Honeyeater in the study area. The species suffers from competition from larger aggressive honeyeaters, particularly Noisy Miners, Noisy Friarbirds and Red Wattlebirds. However, the proposed activity is unlikely to lead to an increase in the incidence of these species in the study area.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The species is not known to breed in the study area, although it has been recorded displaying breeding behaviour to the south of the study area in Pilliga Nature Reserve. The study area could be potentially be used as a foraging resource during the species' breeding period and thus the proposed activity could potentially disrupt the lifecycle of Regent Honeyeater. However, only a small proportion of the foraging habitat in the study region will be removed. Regent Honeyeaters would be able to continue using these resources within and outside of the study area. Thus, the proposed activity is unlikely to seriously disrupt the lifecycle of a Regent Honeyeater population.

***Haliaeetus leucogaster* (White-bellied Sea Eagle) - Migratory**

The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around near-coastal wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea).

While the species is mostly coastal in its distribution, White-bellied Sea-Eagles may travel inland along major rivers. Birds also occasionally visit inland lakes, rivers or reservoirs that occur outside of the usual distribution of the species (DoE 2013bb).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The study area could provide occasional foraging habitat for the species following heavy rainfall periods (within the riparian areas that are within close proximity of the study area), but would be unlikely to provide permanent foraging or breeding habitat for the species as the breeding territories of White-bellied Sea Eagles are typically located close to bodies of water which are absent from the study area.

The proposed activity avoids the main riparian area in proximity to the study area and would not substantially modify potential foraging habitat for White-bellied Sea Eagles.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed activity would not result in the establishment of an invasive species that is harmful to White-bellied Sea Eagles.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The study area does not provide breeding habitat for the species. The species could potentially be present in the study area opportunistically following rain periods, however there is more optimal habitat located to the north and east of the study area along the Namoi River. The proposed activity will not impact on any riparian areas or riparian vegetation. The proposed activity is therefore unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of White-bellied Sea Eagles.

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

The White-throated Needletail is listed as a migratory species under the EPBC Act, and is included in the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement, and the Republic of Korea-Australia Migratory Bird Agreement (DoE 2013b).

In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. Because they are aerial, it has been stated that conventional habitat descriptions are inapplicable, but there are, nevertheless, certain preferences exhibited by the species. Although they occur over most types of habitat, they are probably recorded most often above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy, but they are less commonly recorded flying above woodland. They also commonly occur over heathland, but less often over treeless areas, such as grassland or swamps. When flying above farmland, they are more often recorded above partly cleared pasture, plantations or remnant vegetation at the edge of paddocks. In coastal areas, they are sometimes seen flying over sandy beaches or mudflats, and often around coastal cliffs and other areas with prominent updraughts, such as ridges and sand-dunes (DoE 2013b).

During the non-breeding season in Australia, the White-throated Needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, wasps, flies, termites, moths, locusts and grasshoppers. The White-throated Needletail almost always forage aerially, at heights up to 'cloud level' though usually much lower (DoE 2013b).

The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows. It has been suggested that they also sometimes roost aerially (DoE 2013b).

The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests in Asia, from central and south-eastern Siberia and Mongolia, east to the Maritime Territories of Russia, Sakhalin and the Kuril Islands and south to northern Japan and north-eastern China (DoE 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed activity would remove vegetation above which White-throated Needletail could use to forage. The amount of vegetation that would be directly impacted comprises only a small portion of vegetation in the study region with the majority of vegetation in the study region to be retained. The proposed activity is considered unlikely to constitute important habitat for the White-throated Needletail and is unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed activity would not result in the establishment of an invasive species that is harmful to White-throated Needletails.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

White-throated Needletails do not breed in Australia. The removal of vegetation in the study area would be unlikely to affect the species, which forages aerially over a range of habitats. Therefore the proposed activity is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of White-throated Needletail.

***Apus pacificus* (Fork-tailed Swift) - Migratory**

The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher. In Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. They often occur over cliffs and beaches and also over islands and sometimes well out to sea. They also occur over settled areas, including towns, urban areas and cities. They mostly occur over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. They are also found at treeless grassland and sandplains covered with spinifex, open farmland and inland and coastal sand-dunes (DoE 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed activity would remove vegetation above which Fork-tailed Swifts could potentially forage. However, the majority of vegetation in the study region would be retained. The amount of vegetation that would be directly impacted comprises only a small portion of vegetation throughout the study area and an even smaller portion of vegetation within the Namoi CMA region. The proposed activity is considered unlikely to constitute important habitat for the Fork-tailed Swift and is unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed activity would not result in the establishment of an invasive species that is harmful to Fork-tailed Swifts.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Fork-tailed Swifts do not breed in Australia. The removal of vegetation in the study area would be unlikely to affect the species, which forages aerially over a range of habitats including cleared areas. Therefore the proposed activity is unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of Fork-tailed Swift.

***Merops omatus* (Rainbow Bee-eater) – Migratory**

The Rainbow Bee-eater is listed as a migratory species under the EPBC Act (DoE 2013b).

In Australia, the Rainbow Bee-eater mainly occurs in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (DoE 2013b).

The Rainbow Bee-eater mainly feeds on insects, and will occasionally take other animal items including earthworms, spiders and tadpoles. The insect component of the diet mainly consists of bees and wasps, but also includes various other insects such as beetles, moths, butterflies, damselflies, dragonflies, flies, ants and bugs. The Rainbow Bee-eater captures most of its prey in flight, although it also takes food items from the ground and from foliage, and has occasionally been seen to snatch items from below the surface of rivers and dams (DoE 2013b).

The Rainbow Bee-eater breeds in socially monogamous pairs that are sometimes assisted by a varying number of auxiliary birds or 'helpers' that are usually male. The nests are typically concentrated together in loose colonies, although in some instances pairs will nest solitarily. The nest is located in an enlarged chamber at the end of long burrow or tunnel that is excavated, by both sexes, in flat or sloping ground, in the banks of rivers, creeks or dams, in roadside cuttings, in the walls of gravel pits or quarries, in mounds of gravel, or in cliff-faces. Nesting areas are often re-used, and banding studies indicate that at least some migrant birds return to the same nesting area each year. However, pairs usually excavate a new nesting burrow for each breeding season (DoE 2013b).

The movement patterns of the Rainbow Bee-eater are complex, and are not fully understood. Populations that breed in southern Australia are migratory. However, populations that breed in northern Australia are considered to be resident, and in many northern localities the Rainbow Bee-eater is present throughout the year. Regarding populations that breed in southern Australia, these move north to northern Australia, Papua New Guinea and eastern Indonesia after breeding and remain there for the duration of the Australian winter. Populations of the Rainbow Bee-eater gather together and assemble into flocks before migration. The migrating flocks, which can consist of tens to hundreds or thousands of birds, often fly high above the ground when on passage (DoE 2013b).

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will meet any of the following criteria:

Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species

The proposed activity would remove foraging, roosting and potential breeding habitat for the Rainbow Bee-eater. However, the majority of vegetation in the study region representing foraging, roosting and potential breeding habitat for Rainbow Bee-eater would be retained. The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Rainbow Bee-eater throughout the study area and an even smaller portion of potential habitat within the Namoi CMA region.

The proposed activity is considered unlikely to substantially modify, destroy or isolate areas of important habitat.

Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or

The proposed activity would not result in the establishment of an invasive species that is harmful to Rainbow Bee-eater.

Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The proposed activity would remove foraging, roosting and potential breeding habitat for the Rainbow Bee-eater. However, the majority of vegetation representing foraging, roosting and breeding habitat in the study region that could be used by Rainbow Bee-eater would be retained.

The amount of habitat that would be directly impacted comprises only a small portion of potential habitat for Rainbow Bee-eater throughout the study region and an even smaller portion of potential habitat within the Namoi CMA region. The species could also access vegetation outside of the study area. Thus, the proposed activity is considered unlikely to seriously disrupt the lifecycle of a Rainbow Bee-eater population.

Conclusion

The proposed activity is considered unlikely to have a significant impact on any of these migratory species as the regional extent of suitable habitat types is sufficient that the proposed activity is unlikely to result in the modification, removal or availability of habitat to the extent that it is likely to significantly impact on the species causing decline. Furthermore the proposed activity is unlikely to result in an invasive species becoming established, nor seriously disrupt the lifecycle of any migratory species.

Appendix H: Survey effort compared to recommended survey guidelines (DEC 2004)

Survey guidelines	ELA survey effort	RPS survey effort
Small mammals: <i>Pseudomys pilligaensis</i> (Pilliga Mouse), <i>Cercartetus nanus</i> (Eastern Pygmy-possum) and <i>Petaurus norfolcensis</i> (Squirrel Glider).		
Guidelines for sampling small mammals (DEC 2004): • Elliott trapping: Elliott A terrestrial trapping 100 trap nights per stratification unit (i.e. 25 Elliott traps over four nights). Trap lines spaced between 20 m and 50 m apart. Arboreal Elliott trapping 24 trap nights per stratification unit (i.e. 6 Elliott traps over four nights). Trapping intensity should be increased with decreased abundance. Traps should be checked every morning and should contain materials that allow the animal to keep warm. • Hair tubes: transects of 10 tubes in each stratification unit. Minimum 4 days and nights. Hair samples to be analysed by specialist. • Pitfall trapping: Minimum 24 trap nights over minimum three to four nights. Trap consists of 28 cm diameter and 40 cm deep (20 L bucket). Place rock/wood and dirt/leaves in pit to provide refuge. Objects that float should be used as refuge in case of heavy rains. Drift fencing 5 m either side of hole of 30 cm height with the lower 5 cm buried in soil, supported by steel pegs and of a material which resists small mammals climbing.	This survey: Two transects of six arboreal Elliott A traps (Eastern Pygmy Possum) and two transects of six arboreal Elliott B traps (Squirrel Glider) over three to four nights. Total effort 42 Elliott A arboreal trap nights and 48 Elliott B arboreal trap nights. Remote cameras: 9 cameras positioned facing arboreal Elliott traps for four nights. Total effort 36 trap nights. ELA 2013: 10 small (30 mm diameter) terrestrial hairtubes over 19 nights, baited with oats, peanut butter and honey. Total effort 140 trap nights. Two further small mammal trapping sites within 2 km of study area. However, both sites are in a different habitat type to the study area. Opportunistic surveys for small mammals were also undertaken.	262 Elliott A terrestrial trap nights; 34 Elliott E terrestrial trap nights; 57 pitfall trap nights. Dispersal habitat for Pilliga Mouse.
Medium mammals: <i>Dasyurus maculatus</i> (Spotted-tailed Quoll), <i>Aepyprymnus rufescens</i> (Rufous Bettong) and <i>Macropus dorsalis</i> (Black-striped Wallaby).		

Survey guidelines	ELA survey effort	RPS survey effort
Guidelines for sampling medium mammals (DEC 2004): • Hair tubes: transects of 10 tubes in each stratification unit. Minimum 4 days and nights. Hair samples to be analysed by specialist. • Elliott trapping: Elliott B terrestrial trapping 100 trap nights per stratification unit (i.e. 25 Elliott traps over four nights). Trap lines spaced between 20 m and 50 m apart. Trapping intensity should be increased with decreased abundance. Traps should be checked every morning and should contain materials that allow the animal to keep warm. Large Elliott traps are not appropriate for Spotted-tailed Quolls. Cage traps require 24 trap nights over 3-4 consecutive nights. • Tracks, scats and scratches searches: at least a 30 minute search in appropriate habitat, combined with other searching techniques. • Spotlighting: 2 x 1 hour and 1 km up to 200 ha of stratification unit, walking approximately 1 km per hour on 2 separate nights.	This survey: Fifty terrestrial Elliott B traps over four nights (25 traps at two sites), baited with oats, peanut butter and honey. At each site, traps were set in two line transects spaced approximately 50 m apart, with each trap approximately 10-15 m apart. Total effort: 200 trap nights Spotlighting: two people over five separate nights. On each night, spotlighting was conducted on foot for approximately 20 minutes. ELA 2013: A transect of 40 large (90 mm diameter) hair tubes baited with fish to attract Spotted-tailed Quoll over 25 nights. Transect runs through habitat similar to study area. Total effort 600 trap nights. Opportunistic surveys for medium mammals were also undertaken.	150 hair funnel trap nights. 17 terrestrial Elliott B trap nights Spotlight searches for nocturnal fauna including dedicated listening periods for fauna vocalisations, were carried out over two nights for 1.5 hours. 3 remote cameras with 44 remote cameras survey nights. Opportunistic surveys for Spotted-tailed Quoll were also undertaken.
Large forest birds: <i>Ninox connivens</i> (Barking Owl) and <i>Tyto novaehollandiae</i> (Masked Owl)		
Guidelines for sampling owls (DEC 2004): • Call playback: sites should be separated by 800 metres – 1km, and each site should have the playback session repeated at least five visits per site (Barking Owl) or eight visits per site (Masked Owl) on different nights. • Day habitat search: Search habitat for pellets, and likely hollows • Stag-watching: observing potential roost hollows for 30mins prior to sunset and 60mins following sunset.	ELA 2013: Call playback: within a 1 km radius of the study area for Dewhurst 30 & 31 over five nights. Call playback started with five minutes of listening and five to ten minutes of spotlighting. This was followed by broadcasting a call for 5 minutes using a loudspeaker followed by another five minutes of listening. Recorded calls of Barking Owl and Masked Owl were broadcast. This was then followed by a further 5 – 10 mins of listening for a response and then 5 – 10 minutes of spotlighting. Hollow-bearing trees examined for hollow	No targeted large forest owl surveys were undertaken.

Survey guidelines	ELA survey effort	RPS survey effort
	size. Opportunistic surveys for large forest birds were also undertaken.	
<i>Burhinus grallarius</i> (Bush Stone-curlew)		
Guidelines for sampling Bush Stone-curlew (DEC 2004): • Call playback: sites should be 2-4km apart and conducted during the breeding season. • Day habitat search: flushing of Bush Stone-curlews by walking through potential habitat. • Spotlighting: by foot or from a vehicle driven in first gear.	ELA 2013: Call playback: within a 1 km radius of the study area for Dewhurst 31 & 31 over five nights. Recorded call of Bush Stone-curlew was broadcast over a loudspeaker for approximately 5 mins; this was then followed by a further 5 – 10 mins of listening for a response. Opportunistic surveys for Bush Stone-curlew were also undertaken.	No targeted surveys for Bush Stone-curlew were undertaken.
Diurnal Birds including migratory species: <i>Anthochaera phrygia</i> (Regent Honeyeater), <i>Ardeotis australis</i> (Australian Bustard), <i>Calyptorhynchus lathami</i> (Glossy Black-Cockatoo), <i>Chthonicola sagittata</i> (Speckled Warbler), <i>Circus assimilis</i> (Spotted Harrier), <i>Daphoenositta chrysoptera</i> (Varied Sittella), <i>Falco hypoleucos</i> (Grey Falcon), <i>Glossopsitta pusilla</i> (Little Lorikeet), <i>Grantiella picta</i> (Painted Honeyeater), <i>Hamirostra melanosternon</i> (Black-breasted Buzzard), <i>Hieraaetus morphnoides</i> (Little Eagle), <i>Lathamus discolor</i> (Swift Parrot), <i>Lophoictinia isura</i> (Square-tailed Kite), <i>Melanodryas cucullata</i> (Hooded Robin), <i>Melithreptus gularis gularis</i> (Black-chinned Honeyeater), <i>Neophema pulchella</i> (Turquoise Parrot), <i>Pachycephala inornata</i> (Gilbert's Whistler), <i>Petroica boodang</i> (Scarlet Robin), <i>Polytelis swainsonii</i> (Superb Parrot), <i>Pomatostomus temporalis temporalis</i> (Grey-crowned Babbler) and <i>Stagonopleura guttata</i> (Diamond Firetail).		
Guidelines for sampling diurnal birds (DEC 2004): • area search methods, where observers walk around an area of pre-determined size for a pre-determined length of time. A 1 ha (200m x 500m) 20-minute search is the most common method. • point count methods, where observations are made from a series of pre-determined points for pre-determined lengths of time. By recording the bird's distance from the point, density estimates can also be made. Guidelines for sampling migratory birds (DEC 2004): • Specific guidelines for surveying diurnal birds have not been listed in the DEC guidelines but a few methods for consideration are discussed. The suggested minimum effort is an area search using a species-time curve approach. Using this approach, a survey session will cease when no additional species are identified within a set time period. The area search must be repeated in each stratification	Three sites were surveyed during an AM (first four hours of light) and PM (last four hours of light) survey period by two ELA ecologists. Each survey consisted of an initial 20 minute census recording all bird calls and observations. If new species are added to the list in the last 5 minute period of the survey, an extra five minutes of survey is undertaken. This method was repeated to make a species-time curve until no new species were identified. Opportunistic surveys for diurnal birds were also undertaken.	2 sites with 1 AM and 1 PM survey at each site. Total effort: 2 hours. Opportunistic surveys were also undertaken at all sites.

Survey guidelines	ELA survey effort	RPS survey effort
unit. Can either undertake an area search or point count method: • Area search: observers walk around a predetermined size for a pre-determined length of time. A 1 ha 20 minute search is the most common method. • Point count: observations are made from a series of pre-determined points for pre-determined lengths of time. By recording the bird's distance from the point, density estimates can also be made. A suggested method is 10 minute observations recorded at 0-5m, 5m-10m, 10m- 20m, 20m-30m, 30m-50m and >50m.		
Reptiles: <i>Hoplocephalus bitorquatus</i> (Pale-headed Snake)		
Guidelines for sampling nocturnal reptiles (DEC 2004): • Stream search: 2 person hours per 200 m of stream during the evening (November to March). • Nocturnal spotlighting of tree trunks and other habitat: 30 minute search on two separate nights, targeting specific habitat (November to March). • Active searching for hibernating individuals during cooler months (can look under bark, however other species from the <i>Hoplocephalus</i> genus exhibit prolonged overwinter sequestration and this is potential also for the Pale-headed Snake (Webb & Shine 1997a, b; Fitzgerald et al. 2002; Fitzgerald et al. 2010). • Other sampling techniques for reptiles are not appropriate for Pale-headed Snake.	No additional Pale-headed Snake surveys were undertaken.	38 snake funnel trap nights. Active searches of the area to identify potential habitat for Pale-headed Snake. Survey techniques included: • diurnal searches for sheltering or basking reptiles as well as indirect evidence e.g. tracks, scratches etc. • rock, log and debris rolling • spotlight surveys for nocturnally active species
Bats: <i>Nyctophilus corbeni</i> (South-eastern Long-eared Bat), <i>Chalinolobus dwyeri</i> (Large-eared Pied Bat), <i>Chalinolobus picatus</i> (Little Pied Bat), <i>Miniopterus schreibersii oceanensis</i> (Eastern Bentwing-bat), <i>Saccolaimus flaviventris</i> (Yellow-bellied Sheath-tail-bat), <i>Vespadelus troughtoni</i> (Eastern Cave Bat) and <i>Pteropus poliocephalus</i> (Grey-headed Flying-fox).		
Guidelines for sampling bats (DEC 2004): Harp trapping: four trap nights over two consecutive nights Anabat detector: Two sound activated recording devices utilised for the entire night (a minimum of four hours), starting at dusk for two nights. A combination of trapping and echolocation call recording as the most efficient approach for bat inventory surveys.	Harp traps: four traps over two consecutive nights. Traps were assembled just prior to dusk and checked each morning before 0930 hrs. Any bats caught were identified to the lowest taxonomic level possible. Total effort: eight trap nights. Anabat detectors: Six units over two consecutive nights placed in flyways that were likely to be used by bats. On each night of survey the Anabats were turned on	An Anabat detection unit was placed for one to two nights in suitable flyways located adjacent to the survey sites. Positioning was focused on natural flyways below the canopy, which typically provide an abundance of microbat foraging resources. No targeted mistnet or harp trapping was undertaken.

Survey guidelines	ELA survey effort	RPS survey effort
	time-delayed recording prior to dusk and then turned off the following morning by 0930 hrs.	

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